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Harmful Insects of Okra and Eggplant : A Study Conducted in the Lowland Areas of Daloa

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aims to inventorize and characterize the harmful insects associated with okra and eggplant in the city of Daloa (Central-Western Côte d'Ivoire).
Study Design: Descriptive transversal survey.
Place and Duration of Study: In various lowland areas of the city of Daloa during the dry season, from February to April 2025.
Methodology: Harmful insects were collected from okra and eggplant crops located in various lowland areas of the city of Daloa. At each site, ten (10) plants of each crop were randomly selected when okra and eggplant were cultivated together; when only one of the two species was

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present, the same procedure was applied to the available crop. Sampling focused on the leaves and fruits of mature, productive plants. Insects were captured using transparent white plastic bags. The method consisted of enclosing a portion of the plant, including leaves and/or fruits, inside a labeled bag and then gently shaking this part of the plant to dislodge and trap the harmful insects inside the bag.

Results: In total, three species of jassids were identified, along with two additional types of pests: phytophagous bugs and aphids. The molecular approach confirmed the identification of the jassids and reliably distinguished them from the other insects collected.

Conclusion: The combination of these approaches provides a better understanding of pest distribution, their relationship with host plants, and their relevance for developing effective plant protection strategies.

Keywords: Okra; eggplant; insect pests; Jassid; aphid; bug.

1. INTRODUCTION

The agricultural sector plays a pivotal role in the economy and development of Côte d'Ivoire, both through the size of its active agricultural workforce and its substantial contribution to national wealth creation. Representing approximately one quarter of the Gross Domestic Product (GDP), agriculture employs nearly half of the working-age population (Ducroquet et al., 2017). Côte d'Ivoire ranks among the leading producers of several major agricultural commodities on both the African continent and the global market and is the undisputed world leader in cocoa bean production (Ducroquet et al., 2017). Although less emphasized, food crop production also occupies a significant position in national agriculture. Vegetable farming, in particular, constitutes a critical economic activity, contributing to food security by ensuring stable supplies of fresh produce. Despite its importance, this sector in Côte d'Ivoire remains predominantly oriented toward self-consumption and subsistence agriculture (FAO, 2018), with more than 83% of producers relying on it to meet household needs (Soro et al., 2018). Among the main food crops, okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) are widely cultivated across Côte d'Ivoire (Tuo et al., 2023; Konan et al. 2020). These crops serve both as essential dietary staples and as major income sources for smallholder farmers (Widadie et al., 2024). However, their production is severely threatened by a diverse range of insect pests capable of inducing substantial yield losses. Key pest groups include jassids (leafhoppers), aphids, whiteflies, thrips, caterpillars, beetles, and fruit flies (Koné et al., 2019). These insects attack various parts of the plants, such as leaves, stems, flowers, and fruits, causing deformation, wilting, and reduced productivity (Borkakati et al., 2018). The recent spread of *Amrasca biguttula* in Côte d'Ivoire has caused drastic yield declines in crops such as okra, eggplant, and cotton, posing a significant threat to national food security and farmers' livelihoods (Kouadio et al., 2022). Pest management in these cropping systems frequently relies on the use of chemical pesticides. However, the misuse or overuse of insecticides is widespread, often resulting in increased resistance among pest populations (Sène et al., 2020). Moreover, morphological similarity among certain pest species complicates accurate field identification, which can lead to inappropriate or ineffective control strategies. Genetic variations within and among populations of the pest species could further underscores the need for integrative diagnostic approaches combining morphological and molecular tools (Seehausen et al., 2020). Accurate identification and characterization of pest species are therefore essential prerequisites for developing targeted, sustainable, and effective pest management strategies.

In this context, the present study aims to inventorize and characterize the major insect pests associated with okra and eggplant cultivated in the lowland areas of Daloa. By generating updated morphological and genetic data on local pest populations, this work seeks to support improved diagnostic accuracy and guide the development of more appropriate integrated pest management strategies for vegetable growers in Côte d'Ivoire.

2. METHODOLOGY

2.1 Study Area

This study was conducted in the city of Daloa, specifically within the lowland areas that serve as vegetable production zones, largely managed by women. Okra and eggplant are cultivated either as monocultures or in intercropping systems. Six (6) study sites were randomly selected, based on the presence of these crop species, for insect sampling.

2.2 Sampling

harmful insects were collected from okra and eggplant crops located in various lowland areas of the city of Daloa. The study was conducted during the dry season, from February to April 2025, a period during which pests typically cause more severe damage to vegetable crops than during the rainy season (Zanzana et al., 2025 ; Prabhakar et al., 2024). At each site, ten (10) plants of each crop were randomly selected when okra and eggplant were cultivated together; when only one of the two species was present, the same procedure was applied to the available crop. Sampling focused on the leaves and fruits of mature, productive plants.

Insects were captured using transparent white plastic bags (Fig. 1). The method consisted of enclosing a portion of the plant, including leaves and/or fruits, inside a labeled bag as illustrated in Fig. 1, and then gently shaking this part of the plant to dislodge and trap the pests inside the bag. Although this procedure allowed the collection of a considerable number of insects, it remains non-exhaustive, as some pests may escape capture. The labeled bags corresponding to each sampling site were transported to the laboratory on the same day. Collected specimens were examined under a binocular microscope for identification and subsequently preserved in labeled tubes containing alcohol.

2.3 Morphological Identification of Collected Pests

For more accurate identification, adult specimens were prioritized. Identification was carried out using the consolidated keys provided by Dmitriev and Dietrich (2009) available at :

http://dmitriev.speciesfile.org/key.asp?key=Erythroneura&lng=En&i=1&keyN=12.

Morphological criteria such as body size and shape, coloration, setae arrangement, wing patterns, antenna shape, and specific structures including mouthparts, legs, and the presence or absence of particular projections were examined to identify the collected specimens. Identification was performed using a microscope at 4x and 10x magnification.

Fig. 1. Trapping of insect pests using a plastic bag

2.4 Molecular Analysis

2.4.1 DNA extraction

DNA extraction from the collected specimens was performed using a 2% CTAB protocol (Aikpon et al., 2020). The procedure consisted of grinding each insect specimen in a tube containing 200 µL of 2% CTAB, followed by the addition of 20 µL of Proteinase K and incubation in a water bath at 65 °C for 20 minutes. After incubation, 200 µL of chloroform was added, and the mixture was gently inverted to homogenize. The samples were then centrifuged for 15 minutes at 12,000 rpm at room temperature, after which the upper aqueous phase was transferred to a new tube. Subsequently, 200 µL of isopropanol was added to the supernatant and mixed by gentle inversion. A second centrifugation was carried out for 15 minutes at 12,000 rpm at room temperature, and the isopropanol was carefully discarded. The pellet was drained thoroughly, then washed with 200 µL of 70% ethanol. The samples were centrifuged for 5 minutes at 12,000 rpm at room temperature, the ethanol was removed, and the pellet was allowed to air-dry for 24 hours. Finally, 100 µL of molecular-grade water were added to reconstitute the DNA.

2.4.2 DNA amplification by Polymerase Chain Reaction (PCR)

DNA was amplified using the universal primer pair COI-F (5'-ATAATTTTTTTATAGTTATACC-3') and COI-R (5'-TCCTAAAAAATGTTGAGGAAA-3'), targeting the COI gene (Zhao et al., 2014). PCR conditions were set according to Hossain et al. (2023). The amplified PCR products were analyzed by gel electrophoresis following the standard protocol described by the same author.

2.5 Statistical Analysis

An Excel spreadsheet was used to construct the database. Qualitative variables were presented as frequencies or percentages.

Pearson's Chi-square test or Fisher's exact test (for $n < 5$) was used to assess the association between each insect pest specimen and the host plants. All statistical procedures were performed using computer software, particularly the R statistical package. This comprehensive analytical approach ensured the reliability and scientific rigor of the results, providing a detailed understanding of pest infestations and the identification of the species involved.

3. RESULTS

3.1 Morphological Identification of Collected Insect Pests

Morphological identification of the insects using a microscope allowed their classification into three groups (Table 1) : leafhoppers (jassids), aphids, and true bugs. Among the insects collected from okra and eggplant during this study, leafhoppers were the most frequently encountered, followed by true bugs, and lastly aphids.

Within the leafhoppers, three species were identified on both okra and eggplant : *Amrasca biguttula*, *Jascobiasca lybica*, and *Macrosteles cristatus* (Table 1). The aphid species identified was *Macrosiphum euphorbiae,* and the true bug species was *Macrolophus pygmaeus* (Table 1).

3.2 Molecular Identification of Collected Insect Pests

PCR amplification using the universal COI primer pair enabled the distinction between leafhoppers and other insect pests, such as bugs and aphids. As shown in Fig. 2, fragments of 654 bp correspond to leafhoppers, while fragments of 900 bp correspond to bugs or aphids.

3.3 Distribution According to Host Plants

The distribution of species according to host plants indicates that only one leafhopper species, *Amrasca biguttula*, was found on okra (Table 2). In contrast, all species collected in this survey were found on eggplant (Table 2). These include *Jacobiasca lybica* (leafhopper), which was the most abundant, followed by *A*. *biguttula* (leafhopper), *Macrolophus pygmaeus* (bug), *Macrosiphum euphorbiae* (aphid), and finally *Macrosteles cristatus* (leafhopper). Statistical analyses revealed a highly significant association between pest species and host plants (Table 2, $p < 0.001$). These results indicate that certain leafhoppers, such as *J. lybica* and *M. cristatus*, as well as aphids (*M. euphorbiae*) and bugs (M. pygmaeus), prefer feeding on eggplant rather than on okra.

Table 1. Diverse insect assemblages collected from okra and eggplant

Host plants	Insects collected	Species
Okra	Jassids	*Amrasca biguttula*
Eggplant	Jassids	*Macrosteles cristatus*
		Jacobiasca lybica
		Amrasca biguttula
	Aphid	*Macrosiphum euphorbiae*
	Bug	*Macrolophus pygmaeus*

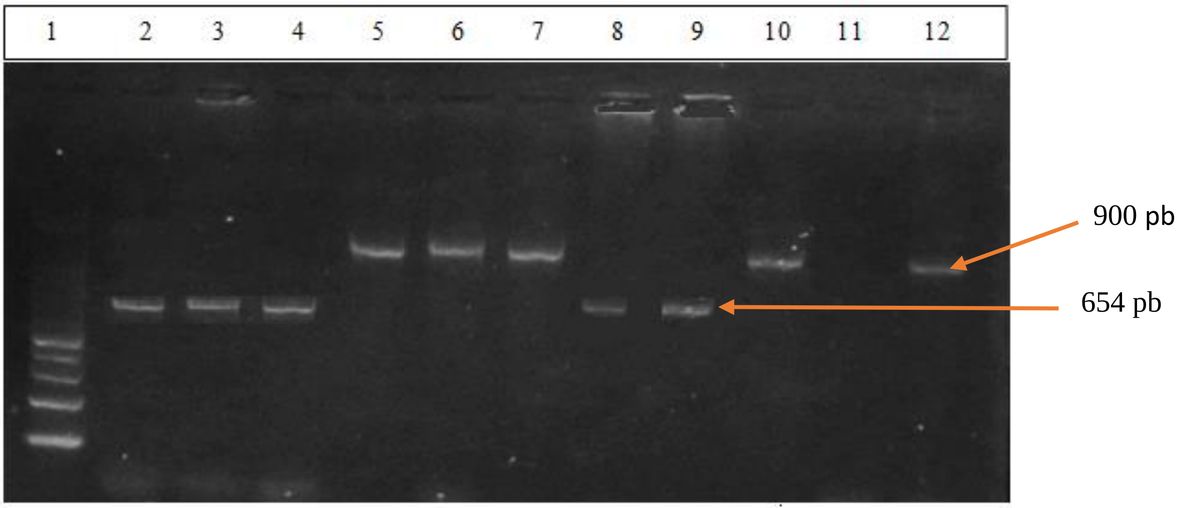

Fig. 2. Electrophoretic profile of PCR products for insect pest identification
Lane 1 : 100 bp DNA ladder ; Lanes 2–4 and 8–9 : leafhoppers ; Lanes 5–7, 10, and 12 : other insect pests; Lane 11: negative control

Table 2. Distribution of leafhopper species according to host plants (okra and eggplant)

Host plants	*Amrasca biguttula* (%)	*Jacobiasca lybica* (%)	*Macrosteles cristatus* (%)	*Macrosiphum euphorbiae* (%)	*Macrolophu spygmaeus* (%)	χ² test (p-value)
Okra	539 (89,53)	0 (0)	0 (0)	0 (0)	0 (0)	< 0,001
Eggplant	63 (10,47)	89 (100)	1 (100)	8 (100)	41 (100)	
Total	**602 (100)**	**89 (100)**	**1 (100)**	**8 (100)**	**41 (100)**	

4. DISCUSSION

Morphological identification of insects collected from okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) leaves allowed the identification of three leafhopper species (*Amrasca biguttula, Jacobiasca lybica*, and *Macrosteles cristatus*), one bug species (*Macrolophus pygmaeus*), and one aphid species (*Macrosiphum euphorbiae*). The higher abundance of leafhoppers on okra and eggplant compared to bugs and aphids can be explained by several ecological and biological factors. Leafhoppers show a particular affinity for these crops, which serve as preferred hosts (Sahu et al., 2024; Tamang et al., 2025). Their piercing-sucking mouthparts are adapted for phloem feeding and the high water and nutrient content of okra and eggplant leaves promotes their establishment and multiplication (Yarou et al., 2023).

In contrast, aphids, although polyphagous, exhibit a marked preference for other plant families, such as Brassicaceae or Cucurbitaceae, which limits their density on these crops (Ahmed et al., 2022). Phytophagous bugs preferentially exploit reproductive organs (fruits and seeds), and their abundance is highly seasonal (Ouaarous et al., 2025). Agro-climatic conditions also play a determining role. Leafhoppers develop optimally under warm and dry conditions, typical of the tropical zones where okra and eggplant are grown (Gupta et al., 2024). Aphids, on the other hand, perform better under temperate and humid climates, explaining their lower density in these agroecosystems (Parajulee, 2007; Soh et al., 2018). Population dynamics may also play a central role. Leafhoppers have a short developmental cycle and high fecundity, allowing them to rapidly and massively colonize crops (Khfif et al., 2023). Thus, the numerical dominance of leafhoppers on okra and eggplant results from a combination of their physiological adaptation to the hosts, high ecological plasticity, rapid reproductive cycles, favorable climatic conditions, and lower pressure from natural enemies. Once considered secondary pests of these crops, leafhoppers have gradually become major pests over recent decades (Kouadio et al., 2022). *Amrasca biguttula* (Shiraki, 1913) was first reported in Africa in Ghana on okra as a minor pest (Kouadio et al., 2022). Favorable climatic conditions may explain its expansion in the sub-region, particularly in Côte d'Ivoire, as there are no geographical barriers for these pests. These results are consistent with those reported by Kouadio et *al.* (2022); however, among the three-leafhopper species identified by these authors, two differ from those found in this study, highlighting the colonization of multiple leafhopper species in the central-western region of Côte d'Ivoire. Similar observations have been made on cotton (Koné et al., 2017).

Molecular identification in this study allowed discrimination of leafhoppers from other insects collected on okra and eggplant leaves. Molecular identification is an essential modern tool for sustainable, knowledge-based agriculture, particularly for vulnerable crops like okra and eggplant. It enables the differentiation of closely related or cryptic species, which is sometimes impossible with morphological identification alone (Wang et al., 2018). This method prevents identification errors, especially at juvenile or larval stages. Indeed, studies have shown that immature stages frequently encountered in quarantine and plant protection activities require rapid and accurate species identification (Wang et al., 2018). Molecular tools are crucial in various pest management fields, including biological control, insecticide resistance management, prevention of invasive and exotic species introductions, and management of vector insects, including the identification of biotypes and cryptic species (Subhashini et al., 2025; Wang et al., 2018). According to Subhashini et al. (2025), molecular approaches are essential for improving crop productivity and sustainability. However, in this study, molecular identification of the different leafhopper species and other pests was not conducted.

Statistical analyses revealed a highly significant association between leafhopper species and host plants, likely because each species shows a preference for a specific plant. For instance, this study showed that only *Amrasca biguttula* was found on okra, despite some samples being collected in fields containing both okra and eggplant. In addition to okra, this species was also found on eggplant along with the two other leafhopper species, aphids, and bugs identified in this study. This is explained by the polyphagous nature of leafhoppers (Kouadio et al., 2022), which attack a wide range of crops, unlike monophagous (single-host) or oligophagous (few closely related hosts) pests. Their ability to feed on diverse plants makes them particularly problematic in agriculture. Numerous studies have shown that leafhoppers are found on a wide variety of crops, including cotton (Koné et al., 2017; Subhashini et al., 2025) and horticultural crops (Al-Hamadany et al., 2017; Kouadio et al., 2022).

The presence of all pests collected in this study on eggplant may lead to damage to the plant and crop yield. Indeed, the co-occurrence of multiple pests on the same crop could lead to co-infestations that increase the virulence of attacks, as different species share similar biological and ecological traits, particularly phloem-sucking feeding behavior (Kumaraswamy et al., 2024).

5. CONCLUSION

This study identified three distinct groups of insect pests, with jassids being the most abundant. These insects are well known for their ability to cause substantial agricultural damage through sap feeding and the potential transmission of phytopathogens. Their simultaneous occurrence on both okra and eggplant highlights their broad nutritional adaptability and underscores the urgent need for improved phytosanitary management of these crops. The combined use of morphological and molecular approaches for pest identification proves essential for promoting sustainable, knowledge-based, and environmentally sound agriculture, particularly for vulnerable crops such as okra and eggplant.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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