

NURSERY PEST PROBLEMS ON *Acacia mangium*, *Cinnamomum cassia* AND *Illicium verum* IN BAC KAN PROVINCE, VIETNAM

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ABSTRACT

Acacia mangium, *Cinnamomum cassia*, and *Illicium verum* are pivotal forestry species in Bac Kan province, where they contribute significantly to economic and environmental welfare. *A. mangium*'s wood is essential for the pulp industry, while *C. cassia* and *I. verum* provide essential oils with extensive industrial applications. Despite their economic value, increased plantation areas have exacerbated insect pest outbreaks, affecting tree growth and yield. However, the focus of previous research on insect pests has primarily been on plantations, leaving nursery infestations largely unexplored. This study aims to overcome this gap by investigating insect pest species diversity in nurseries in Bac Kan province. Field observations and standard plot surveys were conducted in Cho Moi district and Bac Kan city, resulting in the collection of 72 survey forms. The survey revealed significant insect pest species compositions in *A. mangium*, *C. cassia*, and *I. verum* nurseries. Notably, *Helopeltis theivora* was identified as the primary pest infesting young *A. mangium* trees, while *Echinothrips* sp. emerged as the main pest species in *C. cassia* nurseries, and others affected *I. verum* nurseries. These findings underscore the need for ongoing monitoring and research to develop effective pest management strategies. Such insights are crucial for sustaining the economic and environmental benefits of these forestry species in Bac Kan province.

Keywords: *Acacia mangium*, *Cinnamomum cassia*, *Illicium verum*, identification, composition, insect pests.

KẾT QUẢ ĐIỀU TRA THÀNH PHẦN SÂU HẠI CÂY KEO, QUẾ VÀ HỒI Ở VƯỜN ƯƠM TẠI TỈNH BẮC KẠN

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TÓM TẮT

Keo tai tượng (*Acacia mangium*), Quế (*Cinnamomum cassia*) và Hồi (*Illicium verum*) là ba loài cây quan trọng trong ngành lâm nghiệp tại tỉnh Bắc Kạn. Mặc dù có giá trị kinh tế cao, nhưng việc mở rộng các diện tích trồng Keo tai tượng, Quế và Hồi dẫn đến sự gia tăng các côn trùng gây hại, ảnh hưởng đến sự phát triển cây và sản lượng kinh doanh rừng trồng. Nghiên cứu này nhằm điều tra về thành phần các loài sâu gây hại ở vườn ươm của ba loại cây lâm nghiệp này. Kết quả cho thấy Bọ xít muỗi (*Helopeltis theivora*) là loài sâu gây hại chính trên cây Keo tai tượng, Bọ trĩ (*Echinothrips* sp.) là loài gây hại chính trên cây Quế, và một số loài ảnh hưởng đến cây Hồi. Những thông tin này làm nổi bật sự cần thiết của việc giám sát và phòng trừ các loài sâu hại này để duy trì lợi ích kinh tế và môi trường của ba loài cây này tại Bắc Kạn.

Từ khóa: Keo tai tượng, Quế, Hồi, giám định, thành phần, sâu hại

I. INTRODUCTION

Acacia mangium, *Cinnamomum cassia* and *Illicium verum* are three important forestry tree species, which are being planted on a large scale in many provinces across Vietnam, including Bac Kan. While *A. mangium* wood serves as a raw material for the pulp industry, veneer production, and household items (Sein & Mitlöhner, 2011), an essential oil extracted from *C. cassia* bark and *I. verum* fruit finds widespread application in pharmaceuticals, food processing, fragrances, and the livestock industry (Freire *et al.*, 2011; Wang *et al.*, 2011; Matos *et al.*, 2020). The large-scale cultivation of these species for export significantly bolsters rural economies. Similarly, *I. verum* flowers achieve prices between 30,000 and 40,000 VND/kg, reaching over 80,000 VND/kg. In addition to economic benefits, *A. mangium*, *C. cassia*, and *I. verum* play a vital role in environmental conservation by safeguarding soil and water, mitigating erosion in hilly and mountainous terrain, and augmenting forest cover.

In recent years, Bac Kan province has witnessed a substantial increase in plantation areas, prominently featuring *A. mangium*, *C. cassia*, and *I. verum*. However, this expansion, coupled with the impacts of climate change, has precipitated heightened outbreaks of numerous insect pests, and consequently adversely affected tree growth and forest yield and even caused tree mortality. Notably, plant protection agencies have reported significant infestations of leaf-feeding and bark-feeding caterpillars in *C. cassia* trees, impacting over 33 hectares of land. Similarly, *A. mangium* plantations have been attacked by leaf-feeding caterpillars and ambrosia beetles, with affected tree percentages ranging from 5 - 10%. Additionally, previous studies have identified 43 dangerous insect species infesting *I. verum* plantations, with damage incidence from 6.9% to 53.6% and an average damage index of 0.06 to 2.26.

Despite these findings, research has predominantly centred on insect pest compositions in plantations, leaving information on pests impacting *A. mangium*, *C. cassia*, and *I. verum* in nurseries largely unexplored. Hence, this study aims to elucidate the disparities in insect pest species between nursery and plantation sites of these three tree species. Such insights are anticipated to aid forest growers, forest companies, and government authorities in Bac Kan province in formulating tailored management strategies for diverse insect pests.

II. MATERIALS AND METHODS

2.1. Study sites and insect collection

Field observations were conducted from January to December 2023 in Cho Moi district and Bac Kan city, Bac Kan province. Pest composition on *A. mangium*, *C. cassia*, and *I. verum* trees in nurseries was investigated using the standard plot survey method based on the forest pest control standard TCVN 8927:2023. Surveys were conducted in two districts, with 6 standard plots (SPs) per tree species per district, totalling 36 SPs. Each plot measured 4 square meters (1 × 4m), with boundaries marked by stakes. Trees within the plots were selected using a systematic random sampling method, investigating every other row and tree. Surveys were conducted every 15 days (twice a month) over three months, totalling six surveys, on six-month-old *A. mangium*, twelve-month-old *C. cassia*, and eight-month-old *I. verum*.

Insect pest samples, including those affecting leaves, stems, branches, and tips, were collected within the standard plots. Each sample was stored separately and labelled with pertinent details such as the date of collection, the collector's name, and the collection location.

2.2. Damage assessment

Classification of damage for seedlings in standard plots based on a national standard for Forest Pest Control TCVN 8927:2023 as follows:

Damage levels observed for leaf-feeding insects were categorized into the following groups: (0) Leaves are not damaged; (1) Leaves are slightly damaged (less than 25%); (2) Leaves are moderately damaged (25% to less than 50%); (3) Leaves are severely damaged (50% to less than 75%); (4) Leaves are very severely damaged (75% or more).

Damage levels observed for stem, branch, and tip-feeding insects were categorized into the following groups: (0) Stems and tips are not damaged; (1) Stems and tips are slightly damaged (less than 15%); (2) Stems and tips are moderately damaged (15% to less than 30%); (3) Stems and tips are severely damaged (30% to 50%); (4) Stems and tips are very severely damaged (more than 50%).

- Damage indicators included the percentage of damaged trees (P%) and average damage index (DI)

$$P\% = (n/N) \times 100$$

Where: P%: Percentage of damaged trees

n: Number of damaged trees

N: Total number of trees surveyed

$$R = \frac{\sum_{i=1}^i ni.vi}{N}$$

Where: R: Average damage index

ni: Number of trees with damage index i

vi: Value of damage level i

N: Total number of trees surveyed

Damage severity was based on the average damage index as follows:

Average damage index = 0 (No damage)

Average damage index < 1.0 (Light damage)

Average damage index from 1.0 to < 2.0 (Moderate damage)

Average damage index from 2.0 to < 3.0 (Severe damage)

Average damage index from 3.0 to < 4.0 (Severe damage)

Ranking of damage severity: An insect species was a major pest when it caused significant

damage (damage levels 3 or level 4), affecting tree growth or causing mortality and spreading over a large area.

The occurrence frequency of insects was considered as follows: (-) Infrequent occurrence, frequency below 5%; (+): Rare occurrence, frequency between 5 to below 25%; (++) Moderate occurrence, frequency between 25 to below 50%; (+++): Common occurrence, frequency above 50%.

2.3. Insect identification

The scientific names of the collected pest species were determined through morphological descriptions and comparisons with taxonomic keys and published documents. Pest samples affecting *A. mangium*, *C. cassia*, and *I. verum* were processed roughly in the field and then brought to the laboratory for further examination. They were reared, and detailed descriptions of their various life stages (adult, egg, larva, pupa) were documented. These descriptions were then compared with classification keys and existing literature. Scale insects were referenced from Zamar and co-authors (2013). Identification of Lepidoptera pests was relied on Holloway and co-authors (2001). Bug identification was based on Kment & Carapezza (2017). Further comparisons were made with insect collections from the Forest Protection Research Center (FPRC), Vietnam Academy of Forest Sciences (VAFS). Moreover, findings from Zhao and co-authors (2009) regarding pest composition on *I. verum* trees in China were cross-referenced.

III. RESULTS AND DISCUSSION

3.1. Composition of insect pest species infesting *Acacia mangium* in nurseries

The study examined the composition of pest species affecting *A. mangium* across 12 standardized plots in Cho Moi district and Bac Kan City, Bac Kan province. The data obtained from field surveys are summarized in Table 1.

Table 1. Composition of insect pests infesting *Acacia mangium*, their damage incidence, and average damage index

No.	Scientific name	Damage incidence	Average damage index	Frequency of occurrence	Damaged parts of trees
I	COLEOPTERA				
(1)	Curculionidae				
1	<i>Hypomeces squamosus</i> (Fabricius, 1795)	0.5	0.01	-	Leaf
II	HEMIPTERA				
(2)	Coreidae				
2	<i>Leptocorisa varicornis</i> Fabricius, 1803	0.7	0.02	-	Leaf, shoot
3	<i>Riptortus fuscus</i> (Fabricius, 1798)	29.6	1.1	+	Leaf, shoot
(3)	Miridae				
4	<i>Helopeltis theivora</i> Waterhouse, 1886	52.2	1.82	+++	Leaf
III	HOMOPTERA				
(4)	Diaspididae				
5	<i>Aulacaspis tubercularis</i> (Newstead, 1906)	12.8	0.1	+	Leaf, shoot
(5)	Aphididae				
6	<i>Toxoptera aurantii</i> (Fonscolombe, 1841)	10.7	0.08	+	Leaf
IV	LEPIDOPTERA				
(6)	Lymantriidae				
7	<i>Dasychira chekiangensis</i> Collenette, 1938	13.6	0.2	+	Leaf
8	<i>Dasychira mendosa</i> (Hubner, 1934)	9.8	0.08	+	Leaf
(7)	Geometridae				
9	<i>Hyposidra talaca</i> (Walker, 1860)	8.8	0.06	-	Leaf
(8)	Gracillariidae				
10	<i>Acrocercops</i> sp.	9.5	0.08	+	Leaf
(9)	Noctuidae				
11	<i>Spodoptera litura</i> (Fabricius, 1775)	10.5	0.1	+	Leaf
(10)	Psychidae				
12	<i>Canephora hirsuta</i> (Poda, 1761)	12.5	0.5	+	Leaf
(11)	Tortricidae				
13	<i>Archips</i> sp.	52.4	2.05	+	Leaf

The results in Table 1 show that *A. mangium* nurseries in Bac Kan province harbor 13 insect pests distributed across 11 families and 4 orders. Lepidoptera is the most prevalent order, comprising 7 species (53.8%), followed by Hemiptera with 3 species (23.07%), Coleoptera with 2 species (14.3%), and Orthoptera with 1 species (7.1%). Among the observed species, 1 species is common (+++), 9 species are rare (+), and 4 species are very rare (-).

The survey results from the *A. mangium* nurseries identified *Helopeltis theivora*,

commonly known as the tea mosquito bug, as the primary pest infesting young *A. mangium* trees in Bac Kan province. This highlights the need for ongoing monitoring and research to understand the pest's morphology, life cycle, behavior, and seasonal occurrence. Such knowledge is crucial for developing effective pest management strategies. Regular surveillance is essential to track the population dynamics and distribution of *H. theivora* in *A. mangium* nurseries. Additionally, research should focus on the ecological interactions between *H. theivora*, its host plants, natural

enemies, and environmental factors. This information will help stakeholders develop integrated pest management approaches, incorporating biological, cultural, and chemical control methods to mitigate *H. theivora* infestations and sustainably manage *A. mangium* plantations in Bac Kan province.

Previous studies on *A. mangium* in various regions, including Bac Kan and other parts of Northern Vietnam (Thu, 2016) have documented different pest compositions and their impacts on plantation health. For instance, earlier research has identified termites, aphids, or defoliating caterpillars, as significant threats to *A. mangium*. By comparing current findings with these historical data, we could assess whether *H. theivora* has recently become more prevalent or was previously underreported. One notable study conducted in the early 2010s in Northern

Vietnam highlighted that the predominant pests affecting *A. mangium* were aphids and leaf-eating caterpillars. The emergence of *H. theivora* as the primary pest in the latest survey indicates a potential shift in pest dynamics, possibly due to changes in environmental conditions, pest resistance to previous management strategies, or the introduction of new pest species from other regions.

3.2. Composition of insect pest species infesting *Cinnamomum cassia* in nurseries

The survey findings on pest species diversity impacting *C. cassia* nurseries were conducted across 12 designated plots in Cho Moi district and Bac Kan City, Bac Kan province. This investigation resulted in the collection of 72 survey forms. The data gathered during field surveys are summarized in Table 2.

Table 2. Composition of insect pests infesting *Cinnamomum cassia*, their damage incidence and average damage index

No.	Scientific name	Damage incidence	Average damage index	Frequency of occurrence	Damaged parts of trees
I	COLEOPTERA				
(1)	Chrysomelidae				
1	<i>Aulacophora foveicollis</i> (Lucas, 1849)	0.5	0.01	-	Leaf
II	HEMIPTERA				
(2)	Coreidae				
2	<i>Leptocorisa acuta</i> (Thunberg, 1783)	0.7	0.02	-	Leaf, shoot
(3)	Miridae				
3	<i>Helopeltis theivora</i> (Waterhouse, 1886)	29.6	1.1	++	Leaf, shoot
III	HOMOPTERA				
(4)	Aphididae				
4	<i>Toxoptera aurantii</i> (Boyer de Fonscolombe, 1841)	12.8	0.1	+	Leaf, shoot
(5)	Diaspididae				
5	<i>Aulacaspis tubercularis</i> Newstead, 1906	10.7	0.08	+	Leaf, branch, stem
IV	LEPIDOPTERA				
(6)	Papilionidae				
6	<i>Chilasa clytia</i> (Linnaeus, 1758)	0.8	0.02	-	Leaf
7	<i>Graphium sarpedon</i> (Linnaeus)	13.6	0.2	+	Leaf
(7)	Tortricidae				
8	<i>Epiphyas postvittana</i> (Walker, 1957)	10.5	0.1	+	Leaf
(8)	Gracillariidae				
9	<i>Acrocercops</i> sp.	9.5	0.08	+	Leaf
V	THYSANOPTERA				
(9)	Thripidae				
10	<i>Echinothrips</i> sp.	45.5	2.03	+++	Leaf

The investigation results presented in Table 2 identified 10 insect pest species of *C. cassia* across 5 orders and 9 families. Lepidoptera had the highest number of species, with 4 species (40%). Hemiptera and Homoptera each contributed 2 species (20%), while Coleoptera and Thysanoptera each had 1 species (10%). Among these, *Echinothrips* sp. had a high encounter frequency (+++), *Helopeltis theivora* had a moderate frequency (++), 5 species (*Aulacophora foveicollis*, *Leptocorisa acuta*, *Chilasa clytia*) had a low frequency (+), and 3 species had a very low frequency (-). The survey in the *C. cassia* nurseries identified *Echinothrips* sp., commonly known as thrips, as the primary pest species infesting young *C. cassia* trees in Bac Kan province.

Other research on *C. cassia* pests in Northern Vietnam and the Bac Kan region (Thu, 2016; Thanh & Thu, 2020; Binh, 2022) have identified different primary pests or varied frequencies of pest encounters. For example, earlier studies have reported a higher prevalence of Lepidopteran, Coleopteran and Hemipteran species. One notable study from the early 2000s identified the larvae of various Lepidopteran species as the predominant pests in *C. cassia* nurseries, causing extensive defoliation and growth retardation. In contrast, the current survey's identification of *Echinothrips* sp. as the primary pest suggests a potential shift in pest species dominance. This change could be attributed to several factors, including

alterations in environmental conditions, pest management practices, or the introduction of new pest species. Additionally, the moderate frequency of *Helopeltis theivora*, commonly known as the tea mosquito bug, aligns with findings from *A. mangium* nurseries, indicating its broader impact across different plant species in Bac Kan province. Comparing the frequency and impact of *H. theivora* in *C. cassia* nurseries with past data could help determine its prevalence over time.

The presence of other pest species with low to very low frequencies, such as *Aulacophora foveicollis*, *Leptocorisa acuta*, and *Chilasa clytia*, warrants further investigation. Previous studies have recorded these species with different encounter rates and highlighted their impact during specific seasons. By comparing current findings with historical data, we would assess how these factors have contributed to changes in pest composition and frequency. It is also essential to investigate whether any new pest species have emerged in previous surveys.

3.3. Composition of insect pest species infesting *Illicium verum* in nurseries

The survey findings on pest species diversity impacting *I. verum* nurseries were conducted across 12 designated plots in Cho Moi district and Bac Kan City, Bac Kan province. This investigation resulted in the collection of 72 survey forms. The data obtained during field surveys were summarized in Table 3.

Table 3. Composition of insect pests infesting *Illicium verum*, their damage incidence and average damage index

No.	Scientific name	Damage incidence	Average damage index	Frequency of occurrence	Damaged parts of trees
I	COLEOPTERA				
(1)	Attelabidae				
1	<i>Apoderus tranquebaricus</i> (Fabricius, 1798)	0.5	0.01	+	Leaf
(2)	Tenebrionidae				
2	<i>Lagria villosa</i> (Fabricius, 1781)	0.7	0.02	+	Leaf, shoot

No.	Scientific name	Damage incidence	Average damage index	Frequency of occurrence	Damaged parts of trees
II	HEMIPTERA				
(3)	Coreidae				
3	<i>Homoeocerus unipunctatus</i> (Thunberg, 1822)	29.6	0.1.	+	Leaf, shoot
(4)	Miridae				
4	<i>Pseudodoniella</i> sp.	12.5	0.3	+	Leaf, shoot
(5)	Scutelleridae				
5	<i>Poecilocoris rufigenis</i> (Dallas, 1851)	10.7	0.08	+	Leaf, shoot
III	HOMOPTERA				
(6)	Aphididae				
6	<i>Polytrichaphis fragilis</i> (Miyazaki, 1971)	12.8	0.1	+	Leaf, shoot
7	<i>Toxoptera aurantii</i> (Boyer de Fonscolombe, 1841)	48.2	1.89	+	Leaf
(7)	Cicadellidae				
8	<i>Gloridonus</i> sp.	13.6	0.2	+	Leaf
(8)	Coccidae				
9	<i>Ceroplastes rubens</i> (Maskell, 1893)	12.5	0.06	+	Leaf
(9)	Pseudococcidae				
10	<i>Maconellicoccus hirsutus</i> (Green, 1908)	10.8	0.08	+	Leaf
IV	LEPIDOPTERA				
(10)	Erebidae				
11	<i>Artaxa guttata</i> (Walker, 1855)	0.5	0.08	+	Leaf
(11)	Geometridae				
12	<i>Agriopsis marginaria</i> (Fabricius, 1776)	12.5	0.07	+	Leaf
(12)	Gracillariidae				
13	<i>Ochyrotica connexiva</i> (Walsingham, 1891)	24.4	0.3	+	Leaf
(13)	Psychidae				
14	<i>Clania ignobilis</i> (Walker, 1869)	18.4	0.2	+	Leaf
15	<i>Sterropterix fusca</i> (Haworth, 1809)	13.5	0.2	+	Leaf

The survey results in Table 3 show that 15 pest species collected from *I. verum* nurseries in Bac Kan province belonged to 13 families and 4 orders. The order Lepidoptera and Homopptera both had the highest number of species, with 5 species (33.33%) in 4 families and 5 families, respectively, followed by Hemiptera with 3 species (20%) in 3 families. Coleoptera recorded the smallest number of species with two species (13.33%) in 2 families.

Comparing these findings with previous studies on pest composition in *I. verum* nurseries

(Quang *et al.*, 2023) reveals interesting trends and potential shifts in pest dynamics. Historical research on *I. verum* pests in Northern Vietnam and the Bac Kan region may have identified different primary pests or varied frequencies of pest encounters. For instance, earlier studies might have reported a higher prevalence of significant pests of Hemiptera, Coleoptera and Orthoptera. A notable study from the late 1990s in Northern Vietnam documented a diverse range of pests affecting *I. verum*, with Hemiptera species being particularly dominant.

The shift to Lepidoptera having the highest number of species in the current survey suggests changes in pest dynamics over the years. This shift could be due to alterations in environmental conditions, pest management practices, or even the introduction of new pest species.

Furthermore, the presence of other pest species with significant frequencies, such as those from the orders Hemiptera, Coleoptera, and Orthoptera, requires attention. Past studies might have recorded these species with different encounter rates or highlighted their impact during specific seasons. Identifying and studying these new pests would help develop proactive management strategies to mitigate their impact on *I. verum* nurseries.

The findings of this study shed light on the diverse insect pest species infesting nurseries of key forestry tree species in Bac Kan province, Vietnam. The results reveal a notable presence of insect pests across the surveyed nurseries, posing significant challenges to tree health and plantation productivity.

In *A. mangium* nurseries, Lepidoptera emerged as the most prevalent order, with *Helopeltis theivora* identified as the primary pest species. This tea bug infestation underscores the necessity for continuous monitoring and research to comprehend its biology and behavior fully. Understanding the ecological interactions between *H. theivora* and its environment is crucial for devising effective integrated pest management strategies. Such strategies, incorporating biological, cultural, and chemical control methods, are imperative for mitigating *H. theivora* infestations and ensuring the sustainable management of *A. mangium* plantations in Bac Kan province.

Similarly, in *C. cassia* nurseries, *Echinothrips* sp. was identified as the predominant pest species, known commonly as thrips. The prevalence of this pest emphasizes the urgency of implementing proactive pest management measures to curb its impact on young *C. cassia* trees.

A general overview of pest components across these three tree species reveals both similarities and differences in insect pest composition. Lepidoptera species were prominent in both *A. mangium* and *I. verum* nurseries, highlighting their significant impact on these forestry species. However, while *H. theivora* was the primary pest in *A. mangium* nurseries. In contrast, *C. cassia* nurseries were primarily affected by *Echinothrips* sp., representing a different order (Thysanoptera) compared to the other two tree species. This variation in dominant pest species across tree species underscores the need for tailored pest management strategies specific to each type of nursery.

Overall, the findings underscore the importance of ongoing surveillance and research efforts to mitigate the impact of insect pests on forestry tree nurseries in Bac Kan province. Collaborative endeavors between stakeholders, including forest growers, companies, and government authorities, are essential for developing and implementing tailored pest management strategies to safeguard tree health and enhance plantation productivity.

In conclusion, while there are similarities in the pest orders affecting the surveyed nurseries, significant differences in primary pest species and their impact necessitate a nuanced approach to pest management. The emergence of new pests or the increased significance of previously known pests highlights the dynamic nature of pest populations and the need for adaptive management strategies to address these challenges effectively.

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