Advances in Entomology, 2024, 12, 183-194
https://www.scirp.org/journal/ae
ISSN Online: 2331-2017
ISSN Print: 2331-1991

Cotton Leafhoppers, *Amrasca biguttula* (Ishida, 1913) (Hemiptera: Cicadellidae), Identified as a New Species on Okra and Guinea Sorrel in Niger

Zinsou François-Xavier Akonde[1], Ousmane Zakari Moussa[2*], Sanoussi Atta[1], Idriss Hamidou Leyo[2], Iro Dan Guimbo[2]

[1]Agricultural Zoology Laboratory, AGRHYMET Regional Center, Niamey, Niger
[2]Faculty of Agronomy, Abdou Moumouni University, Niamey, Niger
Email: *o.zakari@gmail.com

How to cite this paper: Akonde, Z.F.-X., Zakari Moussa, O., Atta, S., Leyo, I.H. and Dan Guimbo, I. (2024) Cotton Leafhoppers, *Amrasca biguttula* (Ishida, 1913) (Hemiptera: Cicadellidae), Identified as a New Species on Okra and Guinea Sorrel in Niger. *Advances in Entomology*, **12**, 183-194.
https://doi.org/10.4236/ae.2024.123014

Received: May 3, 2024
Accepted: July 12, 2024
Published: July 15, 2024

Abstract

Leafhoppers (jassids) are well-known pests of vegetable crops in Niger. They are often part of a parasitic complex that causes varying degrees of damage. Over the last two crop years, the Niamey region has seen a heavy outbreak of leaf hoppers on okra and guinea sorrel. These insects alone have caused spectacular damage, resulting in losses ranging from 50% to 100% of unharvested plants. Following this observation, infested fields were surveyed, specimens sampled, and the responsible species identified. Two sites were surveyed in the city of Niamey. At each site, two plots of okra and two of guinea sorrel were visited. Fifty (50) plants were randomly sampled using the double "W" method per plot. The sampled plants were used for active and passive leaf hopper capture, damage description and loss assessment. Captured leaf hoppers were identified based on their morphology observed with a binocular magnifying glass and compared with the data in the identification keys. The symptoms observed in the plots were yellowing, leaf curling and drying, stunting, abortion of flowers and immature fruit and very low production. Identification results revealed the single species *Amrasca biguttula* (Ishida, 1913), which can be considered a new invasive species in Niger. Further confirmation of this identification by molecular tests, the distribution of the pest in Niger and the development of appropriate control methods would yield good prospects.

Keywords

Amrasca biguttula, Guinea Sorrel, Niger, Okra, Survey

1. Introduction

Native and exotic vegetables play a key role in most food security and poverty alleviation programs worldwide. In the Sahel, vegetable crops are a source of food and income for farmers, as well as an economic source for nations [1]. In Niger, okra (*Abelmoschus esculentus* (L.) Moench) and Guinea sorrel (*Hibiscus sabdariffa* (L.)) are among the most promising market garden crops, providing economic benefits due to their high marketability, and helping to improve household dietary conditions, particularly for women and small-scale producers. The nutritional value of 53 g of okra is estimated at 16 calories, 1.1 g of protein, 3.7 g of carbohydrates, 0.1 g of lipids and 1.7 g of dietary fibre [2], while that of 53 g of Guinea sorrel is estimated at 28 calories, 6.4 g of carbohydrates, 0.5 g of protein, 0.4 g of lipids, 6.8 mg of vitamin C, 122.6 mg of calcium, 29.1 mg of magnesium and 0.8 mg of potassium [3].

However, Guinean okra and sorrel crops, already suffering from the vagaries of the climate, are subject to pest attacks, including jassids [1] [4] [5]. These biotic constraints limit the productivity of both crops, and consequently reduce growers' incomes. In recent years, Africa has seen invasions of new crop pests such as *Tuta absoluta* on tomatoes and solanaceous plants in 2011, *Spodoptera frigiperda* on maize and other cereals in 2017, and recently *Amrasca biguttula* reported on cotton and other malvaceous plants in 2022-2023. The latter pest is a cotton leafhopper native to the Asian continent, which was first introduced into West Africa. It reproduces and migrates seasonally on a wide range of crops, and rapidly develops resistance to pesticides [6]. It has been reported during 2022-2023 in Burkina-Faso on cotton, okra, and Guinea sorrel in Mali, Togo and Senegal on cotton [7]; in Benin on cotton and okra [8] and in Côte d'Ivoire on cotton, okra and Guinea sorrel [9]. Reported damage reveals that the insect injects phytotoxin into plants, causing leaves to turn pale at the edges, wrinkle, curl, redden and wilt, leading to completed desiccation of the plants. In these countries, the drop in yields of infested crops is between 30% and 50% and represents a major economic loss for the nations concerned [10].

During the years 2022 and 2023 harvesting seasons, market gardeners in Niger complained about the alarming phyto sanitary situation caused by leafhoppers in their okra and Guinea sorrel plots. Following complaints from these growers, a survey was carried out to observe and collect leafhoppers, with a view to diagnosing the damage caused and identifying the insect species responsible.

2. Materials and Methods

2.1. Materials

The survey was carried out in South-west Niger at two market-gardening sites in the city of Niamey (**Figure 1**). The equipment consisted mainly of vacuum cleaners used to actively capture live insects (**Figure 2**), yellow glue traps made of 150 cm^2 pieces of yellow plastic coated with glue to attract and hold insects, alcohol tubes and naphthalene (camphor) boxes for killing and preserving specimens, and GPS to record the geographical coordinates of each site. Led Light microscope model MIC-209, Plan 1X binocular. Wild Heerbrugg and entomological kit were used to observe, manipulate, measure, describe and photograph specimens in the laboratory.

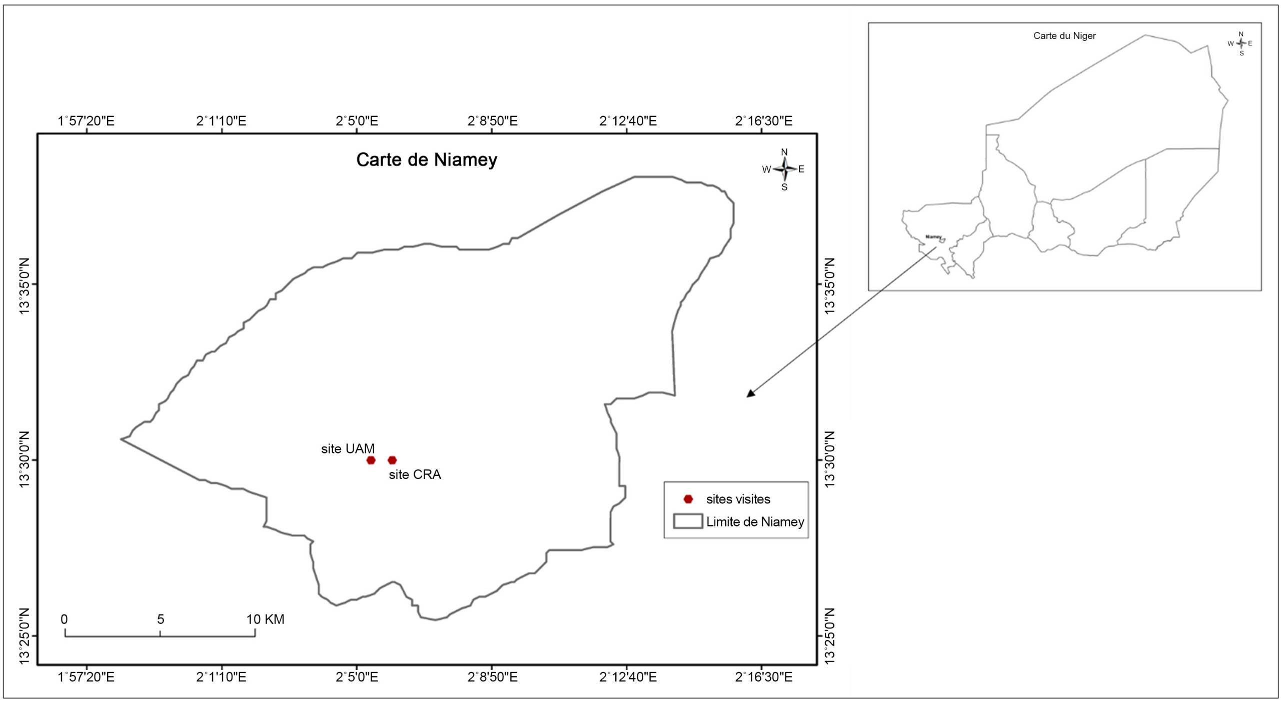

Figure 1. Map of Niamey showing the surveyed sites.

Figure 2. Active leafhopper capture using a vacuum cleaner on a surveyed plot.

2.2. Damage Characterization and Specimen Collection

Two plots of Okra and two plots of Guinea sorrel were visited per site. Symptoms and damage observed were described. Using a pocket magnifier, the different stages of insects on the leaves of both plants were clearly visualized. Fifty (50) plants were randomly selected per plot using the double "W" method and used for specimen collection, description, and damage estimation. Each point of the "W" represented a focus of five (5) sample plants. Leaf hopper specimens were collected from Okra and Guinea sorrel leaves using a manual aspirator, and passively using yellow glue traps set in the plots at five (05) sample focus points for 24 hours (**Figure 3**). Collected specimens were placed in alcohol tubes and boxes containing naphthalene for preservation. The labelled boxes were then sent to the agricultural zoology laboratory of the Agrhymet Regional Center in Niamey for morphological identification. Damage was estimated by assigning a score to each plant sampled according to the following criteria.

Criteria	Scores
Plant without attack	0
10% of leaves yellowed or burnt, fruits present	1
11% to 20% of leaves yellowed or burnt, some fruit present	2
21% to 40% of leaves yellowed or burnt, no fruit	3
41% to 60% of leaves yellowed or burnt, dwarfing, no fruit	4
more than 60% of leaves yellowed or burnt, dwarfing, no fruit	5

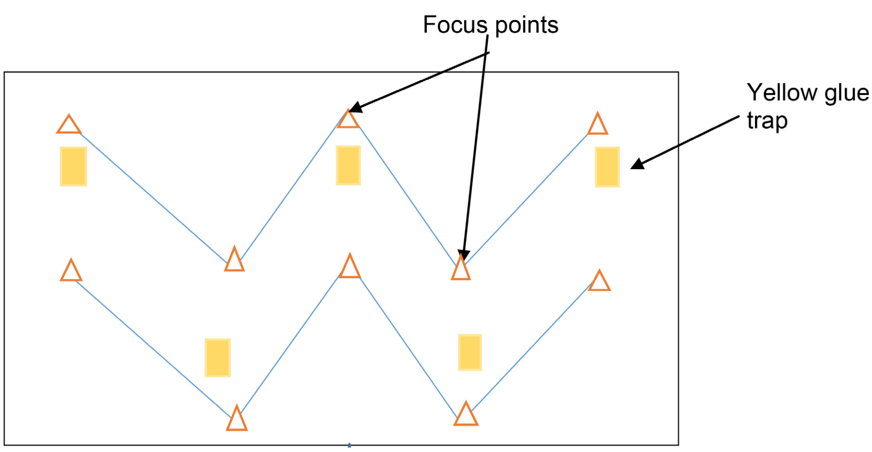

Figure 3. Sampling scheme in a surveyed plot.

2.3. Morpho-Metric Specimen Identification

Morphometric specimen identification was conducted at the Agricultural Zoology Laboratory of the Agrhymet Regional Center in Niamey. The LED Optical Microscope MIC-209 model, the Plan 1X Heerbrugg Wild binocular and the entomological kit were used to observe, manipulate, measure, describe and photograph the tags and appendages of specimen insects at 25× and 40× magnification. The graph paper was used to measure the size of the insects or their parts. Fifty (50) specimens per plot were studied under the microscope, selected at random from the samples. A total of four hundred (400) individuals were studied for the eight (8) plots surveyed.

The key from [11] on the site: 3I Interactive Keys and Taxonomic Databases (http://dmitriev.speciesfile.org/) was used for the identification and was based on the insect's size and general coloration, the characteristic features of its head, wings, legs and abdomen, and the shape and size of its genitalia [12].

2.4. Data Analysis

The analyses focused on describing the morphological traits observed and comparing them with the characteristic traits of the jassid species described in the key. Following a differential approach, species not concerned were progressively eliminated, and only the identified species were retained at the end.

The incidence of attack (I) and the average level of damage (S) were calculated using the formulas:

$$I = \frac{n}{N}$$

with n, number of infested plants and N, total number of plants assessed.

$$S = \sum \frac{nixi}{N}$$

with ni, number of plants having received score i; xi, average percentage corresponding to score i and N total number of plants evaluated.

3. Results

3.1. Characterization of Leafhopper Damage in the Field

On the underside of the leaves were the jassids, which fed on the sap by digging their stylet into the leaf tissue. Infested plants showed tiny puncture marks on the leaves, which turned yellow and began to dry out from the edges towards the center. One infested plot showed a facies similar to that of a virosis: waffling, curling, general yellowing of the leaves, while retaining the green color at the veins, stunting of the plants, abortion of the flowers and some undeveloped fruit. In the event of heavy infestation, we have noted leaf desiccation and fall, followed by stunted growth or death of the plants.

Analysis of the data collected revealed a high average incidence (I) of 98% of infested plants showing visible symptoms. The average level of damage (S) obtained was 55%, corresponding to score 4 (41% to 60% of leaves yellowed or burnt, dwarfing, no fruit and very low yield, etc.).

3.2. Leafhoppers Identification

Specimens observed under the microscope and compared with data from the keys used enabled us to identify a single species of leafhopper: *Amrasca biguttula* (Ishida, 1913) (**Figure 4** & **Figure 5**). The characteristic features observed were:

General appearance: The predominant color was green, yellow with a few symmetrical cream-colored markings on the head and thorax (Figure 6). Males averaged 2.1 mm and females, 2.4 mm.

Head: Prominent black spots were observed on both sides of the midline on the top of the head (Figure 7a). The head was clearly wider than the pronotum (Figure 7b).

Forewing: The Cu Cubital cell has a distal black spot in the apical area. The distal CuP segment is twice as long as the distal CuA segment located between the Cubital Stem and the Posterior Median MP. Apical cell 4 is tapered along its entire length (Figure 8a).

Figure 4. Yellowing and leaf curling (a), leaf tip scorch (b) and Leafhoppers on leaves (c) of Okra.

Figure 5. Leafcurl, leaf tip scorch (a) and presence of Leafhoppers on leaves (b) of Guinea sorrel.

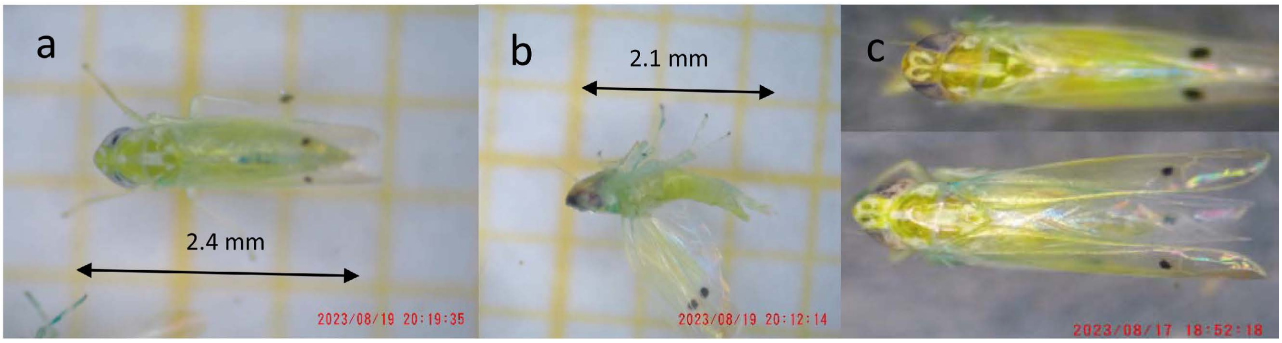

Figure 6. Female length (a), male length (b) and coloration (c) of *Amrasca biguttula*.

Hindwings: The first apical cell of the hind wing is twice as long as it is wide (Figure 8b).

Legs: On capture, the legs are arranged AV. The anterior femur has a clearly enlarged basal bristle and the medial femur has a dorso-apical macrochaete (Figure 9).

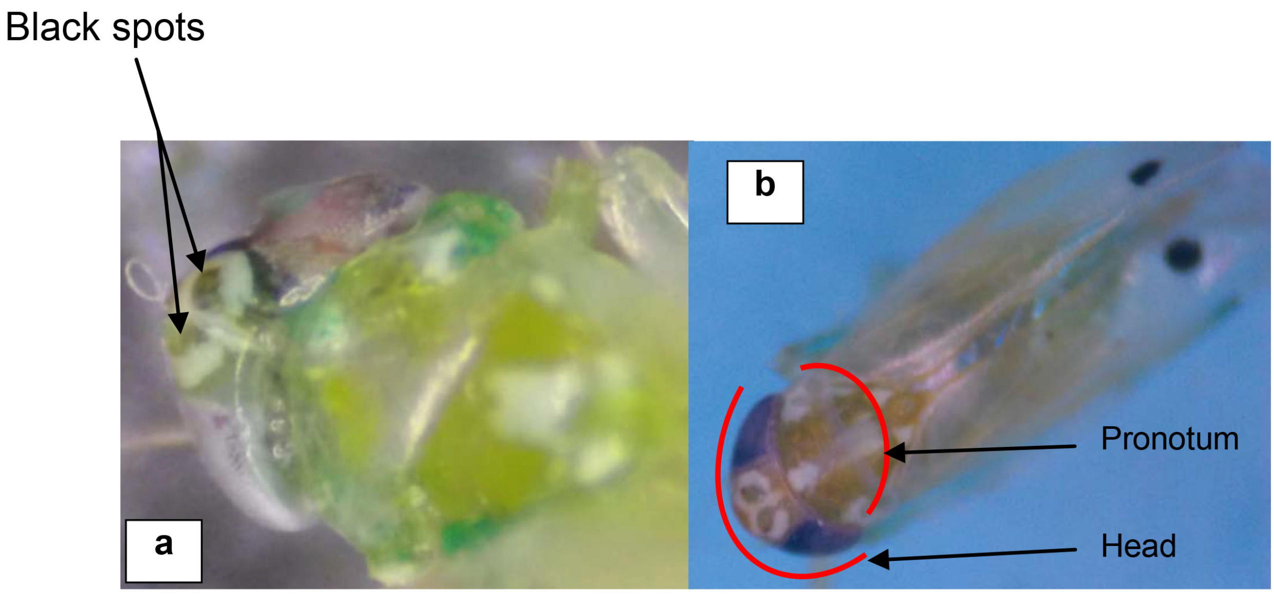

Figure 7. Characteristic features of the *Amrasca biguttula* head.

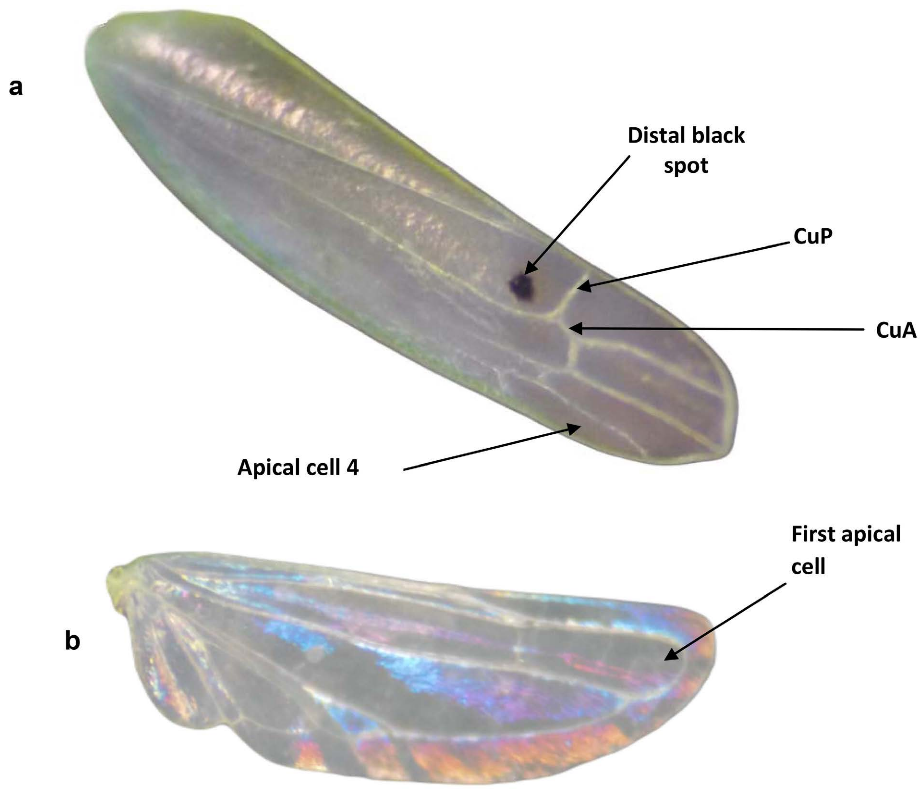

Figure 8. Forewing (a) and Hindwings (b) of *Amrasca biguttula*.

Abdomen: Apodemes are present on the first three sternites. Sternites VII and VIII are modified into pregenital ridges in the male (Figure 10). The female abdomen is rounded, with an ovipositor visible at the tip (Figure 11). The male subgenital plate or pygofer is paired at the distal end. The plate is partially separated from the base by a distinct dorsal membranous slit. The ventral appendage (aedeagus or copulatory organ) of Pygofer is present, visible, wall-free for at least half its length, elongated, extended beyond the apex of pygofer. The aedeagus is straight for most of its length, but curves upwards near its apex (Figure 11a). Pygofer has thin lateral and distal bristles.

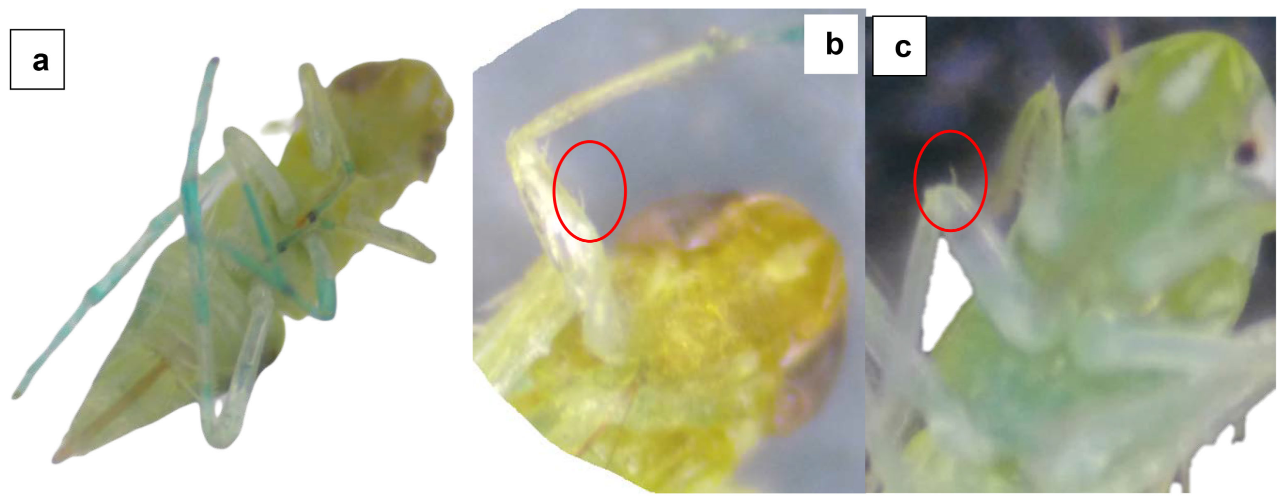

Figure 9. AV legs (a), basal bristle of anterior femur (b), dorso-apical macrochaeta of medial femur (c).

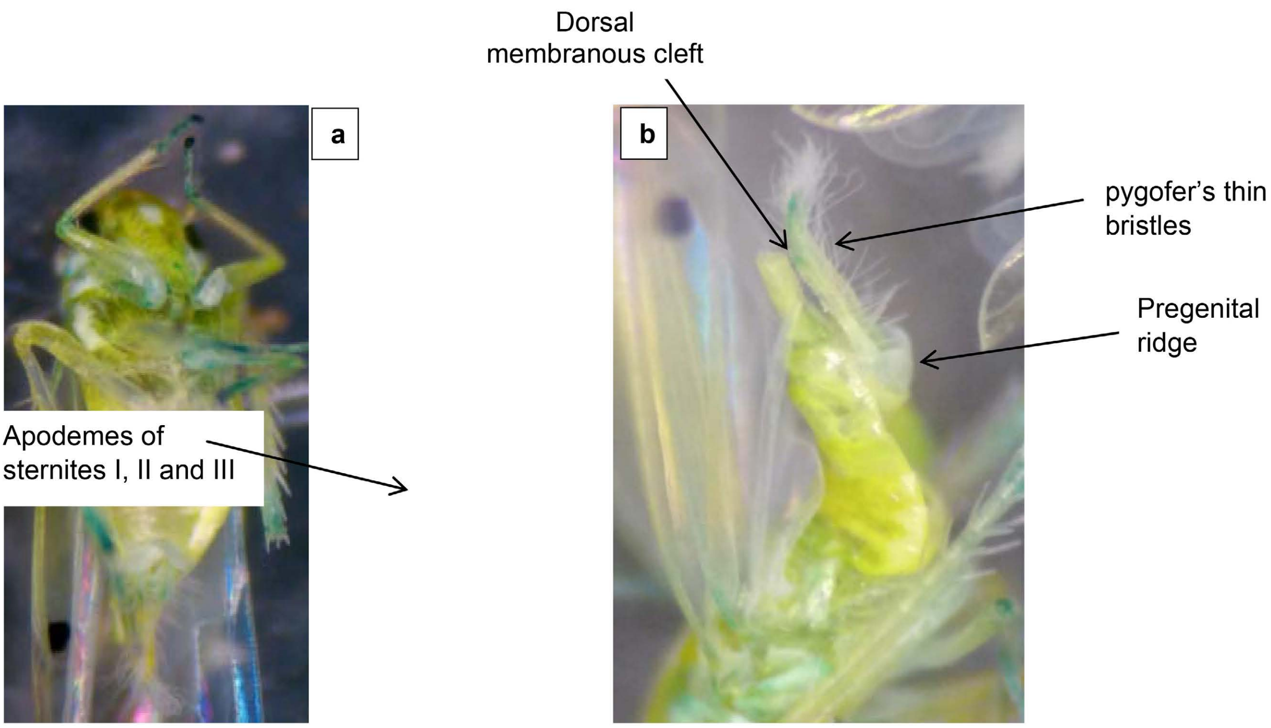

Figure 10. Abdominal Apodemus (a), male sub genital plate (b).

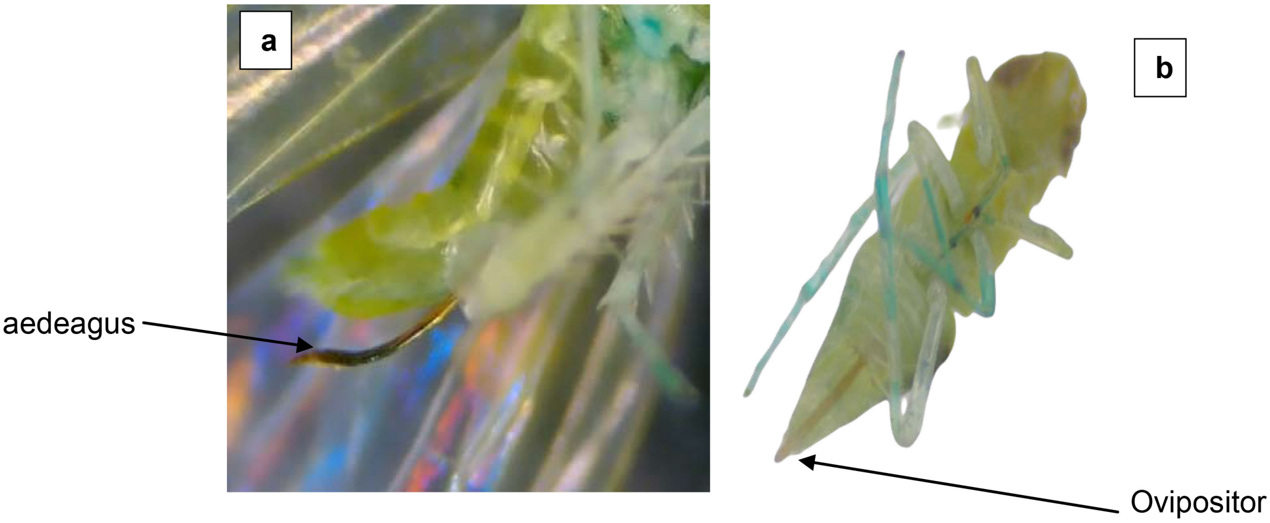

Figure 11. Male copulatory organ (a) and female ovipositor (b).

4. Discussion

The damage observed in the field was: waffling, rolling, yellowing and burning of leaves while retaining the green color of the veins, stunting of plants, abortion of flowers and immature fruits. These clinical signs are those described by [1] [9] and [13] for the same pest on cotton and okra. According to the researchers, the leafhopper digs its stylet into the plant's leaf tissue to extract sap, while injecting a phytotoxic saliva [14] that burns the oldest cells of the leaves, thus their tips. This reduces the plant's photosynthesis, growth and development [15]. The insect also has an indirect impact by transmitting phyto viruses to the attacked plant [16], causing wilting, yellowing, stunting and abortion of flowers and immature fruit. Analysis of the data collected revealed a high average incidence (98%) of infested plants showing visible symptoms. The average level of damage obtained is 55% of leaves, flowers and fruit destroyed, leading to a drastic drop in the harvest. Similar damage and production losses have been estimated by [8] [15] [17]-[19] who have conducted various studies on *Amrasca biguttula* in the field.

Morphological analysis of leafhopper specimens collected in okra and Guinea sorrel plots revealed only the presence of the species *Amrasca biguttula* (Ishida, 1913). The average length (head-tip of abdomen) of the adults measured was between 2.1 mm and 2.4 mm. This corroborates the results obtained by [20] and [21] in their study of *Amrasca* species in Vietnam, Ben Tre province, Pakistan and India. The description of the head of the species by [12] was consistent with the present identification. Similarly, [22] obtained the same results when identifying jassid species in India. The combination of information from scientific morphometric identification work by researchers [6] [23]-[25] on leafhoppers has enabled us to ascertain the identification of *Amrasca biguttula* on okra and sorrel crops in Niger. Molecular tests will enable us to check whether there are any sub species of the same species. The species are well known on okra and cotton in its native range [26]. For the first time in Niger, it has been found on okra and sorrel, with an increased severity of attack. According to [27], the cotton leafhopper is a polyphagous species and causes damage followed by major losses on its host plants. This new leafhopper species seems to have adapted very quickly to Niger's climatic conditions, with a strong capacity for out breeding, to the point where it is said to have a suppressive effect on existing endogenous leafhopper species. Its invasion of these crops has already given rise to considerable concern among growers.

5. Conclusions

This study was the first study of the presence of the Leafhoppers *Amrasca biguttula* (Ishida, 1913) in Niger, an emerging pest in West Africa. It was found on Okra and Guinea sorrel, where it caused severe damage with major crop losses in infested plots. Its distribution, bioecology and host plant diversity, as well as the potential yield losses it may cause, need to be studied in Niger.

In addition, monitoring its population dynamics over the course of the year will make it possible to control the periods of heavy attacks by this new pest, and to design and implement effective integrated pest management strategies.

Funding

This research received SUSTLIVES project (UE) funding.

Data Availability Statement

The data presented in this study are available in this article.

Acknowledgements

The authors are grateful to all those who contributed either way to complete this study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] James, B., Atcha, A., Godonou, I., Baimey, H. and Goergen, G. (2010) Gestion intégrée des nuisibles en production maraîchère: Guide pour les agents de vulgarisation en Afrique de l'Ouest. IITA.

[2] ONU (2020) L'ONU proclame 2021 Année internationale des fruits et légumes|ONU Info. https://news.un.org/fr/story/2020/12/1084622

[3] Soro, L.C., Atchibri, L.O., Kouadio, K.K. and Kouamé, C. (2012) Evaluation de la composition nutritionnelle des légumes feuilles. *Journal of Applied Biosciences*, **51**, 3567-3573.

[4] Ben Dkhil, B. and Denden, M. (2010) Effects of Heat Stress on the Germination, Protein Degradation and Mineral Content in Seeds of Okra (*Abelmoschus esculen-*

tus L.).

[5] Gnago, J.A., Danho, M., Agneroh, T.A., Fofana, I.K. and Kohou, A.G. (2010) Efficacité des extraits de neem (*Azadirachta indica*) et de papayer (*Carica papaya*) dans la lutte contre les insectes ravageurs du gombo (*Abelmoschus esculentus*) et du chou (*Brassica oleracea*) en Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*, **4**, 953-966. https://doi.org/10.4314/ijbcs.v4i4.63035 https://www.ajol.info/index.php/ijbcs/article/view/63035

[6] Sagarbarria, M.G.S., Taylo, L.D. and Hautea, D.M. (2020) Morphological and Molecular Analyses of Leafhopper, *Amrasca biguttula* (Ishida) (Hemiptera: Cicadellidae) Infesting Eggplant (*Solanum melongena* L.) in Luzon Island, Philippines. *Journal of Asia-Pacific Entomology*, **23**, 260-268. https://doi.org/10.1016/j.aspen.2019.12.009

[7] Badiane, G. (2023) Évaluation de l'efficacité biologique du Fluxamétamide 31 g/ha pour le contrôle de *Amrasca biguttula* (I) ravageur du cotonnier (*Gossypium hirsitum* L.) au Sénégal. https://rivieresdusud.uasz.sn/handle/123456789/1831

[8] Yarou, B.B., Francisco, A.R., De Troij, A. and Aboubakar Souna, D. (2023) *Amrasca biguttula* Ishida: Quel avenir pour la production du gombo au Bénin? World Vegetable Center. https://agritrop.cirad.fr/607265/2/607265.pdf

[9] Kouadio, H., Kouakou, M., Bini, K.K.N., Ouattara, M.A.-N., Adepo-Gourène, B.A. and Ochou, O.G. (2022) Diagnostic des attaques de jassides sur des parcelles de gombos et d'aubergines au Centre et au Centre-Ouest de la Côte d'Ivoire. *International Journal of Innovation and Applied Studies*, **38**, 408-416.

[10] Bachelier, B., *et al.* (2023) Gestion de l'invasion de jassides dans les zones cotonnières d'Afrique de l'Ouest et du Centre-Vers une stratégie de recherche interdisciplinaire. PR-PICA. https://agritrop.cirad.fr/604503

[11] Bartlett, C.R., Deitz, L.L., Dmitriev, D.A., Sanborn, A.F., Soulier-Perkins, A. and Wallace, M.S. (2018) The Diversity of the True Hoppers (Hemiptera: Auchenorrhyncha). In: Foottit, R.G. and Adler, P.H., Eds., *Insect Biodiversity*: *Science and Society*, Vol. 2, Wiley, 501-590. https://doi.org/10.1002/9781118945582.ch19

[12] Xu, Y., *et al.* (2021) Phylogeny of the Tribe Empoascini (Hemiptera: Cicadellidae: Typhlocybinae) Based on Morphological Characteristics, with Reclassification of the Empoasca Generic Group. *Systematic Entomology*, **46**, 266-286. https://doi.org/10.1111/syen.12461

[13] Hooda, V.S., Dhankhar, B.S. and Singh, R. (1997) Evaluation of Okra Cultivars for Field Resistance to the Leafhopper *Amrasca biguttula biguttula* (Ishida). *International Journal of Tropical Insect Science*, **17**, 323-327. https://doi.org/10.1017/S1742758400019135

[14] Manivannan, A., Kanjana, D., Dharajothi, B. and Meena, B. (2021) Evaluation of Resistance in Cotton Genotypes against Leafhoppers *Amrasca biguttula biguttula* (Ishida), (Homoptera: Cicadellidae). *International Journal of Tropical Insect Science*, **41**, 2409-2420. https://doi.org/10.1007/s42690-020-00416-0

[15] Ahmad, S. (2020) Evaluation of Indigenous Plant Extracts against Jassid, *Amrasca bigutulla bigutulla* I. (Cicadellidae: Homoptera) on Okra. *Uttar Pradesh Journal of Zoology*, **41**, 38-47.

[16] Jayarao, B., Khadar, B.A., Naik, L.K. and Vinaykumar, M.M. (2015) Assessment of Biology and Morphometric Characteristics of Different Stages of Leafhopper, *Amrasca biguttula biguttula* (Ishida) on Okra. *The Bioscan*, **10**, 671-674.

[17] Kumar, N. and Pathania, P. (2006) Evaluation of Promising Molecules against In-

sect Pests of Okra. *Annals of Plant Protection Sciences*, **16**, 29-32.

[18] Kale, J.V., Wadnerkar, D.W., Zanwar, P.R. and Sangle, P.D. (2005) Bioefficacy of Newer Insecticides against Insect Pests of Okra. *Pestology*, **29**, 9-12.

[19] Ardhendu Chakraborty, A.C., Kumar, K. and Chitra, N. (2014) Computation of Insects Biodiversity in Bhendi (*Abelmoschus esculentus* (L.) Moench) Ecosystem.

[20] Dung, L.T., Liem, N.V., Lam, P.V., Tan, L.V. and Hai, N.N. (2021) Morphological and Molecular Characterization of Two Leafhopper Species of Genus Amrasca (Hemiptera: Cicadellidae) Hosting to Durian. *Journal of Entomological Research*, **45**, 476-481. https://doi.org/10.5958/0974-4576.2021.00074.8

[21] Gogi, M.D., Arif, M.J., Ramzan, R., Nawaz, A. and Bashir, M.H. (2023) Insect Pests of Summer Fodder Crops. In: Ul Haq, I., Ijaz, S. and Ali, H., Eds., *Sustainable Summer Fodder*: *Production*, *Challenges*, *and Prospects*, CRC Press. https://api.taylorfrancis.com/content/chapters/edit/download?identifierName=doi&identifierValue=10.1201/b23394-9&type=chapterpdf

[22] Dworakowska, I. (1977) On Some Typhlocybinae from Vietnam (Homoptera: Cicadellidae). *Folia Entomologica Hungarica*, **30**, 9-47.

[23] Sagar, D., Balikai, R.A. and Bhat, R.S. (2014) Molecular and Taxonomic Diversity of Cotton Leafhopper, *Amrasca biguttula biguttula* (Ishida) in Major Cotton Growing Districts of Karnataka. *Vegetos—An International Journal of Plant Research*, **27**, 225-228. https://doi.org/10.5958/2229-4473.2014.00036.6

[24] Qin, D., Lu, S. and Dietrich, C.H. (2014) A Key to the Genera of Empoascini (Hemiptera: Cicadellidae: Typhlocybinae) in China, with Descriptions of Two New Genera and Two New Species. *Florida Entomologist*, **97**, 1493-1510. https://doi.org/10.1653/024.097.0425

[25] Xu, Y.E., Wang, Y., Dietrich, C.H., Fletcher, M.J. and Qin, D. (2017) Review of Chinese Species of the Leafhopper Genus Amrasca Ghauri (Hemiptera, Cicadellidae, Typhlocybinae), with Description of a New Species, Species Checklist and Notes on the Identity of the Indian Cotton Leafhopper. *Zootaxa*, **4353**, 360-370. https://doi.org/10.11646/zootaxa.4353.2.7

[26] Wang, Y.-M., Xu, Y., Dmitriev, D.A., Dietrich, C.H. and Qin, D.-Z. (2021) Two New Empoascine Leafhopper Genera, Thaioasca and Mjolnirus, from Thailand (Hemiptera: Cicadellidae: Typhlocybinae), with a Checklist of Empoascini in Thailand. *Zootaxa*, **4915**, 246-254. https://doi.org/10.11646/zootaxa.4915.2.4

[27] Renou, A., Eittipibool, W. and Dessauw, D. (1998) Pilosité foliaire chez le cotonnier. Résistance aux jassides et rendement égrenage. CIRAD-CA.