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Research Article

Assessing the impact of *Sternochetus mangiferae* (Coleoptera: Curculionidae) infestation on morphometrics and nutritional composition of mango

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Abstract: *Sternochetus mangiferae* (mango seed weevil) is a major pest affecting mango production, leading to significant economic and nutritional losses. This study evaluated the impact of S. *mangiferae* infestation on the morphometric, nutritional, and anti-nutritional properties of three mango varieties (Oyo, Ogbomoso, and Palaba) collected from different locations in Ibadan, Nigeria. Infested and non-infested mango fruits were analyzed for their physical attributes, nutritional composition, and anti-nutritional factors. Results showed significant reductions ($p < 0.05$) in fruit weight, seed length, and seed width in infested samples across all varieties. Adult infestation led to decreased crude protein, ash, and ether extract contents, with notable declines in calcium, magnesium, and iron levels. Anti-nutritional factors such as saponin, tannin, and flavonoid also showed reductions in infested samples. The percentage of infestation varied across locations, with the highest infestation rate recorded at Omi Adio (50%) and the lowest at Ojoo (26.67%). Among mango varieties, Palaba exhibited the highest infestation (48.33%), while Oyo had the least infestation (30%). These findings highlighted the detrimental effects of S. *mangiferae* infestation on mango fruit quality, emphasizing the need for effective pest management strategies to mitigate post-harvest losses and preserve nutritional integrity.

Keywords: Mango, seed weevil, morphometric, management, nutrients

1. Introduction

Mango (*Mangifera indica* L.) is one of the most economically important fruit crops globally, with annual production exceeding 50 million tonnes, primarily in tropical and subtropical regions, contributing significantly to the economies of major producing countries (Ullah et al., 2024). However, in Africa, mango productivity and quality are threatened by various biotic stressors, particularly insect pests such as fruit borers, fruit flies, and mango seed weevils, which compromise plant immunity and facilitate infections, leading to significant crop losses (Amevoin et al., 2021; Subramaniam et al., 2024). Among these pests, the mango seed weevil *Sternochetus mangiferae* is of considerable concern in mango production, causing economic losses, decreased seed germination, fruit pulp damage, and early fruit drop (Singh & Sangwan, 2024). The mango seed weevil, is a significant pest of phytosanitary concern in mango production (Grové, 2022). It is a univoltine pest whose females deposit eggs in immature mango fruits (Silva & Ricalde, 2017). The larvae develop inside the seed, feeding on the endosperm, which can lead to seed damage and reduced viability (Peng, 2022). All larval and pupal stages occur within the fruit, and adults can remain inside the endocarp for weeks (Silva & Ricalde, 2017). Adults of S. *mangiferae* typically emerge after mango fruits fall and enter a diapause until the next fruiting season (Peng, 2022).

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Several studies have reported that insect infestation negatively affects the morphological and biochemical properties of fruits (Tobih et al., 2002). Variations in infestation rates among mango varieties and locations have been attributed to differences in fruit characteristics, environmental conditions, and pest population dynamics (Soares et al., 2020; Singh et al., 2023). However, there is limited empirical data on the extent of damage caused by S. *mangiferae* on key morphometric traits, nutritional composition and anti-nutritional factors in mango varieties cultivated in Nigeria.

Understanding how the infestation alters these characteristics is essential for developing effective pest management strategies and ensuring sustainable mango production. This study aimed to assess the impact of S. *mangiferae* infestation on the physical attributes of mango fruits, evaluate changes in the nutritional composition of infested fruits, and determine infestation rates across different locations and mango varieties in Ibadan, Nigeria. The results here provided insight into the extent of post-harvest losses and contribute to developing integrated pest management strategies for mango production.

2. Materials and methods

2.1. Study area

Fresh mango fruits of three local varieties (Oyo, Ogbomoso, and Palaba) were collected from six major fruit markets across six local Government Areas in Ibadan, southwest Nigeria. The mango fruits were selected through a stratified random sampling approach to ensure even representation of the different varieties and market locations. Samples were collected from multiple vendors per market to reduce the chance that fruits originated from the same farm. The markets were, Odo-Ona Kekere, Omi Adio, Bodija, Oje, Ayeye and Ojoo. Ten (10) fruits per variety were collected and transported to the Entomology Laboratory of the Department of Crop Protection and Environmental Biology of the University of Ibadan, Ibadan, Nigeria. They were subjected to morphometric analysis (Tobih et al., 2002). Biochemical analysis of the effect of infestation by *Sternochetus mangiferae* on mango samples was carried out at the Central Laboratory, University of Ibadan, Ibadan.

2.2. Sample collection

Ten fruits of each variety were selected per location (market) and sorted, examined, and classified based on morpho-physical characteristics of fruit damage into infested and non-infested fruits.

Table 1: Locations across six Local Government Areas in Ibadan where fresh mango fruits were sourced

Local government areas	GPS Location	Fruit markets
Oluyole	7.3369° N, 3.8595° E	Odo-Ona Kekere
Ido	7.3900° N, 3.7537° E	Omi Adio
Ibadan North	7.4351° N, 3.9143° E	Bodija
Ibadan North East	7.3893° N, 3.909° E	Oje
Ibadan North West	7.3799° N, 3.894° E	Ayeye
Akinyele	7.3892° N, 3.9089° E	Ojoo

2.3. Experimental materials

An electronic digital pocket Diamond Series A04 Metlan (0.1g/g) scale was used to take fresh fruit weights. An electronic digital vernier caliper was used to take fruit length, fruit width, seed length, and seed width (mm). Fresh fruit were slit open manually using a knife. Samples were oven dried at 60°C using the laboratory oven to reduce the moisture content.

2.4. Identification and characterization of damage by mango seed weevil

The fruits were carefully examined and sorted into infested and non-infested categories based on the visible signs of *Sternochetus mangiferae* damage such as oviposition marks, boring on the seed, exit holes, and frass within the seed cavity. Only fruits showing these clear features were considered infested. The infestation was entirely natural, and no artificial infestation was introduced. Identification of S. *mangiferae* damage followed the diagnostic features described by Tobih et al., (2002). Confirmation was done through visual inspection under laboratory conditions by trained personnel.

2.5. Morphometric analysis

A portable digital scale (accuracy 0.1 g) was used to determine the fresh weight of each mango fruit, while a digital Vernier caliper was used to measure fruit length, fruit width, seed length, and seed width, all recorded in centimetres. Ten fruits per variety were measured per market.

The mean values were computed and used for comparison between infested and non-infested fruits. Each measurement was taken three times per fruit, and the average was recorded to minimize human error and ensure accuracy.

2.6. Nutritional analysis

The nutritional composition was analyzed using standard AOAC (2003) procedures. Parameters assessed included crude protein, ash, ether extract, crude fiber, dry matter, and nitrogen-free extract (NFE). Anti-nutritional factors such as saponin, tannin, flavonoid, alkaloid, and phenol were determined using established biochemical methods.

2.7. Statistical analysis

Data collected were subjected to one-way Analysis of Variance (ANOVA) using the Genstat statistical package (Edition 12). Mean separation was done using Tukey's Honestly Significant Difference (HSD) test at a 5% level of significance. Data were checked for normality before analysis, and percentage data were arcsine-transformed where necessary to stabilize variance.

3. Results

3.1 Morphometrics of infested and non-infested fresh fruits of mango by Sternochetus mangiferae

The results presented in Table 2 show that the infestation of S. *mangiferae* significantly reduced the fruit weight, length, and width across all three mango varieties ($p < 0.05$). Infested mangoes from Oyo had a mean weight of 124.2 g, which is 3.8% lower than the non-infested mangoes, which weighed 129.1g. The Ogbomoso and Palaba varieties both exhibited a reduction in weight due to infestation, with the Palaba variety demonstrating the most notable loss at 4.6%. In addition to weight, significant decreases were observed in both the length and width of the infested samples. Specifically, Oyo mangoes displayed a slight reduction in length, measuring 74.25 mm compared to 74.86 mm for non-infested fruits. The Ogbomoso and Palaba varieties exhibited a greater decrease, especially in fruit width. Infested fruits demonstrated a notable reduction in seed length and width for all varieties. Ogbomoso demonstrated the most pronounced effect on seed size, with seed length decreasing from 62.15 mm in non-infested fruits to 60.47 mm in infested ones. These findings indicate that infestation decreases overall fruit size and also impacts seed development, which could have implications for seed viability and germination.

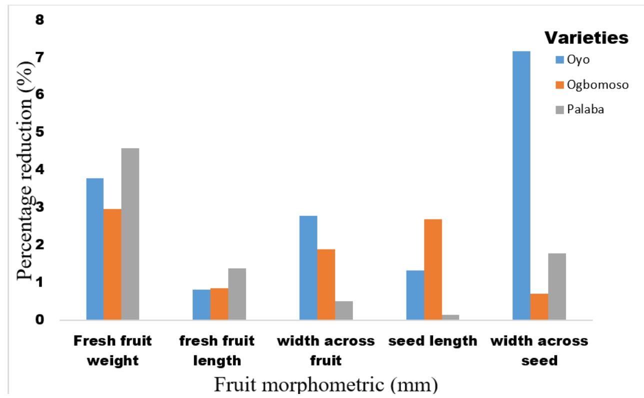

Figure 1: Percentage comparative loss in morphometric relative to non-infested fruit of each variety

3.2 Effect of infestation by Sternochetus mangiferae on the nutritional composition of mango

The crude protein content varied across varieties of mango fruits (Table 3). Infested fruits exhibited significantly lower crude protein content, with Palaba showing the most substantial reduction (5.770% in infested compared to 5.925% in non-infested). Variety Oyo maintained relatively higher protein content even after infestation. Ash content was notably lower in infested samples, particularly

Table 2: Effect of *Sternochetus mangiferae* attack on morphometrics

Variety	degree of infestation	fresh fruit weight(g)	fresh fruit length(mm)	width across fruit (mm)	seed length (mm)	width across seed (mm)
Oyo	Infested	124.2a	74.25a	51.93a	45.69a	25.07a
Oyo	Non infested	129.1ab	74.86a	53.42ab	46.31a	27.01a
Ogbomoso	Infested	153.4ab	81.63b	56.70bc	60.47c	33.50b
Ogbomoso	Non infested	158.1b	82.33b	57.80c	62.15c	33.74b
Palaba	Infested	201.4c	85.12b	63.36d	52.08b	26.48a
Palaba	Non infested	211.1c	86.31b	63.69d	52.16b	26.96a

Means followed by the same letter in the same column are not significantly different at (p>0.05) Tukey's Honestly Significant Difference test.

Table 3: Effect of *Sternochetus mangiferae* attack on nutritional composition

Variety	Degree of Infestation	Crude Protein	Ash	Ether Extract	Crude Fibre	Dry Matter	Nitrogen Free Extract
Oyo	Infested	6.315c	2.500a	1.600a	10.15ab	7.490a	69.99a
Oyo	Non infested	6.385c	3.050b	2.450c	10.70b	7.975ab	71.39b
Ogbomoso	Infested	6.270c	2.840ab	1.750ab	9.45a	8.025ab	69.50a
Ogbomoso	Non infested	6.520bc	2.850ab	2.300bc	10.10ab	8.275bc	71.41b
Palaba	Infested	5.770a	3.150b	1.800ab	9.90ab	8.275bc	69.50a
Palaba	Non infested	5.925ab	3.600c	2.400c	10.75b	9.175d	69.75a

Means followed by the same letter in the same column are not significantly different at (p>0.05) Tukey's Honestly Significant Difference test

in the Oyo variety, which had a 22% reduction (3.05% to 2.50%). A similar trend was observed in ether extract, indicating a decline in lipid content due to infestation. The crude fiber content showed slight variations, with Ogbomoso exhibiting the highest reduction (10.10% to 9.45%). Dry matter content was significantly lower in infested samples, which could affect fruit texture and shelf life. The reductions in crude protein, ash, and ether extract indicate a loss of essential nutrients due to infestation, which may affect the fruit's dietary value.

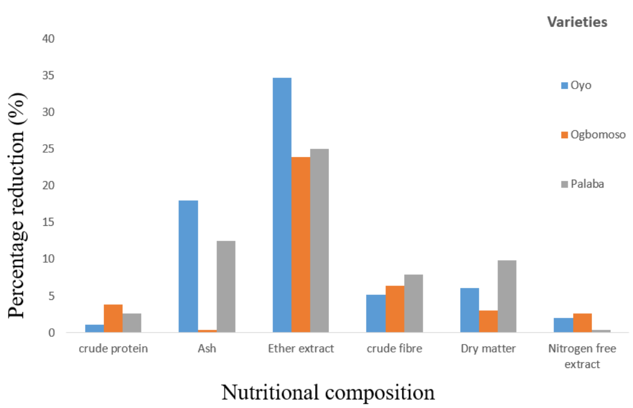

Figure 2: Percentage comparative loss in nutritional composition relative to non-infested fruit of each variety

3.3. Effect of infestation by Sternochetus mangiferae on mineral composition of mango

*T*able 4 shows the impact of S. mangiferae infestation on mineral content. Infestation resulted in lower levels of calcium, magnesium, and phosphorus across all varieties. Oyo exhibited the most pronounced decline in calcium (0.2185% to 0.1535%). The levels of iron, zinc, and copper were significantly lower in infested fruits, with Palaba experiencing the greatest mineral depletion. For instance, iron content in Palaba decreased from 189.3 mg/kg (non-infested) to 166.5 mg/kg (infested), a reduction of nearly 12%. Minerals play a crucial role in human health, and their reduction due to infestation suggests that infested mangoes may provide less nutritional value to consumers.

3.4. Effect of Sternochetus mangiferae infestation on anti-nutritional factors in mango

The anti-nutritional composition of mangoes was also affected by infestation (Table 5). Infested mangoes had lower saponin and tannin levels, with Palaba showing the most significant reductions. This suggests that infestation may alter the fruit's biochemical composition, potentially affecting its taste and resistance to pests. The decline in flavonoid and phenol content was observed across all varieties, with Ogbomoso maintaining relatively higher flavonoid levels despite infestation. This could indicate varietal differences in resistance to S. *mangiferae*. These reductions suggest that infestation not only affects fruit nutrition but may also compromise the fruit's natural defense mechanisms against further pest damage.

Mango fruits varied significantly in Saponin with variety from Palaba being highest (0.6400) > Ogbomoso (0.6285) > Oyo (0.6095). Infestation by *Sternochetus mangiferae* reduced saponin content in Palaba variety from 0.6400 to 0.4985; Ogbomoso variety from 0.6285 to 0.6080; and Oyo variety from 0.6095 to 0.5995. However, infestation reduced the saponin content by 22.11% in Palaba whereas reduction was 3.37% in Ogbomoso and 1.64% in Oyo.Infested mangoes had lower saponin and tannin levels, with variety Palaba showing the most significant reductions. This suggests that infestation may alter the fruit's biochemical composition, potentially affecting its taste and resistance to pests. The decline in flavonoid and phenol content was observed across all varieties, with the Ogbomoso variety maintaining relatively higher flavonoid levels despite infestation. This could indicate varietal differences in resistance to S. *mangiferae*. These reductions suggest that infestation not only affects fruit nutrition but may

Table 4: Effect of *Sternochetus mangiferae* attack on mineral composition

Variety	degree of infestation	Na	K	Ca	Mg	P	Fe	Zn	Cu
Oyo	Infested	0.1885a	0.7755a	0.1535a	0.2035a	0.3095a	157.5a	45.39a	8.75a
Oyo	Noninfested	0.2470c	0.8130d	0.2185c	0.2315c	0.3585c	178.7c	53.86c	10.50c
Ogbomoso	Infested	0.2585d	0.7965c	0.2270d	0.2475d	0.3645d	182.5d	57.13d	10.85d
Ogbomoso	Noninfested	0.2745f	0.8345f	0.2465f	0.2675f	0.3845f	193.5d	61.04f	12.35e
Palaba	Infested	0.1985b	0.7885b	0.1675b	0.2135b	0.3145b	166.5b	47.43b	9.55b
Palaba	Non infested	0.2615e	0.8255e	0.2390e	0.2575e	0.3785e	189.3e	59.77e	10.15d

Means followed by the same letter in the same column are not significantly different at (p>0.05) Tukey's Honestly Significant Difference test.

also compromise the fruit's natural defense mechanisms against further pest damage.

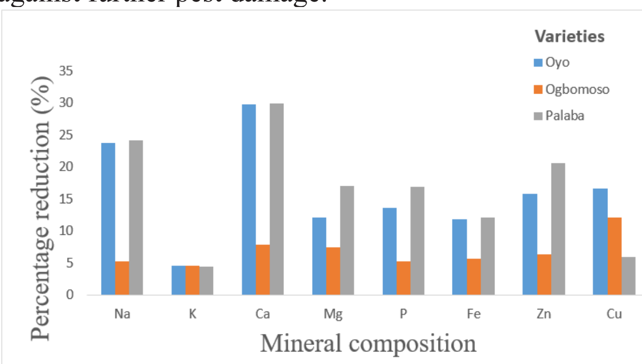

Figure 3: Percentage comparative loss in mineral composition relative to non-infested fruit of each variety

3.5. *Infestation rate across locations and varieties*

The infestation rate varied significantly among the sampled locations (Table 6), with the highest infestation observed in Omi Adio and Odo-Ona Kekere (50%), while Ojoo recorded the lowest (26.67%). This variation could be attributed to environmental factors, local pest populations, and farm management practices. Although there was no significant difference in the percentage infestation of mango fruits across the three varieties in Ibadan (Table 7). However, Among the mango varieties, Palaba exhibited the highest infestation rate (48.33%), followed by Ogbomoso (45.00%) and Oyo (30.00%). The lower infestation rate in Oyo suggests a potential for greater resistance to S. mangiferae attack.

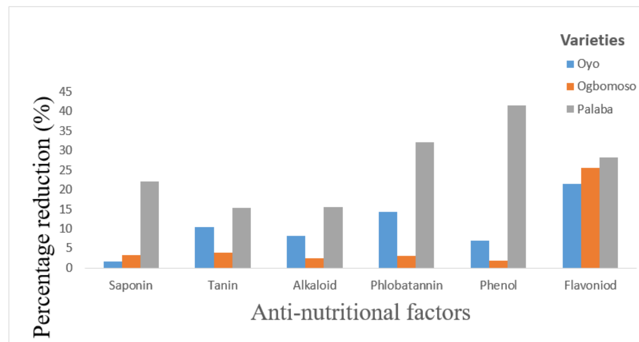

Figure 4: Percentage comparative loss in anti-nutritional factors relative to non-infested fruit of each variety

Table 6: Percentage infestation of fresh mango fruits by *Sternochetus mangiferae* at different locations in Ibadan

Location	Mean of % Infestation
Ojoo	26.67a
Oje	33.33a
Ayeye	40.00a
Bodija	46.67a
Odo-Ona Kekere	50.00a
Omi Adio	50.00a

Means followed by the same letter in the same column are not significantly different at (p>0.05) Tukey's Honestly Significant Difference test.

There is a significant impact of *Sternochetus mangiferae* infestation on the physical, nutritional, and mineral properties of mango fruits. The observed

Table 5: Effect of *Sternochetus mangiferae* attack on antinutritional factors

Variety	degree of infestation	Saponin	Tannin	Alkaloid	Phlobatannin	Phenol	Flavonoid
Oyo	Infested	0.5995a	0.01280a	0.7260b	0.00925b	0.3170b	0.002550ab
Oyo	Non infested	0.6095b	0.01430b	0.7900c	0.01080c	0.3405c	0.003250c
Ogbomoso	Infested	0.6080b	0.01480bc	0.7900c	0.01105cd	0.3420c	0.002750b
Ogbomoso	Non infested	0.6285c	0.01540cd	0.8105d	0.01140cd	0.3485cd	0.003700d
Palaba	infested	0.4985b	0.01345a	0.7000a	0.00805a	0.2085a	0.002200a
Palaba	Non infested	0.6400c	0.01590d	0.8295e	0.01185d	0.3570d	0.003850d

Means followed by the same letter in the same column are not significantly different at (p>0.05) Tukey's Honestly Significant Difference test.

reductions in fruit weight, length, and width align with previous studies (Obra et al., 2013; Obra et al., 2014), which reported that the physical dimensions of mangoes, including length and width, are also adversely affected by weevil infestations, leading to smaller fruit sizes at harvest. The highest fruit weight loss in Palaba (4.6%) suggests that this variety is more susceptible to S. mangiferae attack compared to Oyo (3.8%), which exhibited the least reduction. This could be attributed to differences in fruit firmness and chemical composition that may influence pest preference and infestation severity.

Table 7: Infestation of fresh mango fruits of different varieties by *Sternochetus mangiferae*

Variety	Mean of % Infestation
Oyo	30.00a
Ogbomoso	45.00a
Palaba	48.33a

Means followed by the same letter in the same column are not significantly different at (p>0.05) Tukey's Honestly Significant Difference test.

Nutritional analysis revealed that infestation significantly reduced crude protein, ash, and ether extract across all mango varieties. Similar trends have been reported in insect-damaged fruits and grains, where nutrient depletion occurs due to larval feeding and metabolic activity within the fruit (Omoloye et al., 2016; Pascacio-Villafán et al., 2022). The reduction in crude fiber and dry matter content suggests that infested mangoes may have a softer texture and lower shelf life, making them less desirable for both fresh consumption and processing industries.

Mineral composition was notably affected, with significant reductions in calcium, magnesium, phosphorus, iron, and zinc levels in infested fruits. Minerals play a critical role in human nutrition, contributing to bone health (calcium, phosphorus), enzyme function (magnesium, zinc), and oxygen transport (iron). The reduction in these essential minerals due to infestation implies that consuming infested mangoes could provide lower nutritional benefits. These findings align with those of (Iqbal et al., 2024), who reported a similar decline in mineral content in pest-infested fruits.

Anti-nutritional factors, including tannins, flavonoids, and phenols, also declined in infested fruits. This agrees with Popoola et al. (2015) whose study on dried cassava chips infested by Prostephanus truncatus, found that most anti-nutritional factors, such as hydrogen cyanide, saponins, tannins, and phytates, decreased after infestation, while only alkaloids increased. These compounds are known for their protective role against oxidative stress and microbial infections. The reduction observed in this study suggests that infestation compromises the fruit's natural defense mechanisms, making it more vulnerable to secondary infections. While anti-nutritional factors are sometimes viewed as undesirable, their presence in moderate amounts contributes to fruit quality and resistance to pests. The decline in these compounds in infested mangoes may explain why some varieties suffer higher infestation rates.

The infestation rate analysis revealed location-based variations, with the highest infestation rates recorded at Omi Adio and Odo-Ona Kekere (50%) and the lowest at Ojoo (26.67%). This variation could be influenced by environmental factors such as humidity, temperature, and mango variety distribution. Similar location-dependent infestation patterns have been reported in other studies (Fatnassi et al., 2015; Chikezie et al., 2024), suggesting that microclimatic conditions play a role in pest proliferation. Among mango varieties, Palaba recorded the highest infestation rate (48.33%), followed by Ogbomoso (45.00%) and Oyo (30.00%). This suggests that varietal resistance differs significantly, and breeding programs may focus on enhancing the resistance of highly susceptible varieties.

These findings emphasize the need for integrated pest management (IPM) strategies, including biological control, improved storage practices, and chemical interventions, to minimize post-harvest losses. The significant nutritional depletion in infested fruits also highlights the economic losses associated with S. mangiferae infestation, as lower-quality mangoes may not meet export standards.

4. Conclusion and recommendation

This study has demonstrated that *Sternochetus mangiferae* infestation significantly affects the morphometric, nutritional, and mineral properties of mango fruits in Nigeria. The reduction in fruit size, weight, and seed dimensions, along with declines in crude protein, essential minerals, and anti-nutritional compounds, indicates the detrimental impact of infestation on fruit quality. Infestation rates varied among locations and mango varieties, with Palaba exhibiting the highest susceptibility and Oyo showing potential resistance.

Further research should explore the genetic basis of varietal resistance to S. mangiferae and investigate environmentally friendly pest management solutions to mitigate losses. Promoting resistant mango varieties and enhancing post-harvest handling techniques could help reduce infestation rates and preserve fruit quality for both local consumption and export markets. Further experiments should be conducted to study the bio-ecology of S. mangiferae on different varieties of local mango fruits In Nigeria. Efforts should be intensified to manage infestation by S. mangiferae on mango fruits.

There is urgent need for integrated management strategies to combat S. mangiferae in mango production systems across Nigeria. We recommend that future research focus on screening and promoting resistant mango varieties, especially those with tolerance like Oyo, to encourage broader cultivation. Research should be carried out on the genetic mechanisms behind host resistance to improve breeding programs. It is important to develop other control options, such as botanical insecticides, biological control agents, and better orchard sanitation practices, to reduce dependence on synthetic chemicals. Improving post-harvest handling and storage practices will help maintain fruit quality and minimize losses during distribution. Collaboration among researchers, extension services, and farmers will play a vital role in implementing these strategies. These measures can ensure fruit quality and boost both domestic sales and export potential for mangoes in Nigeria.

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