

SPECIES COMPOSITION AND DENSITY FLUCTUATION OF THE CITRUS LEAFMINER *PHYLLOCNISTIS CITRELLA* STANTON (LEPIDOPTERA: PHYLLOCNISTIDAE) ON XOAN ORANGES IN DONG PHU DISTRICT, BINH PHUOC PROVINCE

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The study on the composition of insect pests on *Xoan Orange* trees in Dong Phu District, Binh Phuoc Province, identified 28 species belonging to 25 families and 7 orders. Among these, the order Hemiptera (true bugs) had the highest number of species, with 8 species (28.57%), while Lepidoptera (moths and butterflies) and Diptera (flies) each had only 1 species (3.57%). Thirteen natural enemy species were recorded, belonging to 8 families and 4 orders. The order Hymenoptera (wasps and bees) accounted for the highest number of species (6 species, 46.16%), while Hemiptera contributed the least (1 species, 7.69%). The density of citrus leafminer (*Phyllocnistis citrella*) varied with the season and type of orchard. In nurseries, the highest density was observed in August (4.56±0.02 larvae/leaf) and the lowest in January (1.42±0.03 larvae/leaf). In young orchards, the peak density occurred in April (3.68±0.01 larvae/leaf) and the lowest in January (1.38±0.02 larvae/leaf). In mature orchards, the highest density was recorded in April (2.61±0.02 larvae/leaf) and the lowest in January (0.78±0.04 larvae/leaf). The percentage of damaged leaves was highest in April across all three orchard types: Nurseries: 28.55±0.02%; Young orchards: 26.05±0.23%; Mature orchards: 25.38±0.02%. The lowest damage rates were observed in January, with corresponding values: Nurseries: 13.59±0.01%; Young orchards: 10.65±0.05%; Mature orchards: 8.67±0.03%.

Keywords: Citrus leafminer; *Phyllocnistis citrella*; *Xoan Orange*.

1. Introduction

Dong Phu District in Binh Phuoc Province is a mountainous area with significant potential for cultivating citrus fruits, including *Xoan Orange* (Thai *Xoan Orange*). This fruit tree is highly valued for its economic benefits and has been increasingly cultivated by local farmers. The fruit is characterized by its small size, thin peel, and sweet taste. It is widely grown in Vietnam and is gaining popularity nationwide. Farmers are actively expanding production to enhance yield and output.

However, pest issues on *Xoan Orange* are becoming increasingly complex, with a diverse range of harmful species observed [1]. Among the pests affecting citrus crops, the citrus leafminer (*Phyllocnistis citrella*) is notably damaging. This insect undergoes a life cycle consisting of four stages: egg, larva, pupa, and adult [2], of which the larval stage is the most destructive as larvae mine under the epidermis of young leaves, feeding on soft tissues and leaving serpentine trails beneath the surface [3].

Chemical pesticides are farmers' primary control measures, often applied with increasing frequency and dosages. However, these chemicals are less effective due to the larvae's location beneath the leaf epidermis. Consequently, research on the pest composition, population dynamics, and damage levels of the citrus leafminer is essential. This research aims to provide scientific insights to determine the optimal timing for pest control, preserve beneficial insects, and improve crop productivity.

2. Research subjects and methods

2.1. Research subjects and duration

The study focused on insect species collected from *Xoan Orange*, with an emphasis on the citrus leafminer (*Phyllocnistis citrella* Stainton), a member of the family Phyllocnistidae under the order Lepidoptera. The research was conducted from February 2021 to May 2022 in *Xoan Orange* orchards in Dong Phu District, Binh Phuoc Province.

2.2. Research methods

Collection and Processing: Insect samples were collected directly from *Xoan Orange* trees using essential agricultural pest and natural enemy investigation methods recommended by the Institute of Plant Protection [4]. Samples underwent the procedures outlined in “Techniques for Collecting, Processing, and Preserving Insects” [5]. Insect species were identified based on morphological characteristics described in the “Fauna of Vietnam” series [2].

Monitoring Population Dynamics of the Citrus Leafminer: The monitoring of citrus leafminer population density and damage rates was conducted by the “National Technical Regulation on Methods for Investigating and Detecting Harmful Organisms on Citrus Fruits” [6]. Orchards with sufficiently large areas were, and surveys were conducted at ten diagonal points in each orchard. At each point, one tree was surveyed; for each tree, four branches (one in each cardinal direction) in the middle canopy were examined. Regular surveys were conducted every seven days from May 2021 to April 2022, enabling the determination of citrus leafminer population density and damage rates on *Xoan Orange* [6].

3. Research results and discussion

3.1. Composition of pest and natural enemy species on Xoan Orange in Dong Phu District, Binh Phuoc Province

3.1.1. Pest species composition

The survey recorded 28 pest species affecting *Xoan Orange*, belonging to 25 families and seven orders. Detailed results are presented in Table 1.

**Table 1: Composition of pest species
on Xoan Orange in Dong Phu District, Binh Phuoc Province**

No.	Species (Scientific name)	Family (Scientific name)	Harmful parts	Frequency of encounter
I. Homoptera				
1	<i>Diaphorina citri</i> (Kuwayama)	Psyllidae	Young leaves, buds, shoots	+++
2	<i>Pseudococcus citri</i> (Risso)	Seudococcidae	Young leaves, buds, shoots	+++
3	<i>Aonidiella aurantii</i> (Maskell)	Diaspidae	Fruit, leaves, bark	+++
4	<i>Coccus hesperidum</i> (Linnaeus)	Coccidae	Young leaves, buds, shoots	++
5	<i>Chrysomphalus ficus</i> (Ashmead)	Diaspidae	Fruit, leaves, bark	++
6	<i>Huechys sanguinea</i> (De Geer)	Cicadidae	Roots, bark	++
7	<i>Aleurocanthus spiniferus</i> (Quaintance)	Aleyrodidae	Young leaves, buds, shoots	+
8	<i>Icerya purchasi</i> (Maskell)	Margarodidae	Young leaves, buds, shoots	+
II. Orthoptera				
9	<i>Atractomorpha chinensis</i> (Bolivar)	Acrididae	Leaves	+
10	<i>Acrida cinerea</i> (Thunberg)	Acrididae	Leaves	+
11	<i>Conocephalus</i> sp.	Tettigoniidae	Leaves	+
12	<i>Acheta domestica</i> (Linnaeus)	Gryllidae	Young roots	+
13	<i>Gryllotalpa gryllotalpa</i> (Linnaeus)	Gryllotalpidae	Roots of seedlings	+
III. Thysanoptera				
14	<i>Scirtothrips dorsalis</i> (Hood)	Thripida	Leaves, fruits, flowers	+++
IV. Hemiptera				
15	<i>Nezara viridula</i> (Linnaeus)	Pentatomidae	Sucks fluids from its host plants	+++
16	<i>Leptoglossus gonagra</i> (Fabricius)	Coreidae	Leaves, fruits	+++

No.	Species (Scientific name)	Family (Scientific name)	Harmful parts	Frequency of encounter
17	<i>Dysdercus cingulatus</i> (Fabricius)	Pyrrhocoridae	Sucks fluids from its host plants	+
V. Coleoptera				
18	<i>Hypomeces squamosus</i> (Fabricius)	Curculiolidae	Roots, leaves, flowers, fruits, trunks	++
19	<i>Anoplophora chinensis</i> (Forster)	Cerambycidae	Chisel the trunk, branches, bark, flowers, leaves	++
20	<i>Chelidonium argentatum</i> (Dalman)	Cerambycidae	Chisel the trunk, branches, bark, flowers, leaves	++
21	<i>Anomala cupripes</i> (Hope)	Scarabariidae	Leaves, flowers, roots, stumps of young trees	++
22	<i>Aeoloderma crucifer</i> (Rossi)	Elateridae	Young branches, young leaves, flowers	++
23	<i>Clitea metallica</i> (Chen)	Chrysomelidae	Leaves	++
VI. Lepidoptera				
24	<i>Cacoecia eucroca</i> (Diakonoff)	Tortricidae	Leaves	+++
25	<i>Phyllocnistis citrella</i> (Stainton)	Phyllocnistidae	Leaves, fruits, shoots	+++
26	<i>Papilio polytes</i> (Linnaeus)	Papilionidae	Leaves	+++
27	<i>Lymantria dispar</i> (Linnaeus)	Lymantriid	Leaves	++
VII. Diptera				
28	<i>Bactrocera dorsalis</i> (Hendel)	Trypetidae	Fruits	+++

The findings on the pest insect species in the study area, as illustrated in Figure 1, indicate that insects from the *Homoptera* (symmetrical wings) are the most abundant, accounting for 28.57% of species. Following this are insects from the *Coleoptera* (beetles), comprising 21.43%. The least represented *Thysanoptera* (thrips) and *Diptera* (flies), each with only one species, making up 3.57%.

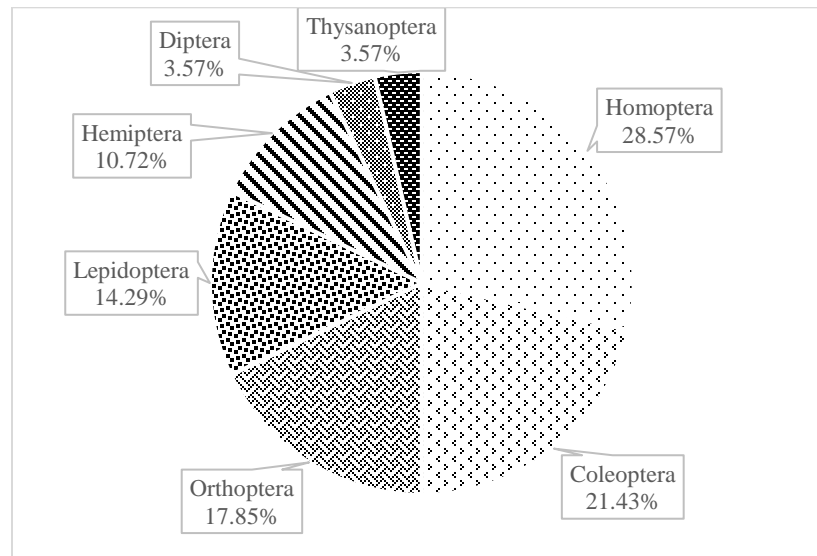


Figure 1: Proportion of insect pests found on Xoan Orange trees in Dong Phu district, Binh Phuoc province

Research on pest species composition on Sành Orange trees in Hà Giang identified 12 species, with the citrus leaf miner (*Phyllocnistis citrella*) appearing at a relatively high frequency, a finding consistent with previous investigations [1].

Pest Frequency on Cam Xoan Orange Trees: Data from Table 1 reveal variations in the frequency of pest insect occurrences on Xoan Orange trees. The most commonly observed pests include the citrus leaf miner (*Phyllocnistis citrella*), common Mormon butterfly (*Papilio polytes*), and citrus leafroller (*Cacoecia eucroca*) from the *Lepidoptera* (scaled wings). Other notable pests are aphid species such as the California red scale (*Aonidiella aurantii*), Asian citrus psyllid (*Diaphorina citri*), and short-tailed mealybug (*Pseudococcus citri*), all from the *Hymenoptera*; citrus thrips (*Scirtothrips dorsalis*) from *Thysanoptera*; and oriental fruit fly (*Bactrocera dorsalis*) from *Diptera*. Additionally, green stink bug (*Nezara viridula*) and squash bug (*Leptoglossus gonagra*) from the *Hemiptera* were frequently recorded.

Less frequently encountered species include the whitefly (*Aleurocanthus spiniferus*) and cottony cushion scale (*Icerya purchasi*) from *Hymenoptera*; grasshopper (*Atractomorpha chinensis*), katydid (*Conocephalus* sp.), house cricket (*Acheta domestica*), and mole cricket (*Gryllotalpa gryllotalpa*) from *Orthoptera*; and red cotton bug (*Dysdercus cingulatus*) from *Hemiptera*.

3.1.2. Composition of natural enemy insect species

Survey data in Table 2 show that the natural enemy insect community on Xoan Orange trees includes 13 species from 8 families across four orders. Among these, the *Hymenoptera* (membranous wings) is the most represented, with six species from 4 families accounting for 46.16%. This is followed by *Coleoptera* (beetles) with 4 species from 1 family (30.77%), *Diptera* (flies) with 2 species from 2 families (15.38%), and *Hemiptera* (half-wings) with 1 species from 1 family (7.69%). Details are illustrated in Figure 2.

Table 2: Natural enemy insect species composition on Xoan Orange Trees in Dong Phu District, Binh Phuoc Province

No.	Species (Scientific name)	Family (Scientific name)	Prey / Host	Frequency of encounter
I. Hemiptera				
1	<i>Sycanus croceovittatus</i> (Dohr)	Reduviidae	Holotrichia sauteri, Clerodendrum cyrtophyllum, Larvae, Green stink bugs	+++
II. Coleoptera				
2	<i>Propylea japonica</i> (Thunberg)	Coccinilidae	Aphids, Pink mealybug	++
3	<i>Coccinella transversalis</i> (Fabricius)	Coccinilidae	Aphids, Pink mealybug	-
4	<i>Lemnia biplagiata</i> (Swartz)	Coccinilidae	Aphids, Pink mealybug	+
5	<i>Menochilus sexmaculatus</i> (Fabricius)	Coccinilidae	Aphids, Pink mealybug	++
III. Hymenoptera				
6	<i>Oecophylla smaragdina</i> (Fabricius)	Formicidae	Larvae	+++
7	<i>Pseudaphycus utilis</i> (Timberlake)	Encyrtidae	Pink mealybug	+++
8	<i>Ageniaspis citricola</i> (Logvinovskaya)	Encyrtidae	Citrus leafminer	++
9	<i>Cirrospilus ingenuus</i> (Gahan)	Eulophidae	Citrus leafminer	++
10	<i>Cirrospilus vittatus</i> (Walker)	Eulophidae	Citrus leafminer	++
11	<i>Brachymeria obscurata</i> (Walker)	Chalcidae	Chalk butterfly pupae	++
IV. Diptera				
12	<i>Dideopsis aegrota</i> (Fabricius)	Syrphidae	Aphids, Larvae	+
13	<i>Tachina fera</i> (Linnaeus)	Tachinidae	Larvae	-

Notes: (+++): Widespread species (frequency of occurrence $c > 50\%$); (++): Common species (frequency of occurrence $25\% < c \leq 50\%$); (+): Rare species (frequency of occurrence $5\% < c \leq 25\%$); (-): Very rare species (frequency of occurrence $c \leq 5\%$).

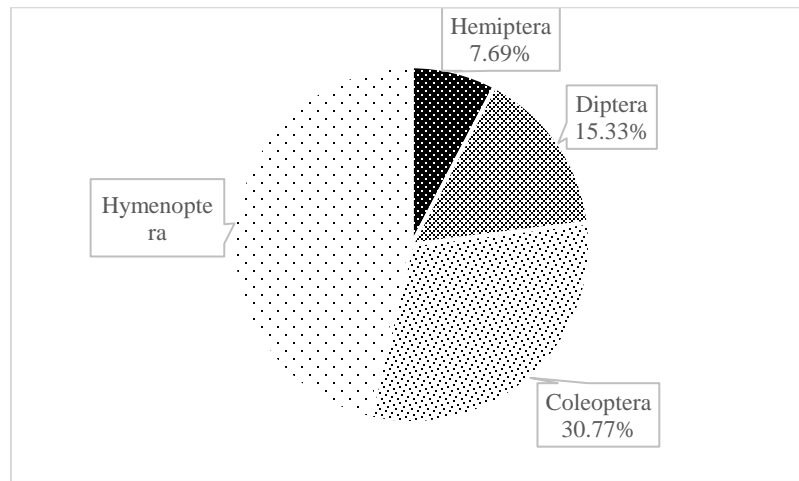


Figure 2: Proportions of natural enemy insect species found on Xoan Orange Trees in Dong Phu District, Binh Phuoc Province

Among the 13 natural enemy insect species collected from Xoan Orange trees, the black assassin bug (*Sycanus croceovittatus*), green weaver ant (*Oecophylla smaragdina*), and parasitic wasp (*Pseudaphycus utilis*) were frequently observed. Conversely, species like the two-spotted ladybird (*Lemnia bipagiata*) and aphid-eating fly (*Dideopsis aegrota*) were rarely encountered. The transverse ladybird (*Coccinella transversalis*) and parasitic fly (*Tachina fera*) were categorized as rare species (Figure 2).

Natural enemy insects are critical in pest management, particularly in controlling citrus leaf miners (*Phyllocnistis citrella*). Predatory and parasitic insects help regulate pest populations, reducing dependence on chemical pesticides in crop protection [7].

3.2. Dynamics of density and damage rate of citrus leaf miner (*Phyllocnistis citrella*) on Xoan Orange

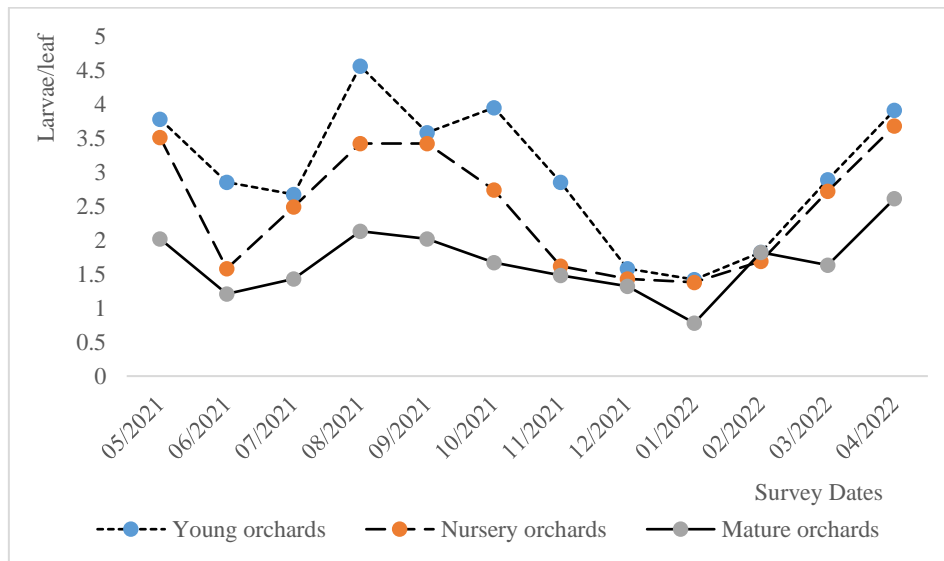


Figure 3: Density of leaf miners (*Phyllocnistis citrella*) in different orange orchards

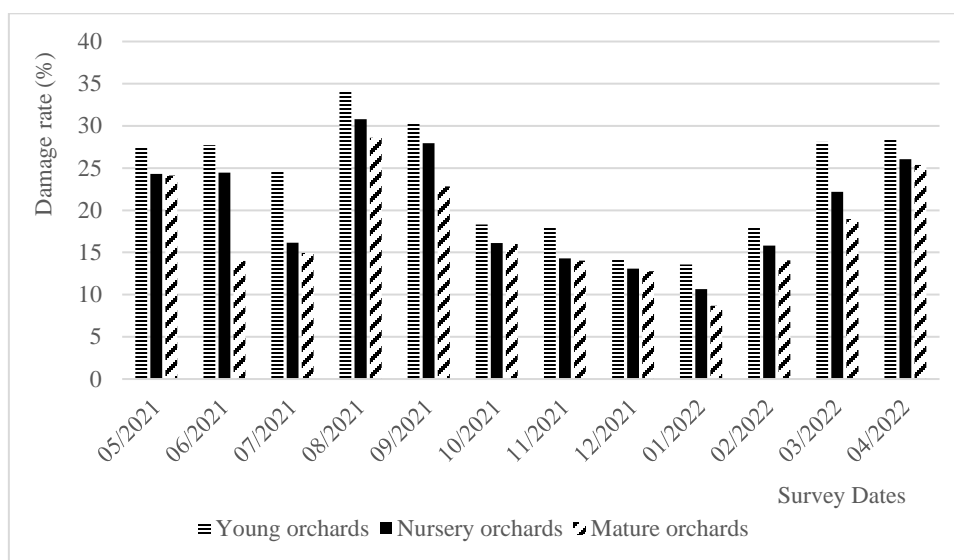


Figure 4: Damage rate of leaf miners (*Phyllocnistis citrella*) on different orange gardens in Dong Phu district, Binh Phuoc province

In fruit tree cultivation, there are typically three types of orchards: Nurseries, Young orchards (1-4 years old), and Mature orchards (over 5 years old). To assess whether the timing and extent of pest damage differ among these orchard types, the research team conducted surveys of the density and damage rates of citrus leaf miners on Cam Xoan orange trees. The results are presented in Figures 3 and 4.

Dynamics of *Phyllocnistis citrella* density across orange orchards

Survey data on Xoan Orange orchards (nursery, young orchards, and mature orchards) reveal variations in the peak times and density of citrus leaf miners (*Phyllocnistis citrella*).

- **Nursery orchards:** The density peaked in August at 4.56 ± 0.02 larvae/leaf, followed by April (3.91 ± 0.01 larvae/leaf), and was lowest in January at 1.42 ± 0.03 larvae/leaf.

- **Young orchards:** The density also showed a similar trend, with the highest density recorded in April (3.68 ± 0.01 larvae/leaf), followed by August (3.42 ± 0.02 larvae/leaf), and the lowest in January (1.38 ± 0.02 larvae/leaf).

- **Mature orchards:** The density was highest in April (2.61 ± 0.02 larvae/leaf), followed by August (2.13 ± 0.02 larvae/leaf), and lowest in January (0.78 ± 0.04 larvae/leaf).

These findings align with Legaspi et al., which reported density peaks around August [8].

Ujiye noted that adult females start laying eggs in mid-March, leading to larval peaks approximately 15 days after egg peaks, around April [9]. This pattern demonstrates a temporal alignment of peak and lowest densities in all three orchard types. Notably, the nursery had the highest densities compared to the other orchard types at corresponding times.

Damage rate of *Phyllocnistis citrella*

Consistent with the density trends, the damage rate caused by *Phyllocnistis citrella* also varied across the three orchard types:

- **April:** The highest damage rates were recorded in all three orchard types - $28.55\pm 0.02\%$ in nurseries, $26.05\pm 0.23\%$ in young orchards, and $25.38\pm 0.02\%$ in mature orchards.

- **January:** The lowest damage rates were observed - $13.59\pm 0.01\%$ in nurseries, $10.65\pm 0.05\%$ in young orchards, and $8.67\pm 0.03\%$ in mature orchards.

Comparing the three orchard types, nurseries experienced the highest damage rates, followed by young and mature orchards.

Seasonal dynamics

The density and damage rate of *Phyllocnistis citrella* reached their highest levels in April, May, August, and September, while the lowest levels occurred in December. Research by Khanh et al. [10] recorded high adult butterfly captures in traps from January to May (dry season and early rainy season) and lower numbers from June to December (heavy rainy season).

This trend can be attributed to favourable conditions in April and May, including high temperatures, synchronized sprouting of tender shoots, and moderate humidity from early rains, which promote larval development. Conversely, the late-year period, characterized by low temperatures, sparse rainfall, and limited tender shoots, reduces pest populations and lowers damage rates.

4. Conclusions

The pest insect community on Xoan Orange trees consists of 28 species from 25 families across seven orders. Among these, *Hemiptera* (true bugs) had the highest number of species (8 species, accounting for 28.57% of the total). In contrast, *Thysanoptera* (thrips) and *Diptera* (flies) had the lowest representation, with only one species each (3.57%). The most frequently observed species were the citrus leaf miner (*Phyllocnistis citrella*), Asian citrus psyllid (*Diaphorina citri*), citrus thrips (*Scirtothrips dorsalis*), green stink bug (*Nezara viridula*), and the common Mormon butterfly (*Papilio polytes*).

The natural enemy community on Xoan Orange trees in the study area includes 13 species from 8 families across four orders. The most represented order was *Hymenoptera* (wasps and ants), with six species accounting for 46.16% of the total, while the least represented was *Hemiptera* (true bugs), with one species (7.69%). The most frequently encountered natural enemies were the parasitic wasp (*Pseudaphycus utilis*), green weaver ant (*Oecophylla smaragdina*), and black assassin bug (*Sycanus croceovittatus*).

Occurrence of the citrus leaf miner (*Phyllocnistis citrella*): The citrus leaf miner was consistently observed on orange trees year-round. In nursery orchards, its density peaked in August (4.56 ± 0.02 larvae/leaf) and was lowest in January (1.42 ± 0.03 larvae/leaf). In young orchards, the highest density occurred in April (3.68 ± 0.01 larvae/leaf), with the lowest in January (1.38 ± 0.02 larvae/leaf). In mature orchards, the density peaked in April (2.61 ± 0.02 larvae/leaf) and was lowest in January (0.78 ± 0.04 larvae/leaf).

The damage rate of *Phyllocnistis citrella* reached its highest levels in April across all orchard types: Nursery orchards: $28.55\pm 0.02\%$; Young orchards: $26.05\pm 0.23\%$; Mature orchards: $25.38\pm 0.02\%$. The damage rate decreased towards the end of the year, reaching

its lowest levels in January: Nursery orchards: $13.59 \pm 0.01\%$; Young orchards: $10.65 \pm 0.05\%$; Mature orchards: $8.67 \pm 0.03\%$.

These results highlight the need for targeted pest management strategies during peak periods to minimize damage and maintain sustainable orange cultivation.

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TÓM TẮT**THÀNH PHẦN LOÀI CÔN TRÙNG VÀ DIỄN BIẾN MẬT ĐỘ
CỦA SÂU VỄ BÙA *Phyllocnistis citrella* Stainton
(Lepidoptera: Phyllocnistidae) TRÊN CÂY CAM XOÀN
TẠI HUYỆN ĐỒNG PHÚ, TỈNH BÌNH PHƯỚC****Nguyễn Thị Việt¹, Dương Thị Hồng Thúy², Vũ Thị Ánh³**¹*Khoa Sinh học, Trường Sư phạm, Trường Đại học Vinh, Nghệ An, Việt Nam*²*Trường Trung học phổ thông Chuyên Quang Trung, Bình Phước, Việt Nam*³*Lớp 62A Sư phạm Sinh học, Trường Sư phạm, Trường Đại học Vinh, Nghệ An, Việt Nam*

Ngày nhận bài 13/9/2024, ngày nhận đăng 29/10/2024

Kết quả nghiên cứu về thành phần côn trùng gây hại trên cây cam Xoàn tại huyện Đồng Phú, tỉnh Bình Phước đã xác định được 28 loài, thuộc 25 họ và 7 bộ. Trong đó, bộ Cánh đều (Hemiptera) chiếm số lượng loài cao nhất với 8 loài (28,57%), trong khi bộ Cánh tơ (Lepidoptera) và bộ Hai cánh (Diptera) chỉ có 1 loài, chiếm 3,57%. Thành phần côn trùng thiên địch được ghi nhận gồm 13 loài, thuộc 8 họ và 4 bộ, với số lượng loài nhiều nhất thuộc bộ Cánh màng (*Hymenoptera*), chiếm 46,16% (6 loài), và ít nhất thuộc bộ Cánh nửa cứng (*Hemiptera*), chiếm 7,69% (1 loài). Mật độ sâu vẽ bùa (*Phyllocnistis citrella*) thay đổi theo mùa và loại vườn cam. Ở vườn ươm, mật độ sâu cao nhất vào tháng 8 ($4,56 \pm 0,02$ con/lá) và thấp nhất vào tháng 1 ($1,42 \pm 0,03$ con/lá). Ở vườn kiến thiết cơ bản, mật độ cao nhất vào tháng 4 ($3,68 \pm 0,01$ con/lá) và thấp nhất vào tháng 1 ($1,38 \pm 0,02$ con/lá). Tại vườn kinh doanh, mật độ sâu cao nhất vào tháng 4 ($2,61 \pm 0,02$ con/lá) và thấp nhất vào tháng 1 ($0,78 \pm 0,04$ con/lá). Tỷ lệ lá bị hại đạt mức cao nhất vào tháng 4 tại cả 3 loại vườn: Vườn ươm: $28,55 \pm 0,02\%$; Vườn kiến thiết cơ bản: $26,05 \pm 0,23\%$; Vườn kinh doanh: $25,38 \pm 0,02\%$. Thấp nhất vào tháng 1 với các giá trị tương ứng: Vườn ươm: $13,59 \pm 0,01\%$; Vườn kiến thiết cơ bản: $10,65 \pm 0,05\%$; Vườn kinh doanh: $8,67 \pm 0,03\%$.

Từ khóa: Sâu vẽ bùa; *Phyllocnistis citrella*; cam Xoàn.