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INFESTATION BY *AMRASCA BIGUTTULA* AND ASSOCIATED FOLIAR DAMAGE IN DIFFERENT OKRA AND EGGPLANT VARIETIES CULTIVATED DURING THE DRY SEASON IN THE LOWLANDS OF DALOA, CÔTE D'IVOIRE

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ABSTRACT

Vegetable production is essential for food security and household livelihoods in sub-Saharan Africa. In Côte d'Ivoire, okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) are widely cultivated in lowland areas, where insect pests can affect crop performance. This study aimed to assess the abundance of the leafhopper *Amrasca biguttula* and its association with foliar damage in four okra and eggplant varieties cultivated in the lowlands of Daloa, Côte d'Ivoire.

Entomological surveys were conducted on two okra varieties ('Koto' and 'Tomi') and two eggplant varieties ('Djamba' and 'Purple-fruited'). Pest abundance and five foliar damage parameters were recorded. Differences in abundance were assessed using chi-square and Kruskal–Wallis tests, while associations between *A. biguttula* abundance and foliar damage were evaluated using Spearman's correlation and linear regression.

A total of 4,874 individuals belonging to 12 taxa were recorded, with *A. biguttula* accounting for 95.24% of all captures. It was the predominant pest in both okra (95.40%) and eggplant (94.97%), with no significant difference between crops ($\chi^2 = 0.47$, $p = 0.492$) or varieties ($p = 0.435$). However, damage severity ($p = 0.043$), leaf yellowing ($p = 0.030$), and leaf curling ($p < 0.001$) differed significantly among varieties. *A. biguttula* abundance was positively correlated with damage severity ($\rho = 0.694$, $p < 0.001$) and other foliar damage parameters, explaining 47.3% of the variation in damage severity.

These findings identify *A. biguttula* as a major pest and emphasize the need for regular monitoring and integrated pest management in lowland vegetable production systems.

Keywords: *Amrasca biguttula*; Okra; Eggplant; Foliar Damage; Varieties; Daloa.

1 INTRODUCTION

Vegetable production is a strategic component of agriculture in sub-Saharan Africa because of its contribution to food security, dietary diversification, and household farm income [1]. In Côte d'Ivoire, okra (*Abelmoschus esculentus* L. Moench) and eggplant (*Solanum melongena* L.) are among the major vegetable crops due to their high nutritional value, economic importance, and strong demand in local and regional markets [2]. In lowland areas, dry-season production helps maintain market supplies during periods of low rainfall while improving farmers' incomes.

However, the sustainability of these production systems is severely constrained by attacks from numerous pests, particularly piercing-sucking insects. Among them, the leafhopper *Amrasca biguttula* (Hemiptera: Cicadellidae) is considered one of the most damaging pests of vegetable crops in tropical and subtropical regions [3, 4]. This polyphagous insect attacks several cultivated crops, including okra, eggplant, cotton, and potato. Both nymphs and adults feed by piercing leaf tissues and sucking plant sap, causing characteristic symptoms such as leaf yellowing, curling, and drying, which can reduce plant growth and lead to substantial yield losses [5, 6]. In recent years, *A. biguttula* has undergone rapid geographical expansion in West Africa. In Côte d'Ivoire, this species has become dominant on okra, eggplant, and cotton, where it appears to be progressively replacing native leafhopper species, particularly *Jacobiasca lybica*, thereby confirming its invasive potential and increasing phytosanitary importance [7].

In response to infestations, farmers primarily rely on repeated applications of synthetic insecticides. This strategy, often implemented without monitoring pest populations or intervention thresholds, promotes the development of insecticide resistance, increases production costs, and may have adverse effects on human health, non-target organisms, and the environment [8]. In this context, integrated pest management approaches based on knowledge of pest population dynamics, pest damage potential, and crop susceptibility are essential alternatives for achieving sustainable vegetable production.

Despite the importance of vegetable production in the lowlands of Daloa, information on the impact of *A. biguttula* on dry-season okra and eggplant crops remains limited. Available data mainly concern species identification and geographical distribution, whereas infestation levels and associated damage under local production conditions remain poorly documented. This knowledge gap constrains the development of effective management strategies adapted to local vegetable production systems.

The present study aimed to assess the abundance of *A. biguttula* and its associated foliar damage across different varieties of okra (*A. esculentus*) and eggplant (*S. melongena*) cultivated during the dry season in the lowlands of Daloa. The findings are expected to contribute to improving integrated pest management strategies in lowland vegetable production systems.

2 METHODOLOGY

2.1 Study Area

This prospective cross-sectional study was conducted at five vegetable production sites (Orly, Kennedy, Tazibouo, Gbokora, and Savonnerie) located in the lowland areas of Daloa, in the Haut-Sassandra Region of central-western Côte d'Ivoire (Figure 1). These lowlands constitute the main vegetable production areas of the city, where okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) are cultivated during the dry season, either as sole crops or in mixed cropping systems.

The city of Daloa is located between latitudes 6° and 7° N and longitudes 7° and 8° W [9]. It covers an area of approximately 5,305 km^2 and had a population of 421,879 inhabitants according to the General Population and Housing Census (RGPH, 2021). The climate is humid tropical, with annual rainfall ranging from 1,000 to 2,000 mm, a long rainy season from March to October, and a dry season from November to February [9]. These climatic conditions favor the year-round cultivation of vegetable crops and the development of insect pest populations.

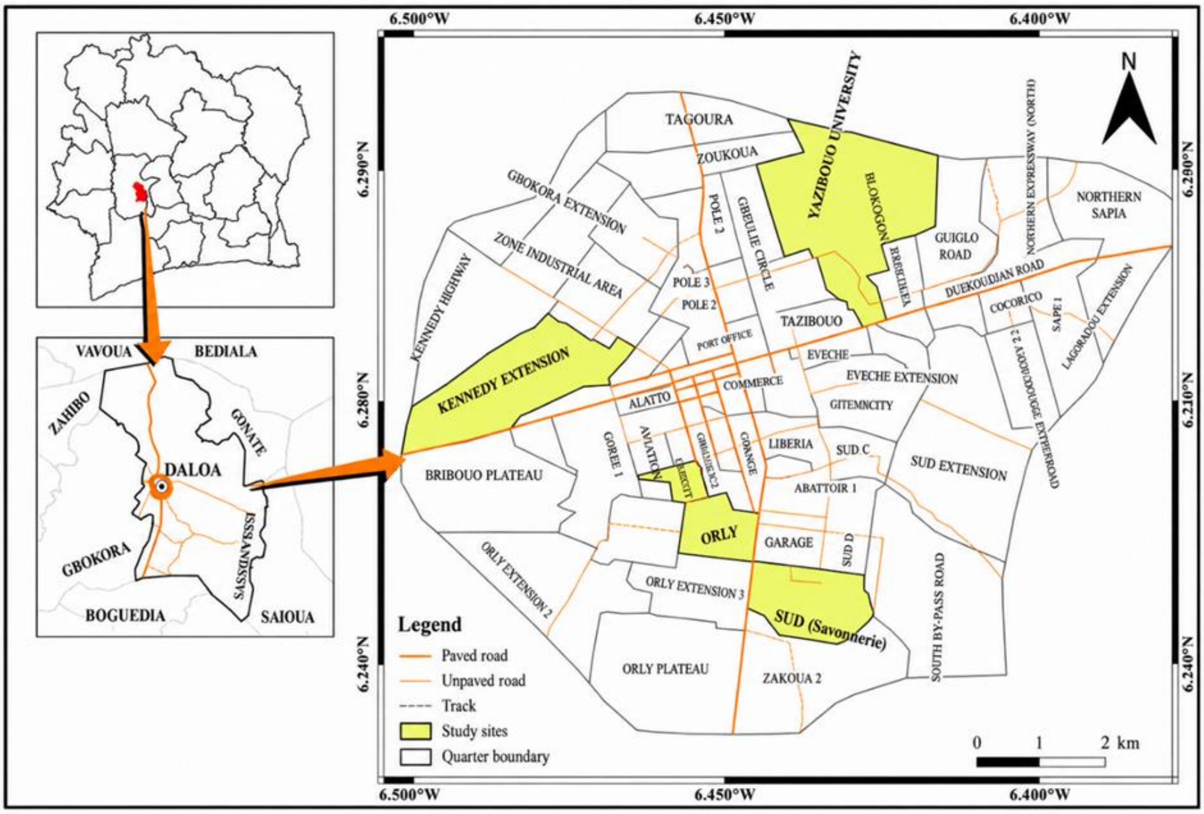

Figure 1: Location of the study sites

2.2 Sampling

After obtaining consent from the plot owners, okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) fields located in the lowlands of Daloa were surveyed to assess the presence, abundance, and damage caused by insect pests across the cultivated varieties. In each plot, plants were randomly selected from both the field margins and the central areas, regardless of the cropping system (monocropping or intercropping). Observations were conducted weekly from February to March, corresponding to the dry season.

Pests were recorded through direct observation and collection from the selected plants. Mobile individuals were collected using transparent plastic bags, while small insects were examined using an entomological hand lens. Only adult specimens were preserved in 70 % ethanol for subsequent taxonomic identification in the laboratory using identification keys.

Damage observed on leaves, stems, and fruits was assessed using standardized field data sheets. The assessment criteria included the plant organs attacked, the presence of characteristic symptoms, and the severity of damage.

2.3 Statistical analysis

Data were analyzed using R software. Pest abundance was expressed as counts and percentages. The distribution of *Amrasca biguttula* between okra and eggplant was compared using Pearson's chi-square test. Differences in *A. biguttula* abundance and leaf damage parameters among the four varieties were assessed using the Kruskal–Wallis test. When significant differences were detected, Dunn's post hoc test with Holm adjustment was used for pairwise comparisons. Associations between *A. biguttula* abundance and damage incidence, severity, leaf yellowing, curling, and drying were assessed using Spearman's rank correlation coefficient (ρ). A simple linear regression was used to graphically illustrate the relationship between *A. biguttula* abundance and damage severity, with R^2 used to describe the proportion of variation explained by the linear relationship. Statistical significance was set at $p < 0.05$.

3 RESULTS

3.1 Composition and abundance of insect pests associated with okra and eggplant

A total of 4,874 individuals belonging to 12 insect pest taxa were recorded on okra and eggplant during the study period (Table 1). The structure of the insect pest community was characterized by a highly uneven distribution of abundances, with a clear predominance of the leafhopper *Amrasca biguttula*, which accounted for 95.24% of all individuals collected (4,642 individuals) (Table 1 and Figure 2). This species was also the dominant pest on both crops, accounting for 95.40% of individuals collected from okra (2,925 individuals) and 94.97% from eggplant (1,717 individuals) (Table 1).

The other taxa collectively accounted for only 4.76% of all individuals collected (n = 232). Among these secondary pest species, the flea beetle *Podagrica decolorata* was the most abundant, with 68 individuals (1.40%), followed by the cotton stainer *Dysdercus voelkeri*, with 43 individuals (0.88%), and the greenhouse whitefly *Trialeurodes vaporariorum*, with 47 individuals (0.96%) (Table 1 and Figure 2). On okra, these species represented the main associated pests after *A. biguttula*. On eggplant, the most abundant secondary species were *Jacobiasca lybica* (23 individuals; 1.27%), *Draeculacephala antica* (22 individuals; 1.22%), and *Trialeurodes vaporariorum* (19 individuals; 1.05%) (Table 1).

The remaining taxa showed very low relative abundances, each accounting for less than 0.5% of the total individuals collected, with numbers ranging from 23 individuals for *Jacobiasca lybica* (0.47%) to a single individual for *Steganocerus multipunctatus* (0.02%). Some species were restricted to a single crop. *Podagrica decolorata*, *Aspavia armigera*, and *Pseudococcus comstocki* were recorded exclusively on okra, whereas *Draeculacephala antica*, *Macrosteles cristatus*, *Riptorus linearis*, *Steganocerus multipunctatus*, *Atractomorpha lata*, and *Jacobiasca lybica* were recorded exclusively on eggplant.

Overall, these findings indicate that the pest community was strongly dominated by *Amrasca biguttula*, which was the predominant pest species in the okra and eggplant agroecosystems investigated in the lowlands of Daloa.

Table 1: Species composition and relative abundance of insect pests recorded on okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) in the lowlands of Daloa

Insect pest species	Okra, n (%)	Eggplant, n (%)	Total, n (%)
Amrasca biguttula	2,925 (95.40)	1,717 (94.97)	4,642 (95.24)
Podagrica decolorata	68 (2.22)	0 (0.00)	68 (1.40)
Dysdercus voelkeri	39 (1.27)	4 (0.22)	43 (0.88)
Trialeurodes vaporariorum	28 (0.91)	19 (1.05)	47 (0.96)
Aspavia armigera	2 (0.07)	0 (0.00)	2 (0.04)
Pseudococcus comstocki	4 (0.13)	0 (0.00)	4 (0.08)
Draeculacephala antica	0 (0.00)	22 (1.22)	22 (0.45)
Macrosteles cristatus	0 (0.00)	11 (0.61)	11 (0.23)
Riptorus linearis	0 (0.00)	5 (0.28)	5 (0.10)
Steganocerus multipunctatus	0 (0.00)	1 (0.06)	1 (0.02)
Atractomorpha lata	0 (0.00)	6 (0.33)	6 (0.12)
Jacobiasca lybica	0 (0.00)	23 (1.27)	23 (0.47)
Total	3,066 (100)	1,808 (100)	4,874 (100)

n = number of individuals. Percentages represent the proportion of individuals within each crop and across the total sample.

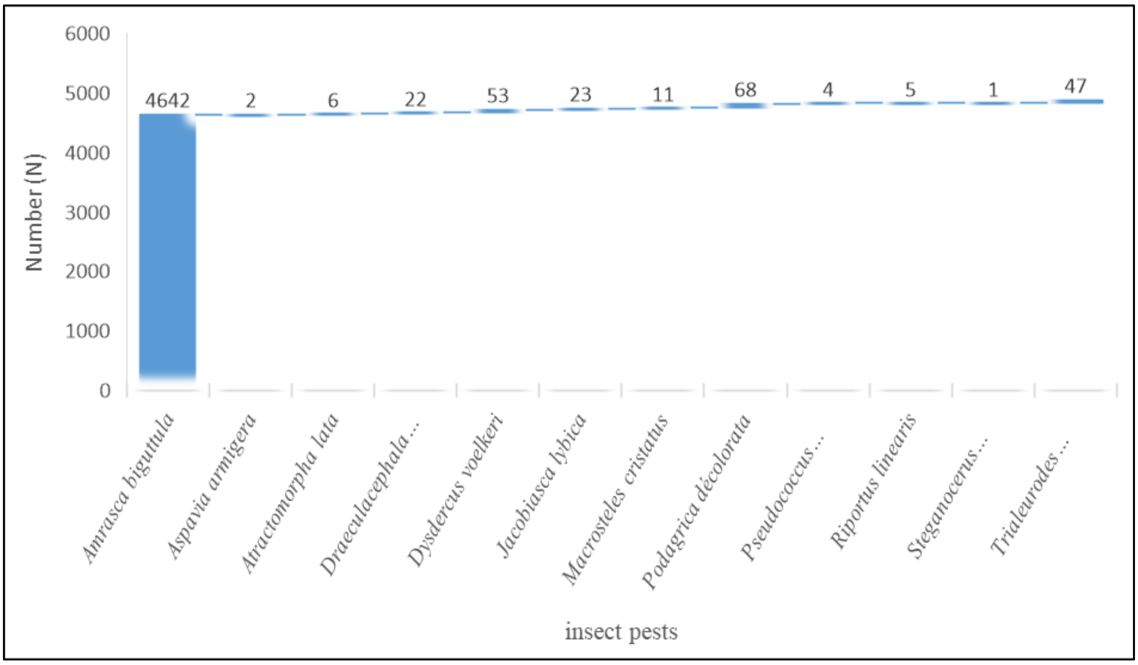

Figure 2: Abundance and species composition of insect pests identified on okra (*Abelmoschus esculentus*) and eggplant (*Solanum melongena*) during the dry season in the lowlands of Daloa, Côte d'Ivoire.

3.2 Distribution of *Amrasca biguttula* by crop

Analysis of the distribution of individuals by host plant revealed an overwhelming dominance of *Amrasca biguttula* on both okra (95.40%) and eggplant (94.97%). The chi-square test of independence showed that the proportion of this leafhopper did not differ significantly between the two crops ($\chi^2 = 0.47$; df = 1; $p = 0.492$).

Table 2: Comparison of *Amrasca biguttula* distribution between okra and eggplant crops in the lowlands of Daloa, Côte d'Ivoire.

Taxa	Okra, n (%)	Eggplant, n (%)	Total, n (%)	χ^2 (df = 1)	*p*
Amrasca biguttula	2,925 (95.40)	1,717 (94.97)	4,642 (95.24)	0.47	0.492
Other insect pests[a]	141 (4.60)	91 (5.03)	232 (4.76)	—	—
Total	3,066 (100.0)	1,808 (100.0)	4,874 (100.0)	—	—

[a]: Other insect pests include all taxa recorded apart from *Amrasca biguttula* ;*df* : degrees of freedom

3.3 Variation in *Amrasca biguttula* abundance and damage parameters among varieties

The abundance of *Amrasca biguttula* varied among varieties, with higher total numbers recorded on the okra variety 'Koto' (n = 2,737) than on 'Tomi' (n = 188), and on the eggplant variety 'Djamba' (n = 1,471) than on 'Purple-fruited' (n = 246) (Figure 3). Thus, 'Koto' and 'Djamba' accounted for the majority of individuals collected. However, when abundance was compared based on individual observations, no statistically significant difference was detected among the four varieties (Kruskal–Wallis test: H = 2.73; $p = 0.435$; Table 3). Mean abundances were 109.48 ± 60.22 individuals for 'Koto', 94.00 ± 11.31 for 'Tomi', 147.70 ± 73.01 for 'Djamba', and 123.00 ± 4.24 for 'Purple-fruited' (Table 3).

In contrast, several foliar damage parameters differed significantly among varieties (Table 3). Damage severity varied significantly among the four varieties (H = 8.15; $p = 0.043$), with the highest mean value recorded for 'Djamba' (3.40 ± 1.07) and the lowest for 'Purple-fruited' (1.00 ± 0.00). Leaf yellowing also varied significantly among varieties (H = 8.93; $p = 0.030$), while leaf curling showed the most pronounced difference (H = 19.38; $p < 0.001$). In contrast, no significant differences were observed in overall damage incidence ($p = 0.091$) or leaf drying ($p = 0.127$).

Table 3: ***Amrasca biguttula*** **abundance and damage parameters by variety**

Crop	Variety	n	*A. buguttela* Abundance	Damage incidence (%)	Damage severity (0–5)	Leaf yellowing (%)	Leaf curling (%)	Leaf drying (%)
Okra	Koto	25	109.48 ± 60.22	60.50 ± 19.56	2.80 ± 0.96	53.96 ± 21.55	23.20 ± 16.83	9.80 ± 8.48
Okra	Tomi	2	94.00 ± 11.31	83.75 ± 5.30	3.00 ± 0.00	82.50 ± 3.54	7.50 ± 3.54	5.00 ± 0.00
Eggplant	Djamba	10	147.70 ± 73.01	63.15 ± 12.87	3.40 ± 1.07	63.67 ± 23.58	4.00 ± 3.16	16.00 ± 8.43
Eggplant	Purple-fruited	2	123.00 ± 4.24	40.97 ± 8.04	1.00 ± 0.00	16.32 ± 1.87	0.00 ± 0.00	7.50 ± 3.54
p-value			0.435	0.091	0.043	0.030	<0.001	0.127

Values are presented as mean ± standard deviation; *n* = number of observations; Damage severity was assessed on a 0–5 scale.

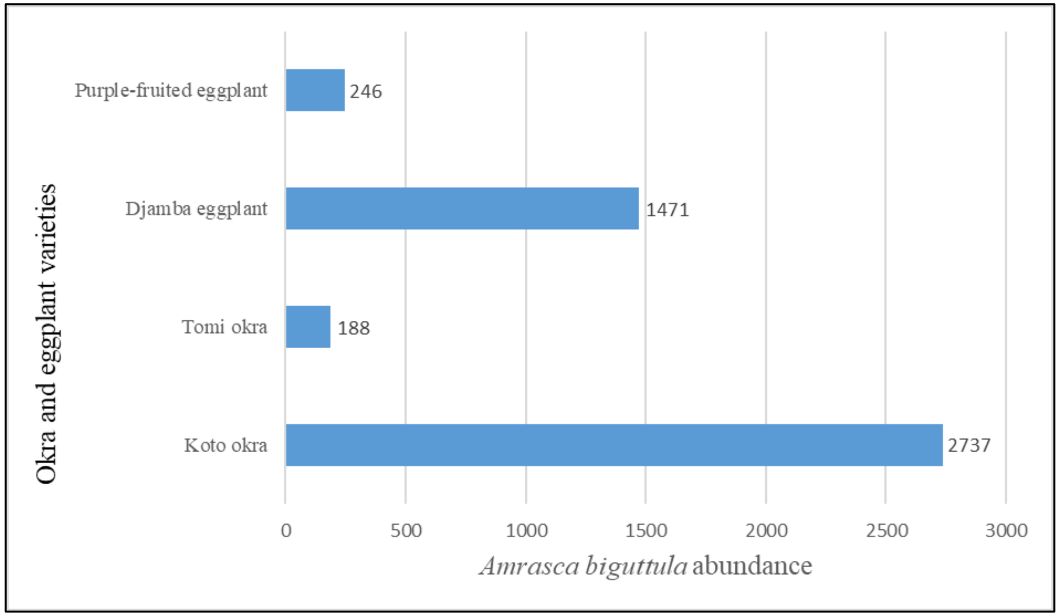

Figure 3: Number of *Amrasca biguttula* individuals recorded across okra and eggplant varieties

3.4 Relationship between *Amrasca biguttula* abundance and foliar damage in okra and eggplant

Spearman's rank correlation analysis revealed positive and significant associations between *Amrasca biguttula* abundance and several foliar damage parameters (Table 4). The strongest correlation was observed with damage severity (ρ = 0.694; $p < 0.001$), followed by leaf yellowing (ρ = 0.623; $p < 0.001$). *Amrasca biguttula* abundance was also positively correlated with damage incidence (ρ = 0.492; $p = 0.001$) and leaf drying (ρ = 0.448; $p = 0.004$). In contrast, no significant association was observed between pest abundance and leaf curling (ρ = −0.243; $p = 0.136$; Table 4).

The relationship between *A. biguttula* abundance and damage severity is illustrated in Figure 4. The observations showed an increasing trend in damage severity with increasing pest abundance, with higher pest abundances generally associated with higher levels of damage severity. The regression line showed a positive slope and explained 47.3% of the variation in damage severity ($R^2 = 0.473$). Overall, these findings indicate that increasing *A. biguttula* abundance was associated with greater foliar damage, particularly in terms of damage severity and leaf yellowing.

Table 4: Correlation between *Amrasca biguttula* abundance and leaf damage parameters

Damage parameter	Spearman's ρ	p-value	Interpretation
Damage incidence (%)	0.492	0.001	Positive, significant
Damage severity (0–5)	0.694	<0.001	Strong positive, significant
Leaf yellowing (%)	0.623	<0.001	Positive, significant
Leaf curling (%)	−0.243	0.136	Not significant
Leaf drying (%)	0.448	0.004	Positive, significant

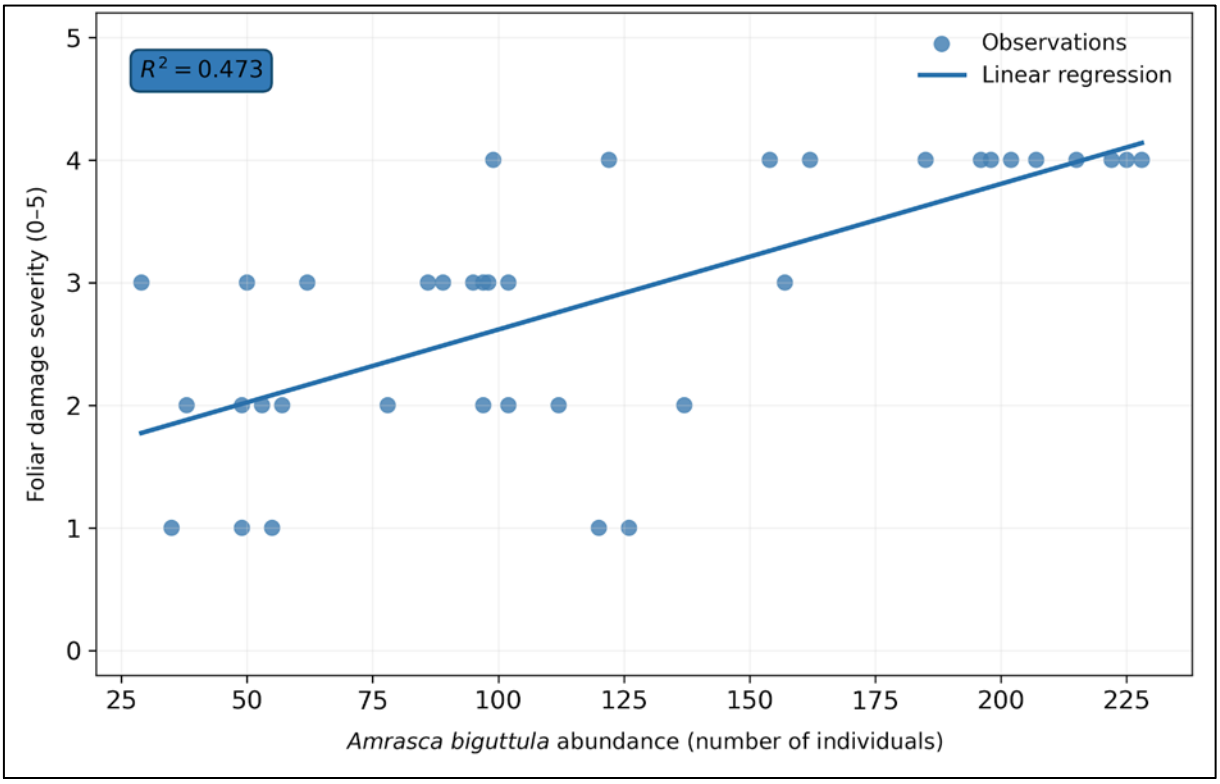

Figure 4: Relationship between *Amrasca biguttula* infestation and damage severity

4 DISCUSSION

The present study revealed a highly unbalanced pest community in the lowland vegetable production systems of Daloa, with *Amrasca biguttula* accounting for 95.24% of the 4,874 individuals recorded across 12 taxa. Its relative contribution was remarkably similar on okra (95.40%) and eggplant (94.97%), indicating that this leafhopper currently constitutes the principal insect pest associated with both crops in the study area. This pattern differs from previous observations in Côte d'Ivoire. [10], for example, identified *Jacobiasca lybica* and *A. biguttula* as the two major jassid species on okra and eggplant in central and central-western Côte d'Ivoire, representing 49.4% and 47.8% of the recorded individuals, respectively. The marked predominance of *A. biguttula* observed in Daloa therefore suggests a substantial shift in the structure of the jassid complex affecting these vegetable crops.

This finding is consistent with the recent expansion of *A. biguttula* reported in Côte d'Ivoire. [11], documented a rapid change in jassid community composition between 2021 and 2022 in several cotton-producing areas, with *A. biguttula* increasing from a previously minor component to 90–100% of jassid populations, while *J. lybica* became less frequent. This shift was also associated with increased crop damage. The predominance recorded in Daloa may therefore reflect the broader establishment of *A. biguttula* in Ivorian agroecosystems rather than a phenomenon restricted to the study sites.

Several ecological characteristics may contribute to the successful establishment of this species. *Amrasca biguttula* is polyphagous and can exploit a wide range of cultivated and non-cultivated hosts, including okra, eggplant, cotton, and other crops [12]. In lowland vegetable production systems, the simultaneous presence of several crops and spontaneous vegetation may provide continuous feeding and refuge resources, thereby facilitating population persistence and dispersal. Nevertheless, this interpretation remains hypothetical because the present study did not investigate seasonal population dynamics, alternative host plants, or environmental factors. Further research should therefore determine the relative contribution of these factors to the establishment of *A. biguttula* in Daloa.

The absence of a significant difference in the relative proportion of *A. biguttula* between okra and eggplant ($\chi^2 = 0.47$; $p = 0.492$) indicates that both crops are important hosts within the studied agroecosystems. Although the total number of individuals differed between crops, the contribution of the species to the respective pest communities was almost identical. This observation is consistent with recent reports identifying okra and eggplant among the vegetable crops frequently attacked by *A. biguttula* [7]. Its occurrence on both crops has also been reported outside West Africa, including Puerto Rico, where characteristic foliar symptoms were observed on okra and eggplant [12]. More recent records of its geographical expansion further illustrate its capacity to establish on new hosts and in new environments [13].

Host suitability, however, should not be inferred solely from pest occurrence. Plant responses to herbivory depend on both pest pressure and intrinsic host characteristics. Morphological and biochemical traits, including trichome density and length and phenolic compound content, have been associated with reduced jassid infestation in okra [5]. In the present study, mean *A. biguttula* abundance did not differ significantly among the four varieties ($p = 0.435$), despite higher cumulative numbers on 'Koto' and 'Djamba'. In contrast, damage severity, leaf yellowing, and leaf curling differed significantly among varieties. 'Djamba' exhibited the highest mean damage severity (3.40 ± 1.07), whereas 'Purple-fruited' showed the lowest value (1.00 ± 0.00). These results indicate that varieties exposed to comparable pest pressure may express different levels of foliar injury, suggesting possible differences in susceptibility or tolerance.

Such varietal variation is consistent with previous studies reporting differential responses of okra genotypes to jassid infestation, potentially associated with plant morphological and biochemical characteristics [5, 14]. However, the observed differences should be interpreted cautiously because the number of observations was highly unbalanced, particularly for 'Tomi' and 'Purple-fruited', which were each represented by only two observations. Consequently, the apparent differences among varieties cannot yet be considered evidence of genetic resistance or tolerance. Experiments involving balanced sample sizes, controlled conditions, and repeated cropping cycles would be required to determine whether the observed responses are stable varietal traits.

The relationship between pest pressure and plant injury provides additional insight into the potential importance of *A. biguttula*. Spearman's analysis showed positive associations between its abundance and damage severity, leaf yellowing, damage incidence, and leaf drying. The strongest association occurred with damage severity ($\rho = 0.694$; $p < 0.001$), followed by leaf yellowing ($\rho = 0.623$; $p < 0.001$). This pattern is biologically plausible given the piercing-sucking feeding behaviour of the species, which can interfere with plant tissues and physiological processes and produce symptoms such as chlorosis, necrosis, and, under severe infestation, leaf drying [4].

The regression analysis further showed that *A. biguttula* abundance accounted for 47.3% of the variation in damage severity ($R^2 = 0.473$). This relatively high proportion indicates that pest pressure is an important predictor of foliar injury under the conditions investigated. Nevertheless, the relationship should not be interpreted as evidence of exclusive causality. Nearly half of the variation remained unexplained, indicating that other factors, including varietal characteristics, leaf age, plant developmental stage, microclimatic conditions, and potentially other herbivores or pathogens, may contribute to the expression of damage. The absence of a significant relationship with leaf curling ($\rho = -0.243$; $p = 0.136$) also suggests that not all visual symptoms respond similarly to changes in pest abundance. Leaf curling may therefore be a less reliable indicator of *A. biguttula* pressure than overall damage severity or leaf yellowing under the conditions of this study.

From an agronomic perspective, the predominance of *A. biguttula* and its association with several damage indicators warrant increased attention in lowland vegetable production systems in Daloa. The species should be considered a priority target for field monitoring, particularly given its recent expansion in West Africa and increasing importance in Côte d'Ivoire. However, management should not rely exclusively on repeated applications of synthetic insecticides. Integrated pest management strategies combining regular pest monitoring, appropriate intervention thresholds, conservation of natural enemies, use of tolerant varieties, and alternative control methods would provide a more sustainable approach. Recent work has demonstrated the potential of biopesticides and botanical extracts for reducing jassid populations on okra [15]. The identification and deployment of varieties expressing lower levels of damage could complement these approaches.

Several limitations should be acknowledged. First, the number of observations was highly unequal among varieties, with only two observations for 'Tomi' and 'Purple-fruited', which reduces the statistical power and reliability of comparisons involving these varieties. Second, the study was conducted over a limited period and within a specific agroecological context; consequently, the recorded infestation levels cannot be directly extrapolated to all vegetable production systems in Côte d'Ivoire. Third, although the correlation and regression analyses demonstrated strong associations between pest abundance and foliar damage, they cannot establish a causal relationship.

Future studies should therefore encompass several cropping seasons and a larger number of production sites, with balanced sampling among varieties. Monitoring should also distinguish between developmental stages of *A. biguttula* and incorporate environmental variables, alternative host plants, natural enemies, and crop yield. Controlled varietal trials would be particularly valuable for determining whether differences in damage result from resistance, tolerance, or variations in plant growth and phenology. Such information would provide a stronger scientific basis for developing locally adapted integrated pest management strategies against *A. biguttula* in the vegetable-growing lowlands of Côte d'Ivoire.

5 CONCLUSION

This study revealed a strong dominance of *Amrasca biguttula* in vegetable agroecosystems of the lowland areas of Daloa. Of the 4,874 individuals recorded, this leafhopper accounted for 95.24% of all captures and was the main pest associated with both okra and eggplant. Its relative abundance did not differ significantly between the two crops, confirming their importance as host plants under the conditions investigated.

Although the mean abundance of *A. biguttula* did not differ significantly among the four varieties, several damage parameters, particularly damage severity, leaf yellowing, and leaf curling, varied among varieties. Moreover, *A. biguttula* abundance was positively associated with damage severity, leaf yellowing, damage incidence, and leaf drying, highlighting its potential role in intensifying foliar damage.

These findings indicate that *A. biguttula* should be considered a priority pest for monitoring in okra and eggplant production systems in Daloa. They also highlight the importance of integrating population monitoring, varietal tolerance assessment, and integrated pest management approaches into crop protection strategies. Further studies conducted across multiple seasons, sites, and varieties, with balanced sample sizes, are needed to confirm these findings and to better assess the impact of this leafhopper on crop yield

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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