Occurrence Investigation and Molecular Biological Identification of Vegetable Thrips in Central Hunan

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Abstract [**Objectives**] This study was conducted to better understand the occurrence status of thrips in Central Hunan, clarify thrips species, and provide a basis for scientific control. [**Methods**] The occurrence of thrips in the Central Hunan Region were investigated and analyzed. Through field collection, molecular biological identification and sequencing, thrips populations in the region were identified. [**Results**] Six species of thrips infesting vegetable crops were identified in the Central Hunan Region, with *Megalurothrips usitatus*, *Thrips palmi*, and *Frankliniella intonsa* being the dominant species. These pests were particularly severe on leguminous and cucurbit crops. [**Conclusions**] Combined with integrated control strategies, this study provides theoretical and technical support for the scientific management of thrips in the Central Hunan Region, ensuring the sustainable development of the local vegetable industry.

Key words Central Hunan; Thrips; Species; Identification

DOI: 10.19759/j.cnki.2164-4993.2025.02.008

Thrips (Thysanoptera) are small pests characterized by rapid reproduction and broad host ranges, primarily harming cereal crops, vegetables, fruit trees, and other agricultural plants. Through direct feeding on plant sap and indirect transmission of pathogenic viruses, they cause significant economic losses in crop production[1-5]. In recent years, with the global climate change and the adjustment of agricultural planting structure, the occurrence range of thrips has been continuously expanding, and the degree of harm has been increasing. They have become one of the important pests in agricultural production. Currently, over 7 400 species of thrips have been documented globally, with more than 580 species recorded in China[6]. Notably, China's Ministry of Agriculture and Rural Affairs classified thrips as a Class I crop pest in 2023[7].

As a crucial vegetable-producing province in China, Hunan recorded a vegetable and edible mushroom cultivation area of 1.355 million hm^2 with an output of 41.1008 million t and agricultural production value exceeding 90 billion yuan in 2022[8]. However, with the continuous expansion of vegetable planting area, the occurrence of thrips in central Hunan is becoming more and more serious, especially on a variety of melons, legumes and solanaceae crops, which brings great challenges to local vegetable production. At present, the control of thrips in the field mainly depends on chemical control methods. However, because thrips are small in size, strong in concealment, and often hide among plant flowers, it is difficult for pesticides to contact thrips effectively, and the control effect is not good[9-11]. Moreover, farmers lack scientific basis in pesticide screening and dosage use, and there is a phenomenon of blind drug use, which not only increases the control cost, but also easily induces resistance in thrips.

Thrips are also major vectors for various plant viral diseases, transmitting over 30 plant viruses including *Orthotospovirus*, *Sobemovirus*, *Carmovirus*, *Ilarvirus*, *Machlomovirus*, and *Nepovirus*. These viruses infect more than 1 090 plant species, causing significant economic losses[12-13].

To better understand the current status of thrips occurrence in the central Hunan region, clarify thrips species, and provide a basis for scientific control, in this study, thrips populations on vegetable crops across multiple areas in central Hunan from 2022 to 2024 were investigated. Through field sampling, molecular biological identification and sequencing methods, the species composition, dominant populations and host preferences of thrips in the central Hunan region were determined. Current issues in control measures were analyzed, and integrated management strategies were proposed, aiming to provide theoretical support and technical guidance for the scientific management of thrips in central Hunan, ensuring the sustainable development of local vegetable industry.

Materials and Methods

Thrips collection

Samples were collected from vegetable crops in regions including Changsha, Loudi, Shaoyang, and Huaihua in Hunan Province. Host plant tissues (leaves or flower buds) infested with thrips were collected and put into transparent sealed bags, and then transported to the laboratory. Thrips were separated using a fine brush, and preserved in 5 ml cryovials and 15 ml alcohol bottles containing 75% ethanol, which were then labeled with collection dates, locations, and host plant information. All samples were stored in refrigerators.

Molecular biological identification and sequencing

From the thrips population collected in each region, 20 individuals were randomly selected for molecular biological identification. A single thrips was placed in a 1.5 ml centrifuge tube, and DNA was extracted using the KAPA kit. The mt CO1 sequence of

Received: January 8, 2025 Accepted: March 10, 2025

Supported by Research Innovation Program for College Graduates of Hunan Province (CX20231269).

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thrips was amplified using specific primers LCO1490: 5'-GGTCAACAAATCATAAAGATATTGG-3' and HCO2198: 5'-TAAACTTCAGGGTGACCAAAAAATCA-3'[13].

The PCR reaction system (20 μl in total) contained ddH_2O 7 μl, 2×PCR Mix 10 μl, forward and reverse primers 1 μl, and thrips DNA template 1 μl. The PCR amplification program was stared with pre-denaturation at 95 ℃ for 10 min, followed by 35 cycles of 94 ℃ for 1 min, 52 ℃ for 1 min and 72 ℃ for 1 min, and finally completed by extension at 72 ℃ for 10 min, and the obtained PCR products was stored at 4 ℃. Next, the products were detected via gel electrophoresis and sent to a company for sequencing. The sequencing results were aligned and analyzed using the NCBI nucleotide database, with species identification based on a similarity threshold of >90%. Dominant thrips populations on vegetable crops were determined according to the investigation results.

Results and Analysis

Through DNA extraction, specific primer amplification, sequencing and alignment, six thrips species were identified as dominant in the central Hunan region: *Megalurothrips usitatus*, *Thrips palmi*, *Frankliniella intonsa*, *Thrips hawaiiensis*, *Odontothrips loti*, and *Pseudodendrothrips mori*. Among 25 populations sampled across the four regions, *T. palmi* was detected in 16 populations, accounting for 64% of tested populations. *M. usitatus* was detected in 14 populations, accounting for 56% of tested populations. *F. intonsa* was detected in 11 populations, accounting for 44% of tested populations. *T. hawaiiensis* was detected in 3 populations, accounting for 12% of tested populations. *O. loti* was detected in 1 population, accounting for 4% of tested populations. *P. mori* was detected in 1 population, accounting for 4% of tested populations.

The analysis of total thrips individuals (500 specimens) revealed following proportions: *M. usitatus* 37% (185 individuals), *T. palmi* 44.6% (223 individuals), *F. intonsa* 17.2% (86 individuals), *T. hawaiiensis* 0.8% (4 individuals), *O. loti* 0.2% (1 individual), and *P. mori* 0.2% (1 individual) (Table 1).

The results indicate that *M. usitatus*, *T. palmi*, and *F. intonsa* are the most prevalent and dominant pest populations causing thrips-related damage in the central Hunan region.

Table 1 Thrips populations and distribution

No.	Collection location	Host crop	Time	Thrips species//%
1	Baotaishan, Lianyuan City, Loudi	Cucumber	Sept. 2023	*M. usitatus* (60%), *T. palmi* (25%), *F. intonsa* (15%)
2	Baotaishan, Lianyuan City, Loudi	Cowpea	Sept. 2023	*M. usitatus* (100%)
3	Baotaishan, Lianyuan City, Loudi	Eggplant	Sept. 2023	*M. usitatus* (20%), *T. palmi* (75%), *T. hawaiiensis* (5%)
4	Houwan Village, Lianyuan City, Loudi	Eggplant	Sept. 2023	*M. usitatus* (5%), *T. palmi* (75%), *F. intonsa* (20%)
5	Miaoshanwan, Lianyuan City, Loudi	Luffa	Sept. 2023	*T. palmi* (80%), *F. intonsa* (20%)
6	Miaoshanwan, Lianyuan City, Loudi	Eggplant	Sept. 2023	*T. palmi* (30%), *F. intonsa* (70%)
7	Hongshandian Town, Shuangfeng County, Loudi	Cucumber	Oct. 2023	*M. usitatus* (15%), *T. palmi* (85%)
8	Hongshandian Town, Shuangfeng County, Loudi	Cowpea	Oct. 2023	*M. usitatus* (100%)
9	Hongshandian Town, Shuangfeng County, Loudi	Eggplant	Oct. 2023	*T. palmi* (75%), *F. intonsa* (25%)
10	Shanshan Town, Louxing District, Loudi	Cucumber	Oct. 2023	*T. palmi* (55%), *F. intonsa* (40%), *P. mori* (5%)
11	Shanshan Town, Louxing District, Loudi	Luffa	Oct. 2023	*T. palmi* (95%), *O. loti* (5%)
12	Shijing Town, Louxing District, Loudi	Eggplant	Nov. 2023	*M. usitatus* (25%), *F. intonsa* (75%)
13	Shijing Town, Louxing District, Loudi	Pepper	Nov. 2023	*T. palmi* (100%)
14	Qixingjie Town, Lianyuan City, Loudi	Luffa	Nov. 2023	*T. palmi* (40%), *F. intonsa* (60%)
15	Qixingjie Town, Lianyuan City, Loudi	Pepper	Nov. 2023	*T. palmi* (90%), *T. hawaiiensis* (10%)
16	Qixingjie Town, Lianyuan City, Loudi	Cowpea	Nov. 2023	*M. usitatus* (100%)
17	Jingjinpu, Ningxiang City, Changsha	Cowpea	Apr. 2024	*M. usitatus* (100%)
18	Jingjinpu, Ningxiang City, Changsha	Pepper	Apr. 2024	*T. palmi* (95%), *T. hawaiiensis* (5%)
19	Jingjinpu, Ningxiang City, Changsha	Cucumber	Apr. 2024	*M. usitatus* (45%), *F. intonsa* (55%)
20	Jingjinpu, Ningxiang City, Changsha	Cowpea	Apr. 2024	*M. usitatus* (100%)
21	Pingshan Town, Xinshao County, Shaoyang	Cowpea	Aug. 2023	*M. usitatus* (100%)
22	Pingshan Town, Xinshao County, Shaoyang	Cucumber	Aug. 2023	*T. palmi* (70%), *F. intonsa* (30%)
23	Pingshan Town, Xinshao County, Shaoyang	Eggplant	Aug. 2023	*M. usitatus* (30%), *T. palmi* (50%), *F. intonsa* (20%)
24	Huitong County, Huaihua City	Cowpea	Jul. 2022	*M. usitatus* (100%)
25	Zhijiang Dong Autonomous County, Huaihua City	Cucumber	Jul. 2022	*M. usitatus* (25%), *T. palmi* (75%)

The analysis of thrips host plants revealed that *M. usitatus* primarily infested leguminous crops, with heavy infestations observed on cowpeas, while also found on cucurbit crops such as cucumber and luffa. *T. palmi* infested host crops including eggplant, cucumber, and luffa, and *F. intonsa* was detected on cucumber, eggplant, and luffa. These three species accounted for 98.8% of the total collected thrips. According to the literature, *T. hawaiiensis* is distributed in the south of Huaihe River, and Hunan can serve as an occurrence place, but the results of this study showed that it had low occurrence in central Hunan.

P. mori, a species mainly damaging mulberry trees, is sporadically distributed in central Hunan, where mulberry trees are sparsely distributed and may be accidentally transported via human or animal activity. *O. loti*, a major pest of alfalfa crops in northern China[14], damages *Trifolium* plants. *Trifolium repens*, widespread in many areas of Hunan, may serve as a host crop for *O. loti*.

Conclusions and Discussion

Thrips, as small pests infesting various vegetable crops, are challenging to control due to their tiny size, cryptic behavior, and tendency to hide on the undersides of leaves or within flowers, making early detection difficult. By the time their presence is noticed, the populations often reach outbreak levels, hindering effective suppression of initial population growth[15]. Following outbreaks, chemical control is the most common strategy. However, literature on pesticide monitoring indicates differences in susceptibility among thrips species. For example, the sensitivity to imidacloprid follows following order: *Thrips flavus* > *Thrips tabaci* > *F. intonsa* > *Frankliniella occidentalis*. Selecting appropriate insecticides is critical for achieving optimal control efficacy[16-18].

Different thrips species transmit distinct viral diseases with varying transmission efficiencies[19]. *T. palmi* transmits viruses including tomato spotted wilt virus (TSWV), watermelon silver mottle virus (WSMoV), melon yellow spot virus (MYSV), Capsicum chlorosis virus (CaCV), groundnut bud necrosis virus (GBNV), watermelon bud necrosis virus (WBNV), and tomato chlorotic spot virus (TCSV). Notably, WSMoV and WBNV are transmitted exclusively by *T. palmi*, which is also the most efficient vector for GBNV[20-23]. *F. intonsa* transmits TSWV, impatiens necrotic spot virus (INSV), and TCSV[20,23-25]. *M. usitatus* acts as a pollinator vector for tobacco streak virus (TSV)[19]. Studies indicate that the prevalence and severity of viral diseases correlate with the distribution of their corresponding thrips vectors[12,18]. Therefore, identifying local thrips species is critical for understanding and predicting the potential occurrence of thrips-transmitted plant viruses in the region.

Understanding the dynamics of local thrips populations and identifying dominant species enable targeted insecticide selection for thrips control. Combined with monitoring thrips population trends and resistance development, adjustments to insecticide choices, dosage, and application frequency can be made dynamically to optimize control efficacy. Predicting thrips-transmitted viral diseases and appropriately adjusting crop planting based on viral host ranges will reduce economic losses caused by these diseases.

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mg/L, respectively. A statistically significant positive relationship was found between these values ($P < 0.05$). Additionally, the biological activity (S) at 24, 48, 72, and 96 h were determined to be 1.1887, 1.059 8, 1.003 2, and 0.979 7, respectively. Furthermore, the additive index (AI) values at 24, 48, 72, and 96 h were found to be 0.841 2, 0.943 5, 0.996 9, and 0.020 7, respectively. It is vital to note that a synergistic effect was seen, as evidenced by computed AI. To counteract these effects, improved regulation, education, and potentially decreased use of harmful chemicals in delicate ecosystems will be required. Furthermore, more research is needed to understand the cumulative effects of acute toxicity on different fish species, as well as to quantify these effects in each species.

Conclusions

These findings confirmed the neurotoxicity of IMI and THM in zebrafish. The results of this study revealed that IMI and THM in the aquatic environment may represent possible dangers to fish fitness and survival in the long run. Sustainable farming practices that encourage biodiversity can reduce pesticide consumption by improving natural pest control mechanisms. These offer more environmentally friendly alternatives to traditional chemical pesticides. There are several agricultural environmental regulations and farm management practices that enhance environmental benefits. When considering alternatives to traditional pest control methods that are more environmentally friendly, several options emerge as effective and sustainable choices. These alternatives range from natural substances to integrated pest management strategies, offering a safer approach to controlling pests without harming the environment or human health. Every nation's government has a significant responsibility to play in ensuring that the environment is safe and devoid of harmful pollutants. In order to address public, scientific, and governmental concerns that chemical exposures are linked to human diseases and disabilities, as well as to protect the public from the health effects of chemical exposures, laws such as the Toxic Substances Control Act should be passed. These laws would give the Environmental Protection Agency (EPA) the authority to require testing and reporting, as well as to impose restrictions on the manufacture and use of chemicals and mixtures. To address this mission, the Environmental Protection Agency (EPA) and other agencies should be involved in collecting data and conducting studies, as well as using the best available scientific data to prevent and stop exposures, performing testing of chemicals currently in use, setting new risk-based safety standards, requiring protection for vulnerable populations, and increasing public transparency for chemical information to ensure community health.

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Editor: Yingzhi GUANG Proofreader: Xinxiu ZHU

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