Seasonal Occurrence and Damage Assessment of Key Pests of Okra (Abelmoschus esculentus L. Moench) in South-south Nigeria

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Abstract

Okra (*Abelmoschus esculentus* L. Moench) is a vital vegetable crop in tropical regions, yet its productivity is severely constrained by pest attacks. This two-year field survey was conducted across three locations in Abak, Akwa Ibom State, Nigeria, to investigate the seasonal **occurrence**, incidence, and impact of insect and non-insect pests on Yar-Balle and an improved variety (Yelle) of okra. Insects were collected and identified across different growth stages, and pests were grouped into their respective orders and families. A high diversity of Coleoptera, Lepidoptera larvae (including *Sylepta derogata*, *Anomis flavus*, *Earias* spp. and *Helicoverpa armigera*), and hemipteran bugs were recorded, predominantly damaging okra leaves and fruits with an average infestation rate that is statistically **s**ignificant *at* $p \leq 0.005$. Additionally, a significant incidence of gastropods (garden snails) was observed, causing foliar damage with an estimated severity of 40–65% in some plots. Pest populations and damage levels were consistently higher throughout the plant growth stages, with notable variations among the surveyed locations. Findings from this study highlight the need for integrated pest management strategies addressing both insect and non-insect pests across seasons to ensure sustainable okra production in South-south Nigeria.

1.0 INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is one of the most widely cultivated vegetable crops in Nigeria, ranking third after tomato and pepper in terms of fruit vegetable production (Sulaiman et al., 2022). It is valued not only for its short growth cycle, especially the early-maturing varieties that are ready for harvest within 40–60 days, but also for its economic and nutritional significance (Alhassan, 2019). The crop provides income and food security for small and medium-scale farmers and plays a critical role in household food security (Gemede et al., 2015; Ahmad, 2020). Beyond its immature pods, which are commonly used in traditional dishes, okra leaves and fruits are rich in essential nutrients vital for both human and animal health (Maheerthanan et al., 2024).

Despite its economic and dietary importance, okra production is increasingly challenged by a wide range of insect pests. These pests feed on leaves, stems, flowers and fruits, causing defoliation, flower abortion and fruit damage. Infestations by sap-sucking bugs and lepidopteran larvae often result in reduced pod quality and marketability (Zia and Haseeb, 2019). Over 70 species of insects, including mites, have been reported on field-grown okra crops globally (Kodandaram et al., 2017; Rahman et al., 2013). However, there is limited regional information on the biology, abundance and impact of major insect and non-insect pests like *Sylepta derogata*, *Amrasca biguttula biguttula*, *Earias* spp., *Helicoverpa armigera* and *Limicolaria* spp. in Nigerian okra fields, which presents a challenge for localised pest management strategies.

Although several studies in different regions of the world have explored insect pest control in okra (Bhutto et al., 2017; Berwa et al., 2017; Patil et al., 2023), most have focused solely on insects, often overlooking other arthropods and non-insect pests. A recent study by Rivers et al. (2024) highlighted the

presence of several insect pest species in the region, but comprehensive data on non-insect pests such as the garden snail, a known pest of many crops in Southern Nigeria (Borisade et al., 2021), remains scarce. Our earlier research documented the predatory activities of *Drilus* beetles on garden snails across various agroecological zones, suggesting a natural biocontrol interaction. Unfortunately, cultural practices such as indiscriminate pesticide application and physical destruction of beetle larvae may be contributing to the decline of these beneficial agents. At the same time, garden snail populations appear to be rising, possibly due to favourable weather patterns and their ability to survive chemical treatments by retracting into their shells.

The challenges posed by pod borers are particularly severe in okra fields where pods are left to mature for seed. These pests often infest pods internally, evading pesticide sprays that are typically applied during the day, even though egg-laying occurs at night. This timing mismatch further reduces the effectiveness of chemical control. Moreover, concerns about pesticide residues on fresh okra and the associated risks to human and environmental health have discouraged the consistent use of chemical inputs.

In the study area, okra farming is practised intensively and extensively. Farmers not only depend on the sale and consumption of fresh pods but also harvest and dry mature pods for seed saving. However, the high incidence of pod borers and bugs during pod maturation often results in seed deformation and reduced germination potential.

To support more effective pest management, this study seeks to provide up-to-date records of pest species associated with okra at various growth stages, including both major and emerging threats from non-insect members. It aims to document pest abundance and plant–pest interactions, assess the nature and severity of the damage caused by key pests, and identify beneficial organisms that could serve as natural enemies. The information generated is intended to guide the development of sustainable, cost-effective and environmentally friendly control strategies tailored to local farming systems in the study area.

2.0 MATERIALS AND METHODS

2.1 Study Location and Planting Materials

The field survey was carried out during the early farming seasons of February to June in both 2022 and 2023 across three farmer-managed plots in Akwa Ibom State, Nigeria. The sites were located approximately 6 kilometres apart, and their geographic coordinates are provided in Table 1.

Each plot was manually prepared and cultivated with two varieties of okra: Yar-Balle and Yelle variety obtained from “Unique Agro-Allied Store” in Abak. Both varieties are early maturing, with a harvest window of 35 to 45 days, and are known for producing high-quality pods. Yar-Balle, a cultivar native to the Sokoto region of Nigeria, has been previously described for its agronomic traits and adaptability under different management systems (Alhassan, 2019).

Seeds were sown at a rate of two per hole using a standard planting distance of 60 × 40 cm. An organic farming approach was adopted, with no application of synthetic pesticides, to preserve potential insect and non-insect pest activity for observation. Weed control was carried out manually using hoes once the crops were established, and other agronomic practices were uniformly maintained across all sites.

2.2 Survey of Okra Pests

Following germination and the development of three to four true leaves, field visits were conducted three times per week across the study plots. Once the okra plants were well established, sixty plants were randomly selected and tagged in each location, making a total of 180 plants across all three locations.

Observations were carried out during the morning (8:00 – 10:00 a.m.) and evening (4:00 – 7:00 p.m.) hours on each sampling day, as insect populations were higher and most species were less active in feeding, making them easier to collect. To capture nocturnal pests, especially adult moths, routine night visits were also made between 8:00–10:00 p.m. using white lamps. All parts of the plant; leaves, flowers, stems and fruits were carefully examined.

2.3 Rearing and Identification of Insects

Larvae collected from the undersides of leaves, as well as pupae found on foliage or within the soil, were reared in insect cages under laboratory conditions. Fresh okra leaves were supplied regularly as food until adult emergence. Leaves were replaced every three days, and larval feeding was visually assessed and compared with field infestation. To prevent rapid drying, the leaves were lightly moistened with water. Identified adults were recorded,, while unclear specimens were photographed and their images sent to curators at Museum Victoria Public Research and Information Centre, Melbourne, Australia (AskUs@museum.vic.gov.au) for expert identification.

2.4 Assessment of Pest Damage on Okra

a. Leaf Damage

Leaf damage was assessed visually and categorised as:

- Severe – if two-thirds or more of the leaf surface had visible perforations;
- Moderate – if about one-third showed perforations;
- None – when no perforations were observed.

Presence of webbing, curled or folded leaves, and faecal pellets of garden snails were also recorded.

b. Pod and Stem Damage

Damage to okra pods and stems was assessed by counting the number of perforations per fruit and recording the number of perforated fruits per plant. Heavily damaged pods were collected and kept in perforated jars to monitor for borer emergence.

2.5 Data Analysis

Descriptive statistics were used to present data on pest species abundance and associated damage levels. Data were analysed using IBM SPSS Statistics 20. Pest species frequency and distribution were illustrated using tables and charts (in percentage format). Specifically, data on the total number of leaves on the sampled plants, leaves infested with larvae, and the extent of infestation in each sampling year were subjected to analysis of variance (ANOVA). Mean differences significant at the 5% probability level were separated using the Least Significant Difference (LSD) test.

3.0 RESULTS

3.1 Pest Profile and Species Abundance

A total of 92 **insect and non-insect pest species** belonging to 13 different orders were recovered on okra throughout the growth stages in both sampling years (Table 2). The order Coleoptera had the highest proportion (20.7%), followed by Lepidoptera (19.6%), Hemiptera (17.4%) and Orthoptera (15.2%) (Fig. 1). This trend was consistent in both 2022 and 2023, although individual species varied in abundance.

For example, the incidence of cotton stainer bugs was higher in the second sampling year than in the first. A similar trend was observed for the okra fruit borer, *Helicoverpa armigera*, which led to more fruit infestation in the second year. In contrast, we observed a reduction in the population of black soldier fly (*Hermetia illucens*), a beneficial insect, during the second year (2023). Other major pests such as *Sylepta derogata*, *Earias* spp., *Anomis flavus*, *Limicolaria* spp. and orthopterans were recorded in both years, and their populations were statistically similar.

Garden snail *(Limicolaria spp.*) populations appeared higher but were not statistically different at $\mathbf{p \leq .05}$ across all sampling periods.

Table 1
geographical location and coordinate of the study areas

Locations	Names	Coordinates
Location 1	The Cross River Basin Development Authority, Abak Irrigation Project, Abak Usung-idim	4°57, 7°47
Location 2	6 battalion Nigerian Army Barracks, Ibagwa	4°54, 7°47
Location 3	Agricultural Science demonstration plot of The Nigerian Navy Military School, Ikot Ntuen, Oruk Anam	4°55, 7°48

Table 2
List of insects and non-insect's pest on okra in both sampling seasons

S/N	Common name	Scientific name	Order	Family
1	Garden spider**	*Araneus diadematus*	Araneae	Araneidae
2	Bordered Orbweaver**	*Neoscona adianta*	Araneae	Araneidae
3	Adonis Lady Beettle**	*Hippodamia variegate*	Coleoptera	Coccinellidae
4	Cassid beetles	*Psylliodes luridipennis*	Coleoptera	Chrysomelidae
5	Click beetles (Wire worms)	*Pterohelaeus spp*	Coleoptera	Elateridae
6	Okra flea beetle	*Podegrica uniformis*	Coleoptera	Chrysomelidae
7	Darkling beetles	*Lagria villosa*	Coleoptera	Lagriidae
8	Flea beetles	*Epitrix spp*	Coleoptera	Chrysomelidae
9	Transverse Lady beetles**	*Coccinella transversalis*	Coleoptera	Coccinelidae
10	Tortoiseshell beetle	*Aspidomorpha spp*	Coleoptera	Coccinellidae
11	Okra stem weevil	*Alcidodes affaber*	Coleoptera	Curculionidae
12	Chafer beetle	*Oxycetonia versicolor*	Coleoptera	Scarabidae
13	Nine-spotted ladybug**	*Coccinella novemnotata*	Coleoptera	Coccinellidae
14	Darkling beetles	*Lagria spp*	Coleoptera	Tenebrionidae
15	Leaf beetle	*Plagiodera versicolora*	Coleoptera	Chrysomelidae
16	28-spotted ladybug**	*Henosepilachna Vigintioctopunctata*	Coleoptera	Coccinellidae
17	Ladybird**	*Coccinella transversalis*	Coleoptera	Coccinellidae
18	Net-winged beetles	*Porrostoma rhipidium*	Coleoptera	Lycidae
19	Variable blister beetle	*Mylabris variabilis*	Coleoptera	Meloidae
20	Asian lady beetle**	*Harmonia axyridis*	Coleoptera	Coccinellidae
21	Spotted June beetle	*Pelidnota runctata*	Coleoptera	Scarabaeidae
22	Common earwig	*Forficula auricularia*	Dermaptera	Forficulidae

****beneficial insects, *non-insect pest**

S/N	Common name	Scientific name	Order	Family
23	Flesh fly	*Sarcophaga carnaria*	Diptera	Sarcophagidae
24	Okra pod fly	*Melanagromysa obtusa*	Diptera	Agromyzidae
25	Black soldier fly**	*Hermetia illucens*	Diptera	Stratiomyidae
26	Bumblebee robber fly**	*Laphria flava*	Diptera	Asilidae
27	Okra leafminer	*Liriomyza sativae*	Diptera	Agromyzidae
28	The green darner**	*Anax junius*	Odonata	Aeshnidae
29	Skimmers**	*Orthetrum chrysostigma*	Odonata	Libellulidae
30	Damselfly**	*Ceriagrion cerinorubellum*	Odonata	Coenagrionidae
31	Green leafhopper	*Empoasca onukii*	Hemiptera	Cicadellidae
32	Leafhopper assassin bug**	*Zelus renardii*	Hemiptera	Reduviidae
33	Rose leafhopper	*Edwardsianan rosae*	Hemiptera	Cicadellidae
34	Aphis	*Aphis gossypii*	Hemiptera	Aphididae
35	Cotton seed bug	*Oxycarenus hyalinipennis*	Hemiptera	Lygaeidae
36	Leaf hoppers	*Austroasca spp*	Hemiptera	Cicadellidae
37	Horned coreid bug	*Cletustrigonus*	Hemiptera	Coreidae
38	Green peach aphids	*Myzus persicae*	Hemiptera	Aphididae
39	Potato leafhopper	*Empoasca fabae*	Hemiptera	Cicadellidae
40	Silverleaf whitefly	*Bemisia tabaci*	Hemiptera	Aleyroididae
41	Mealy bug	*Ferrisia virgata*	Hemiptera	Pseudococcidae
42	Okra soft scale	*Saissetia coffeae*	Hemiptera	Coccidae
43	African pod bug	*Clavigralla tomentosicollis*	Hemiptera	Coreidae
44	Green stink bug	*Nezara viridula*	Hemiptera	Pentatomidae
45	True bugs	*Anoplocnemis curvipes*	Hemiptera	Coreidae
46	Cotton stainer bug	*Dysdercus koenigii*	Hemiptera	Pyrrhocoridae
47	Black crazy ant	*Paratrechina longicornis*	Hymenoptera	Formicidae
48	Honey bee**	*Apis mellifera*	Hymenoptera	Apidae
****beneficial insects, *non-insect pest**				

S/N	Common name	Scientific name	Order	Family
49	Black crazy ant	*Paratrechina longicornis*	Hymenoptera	Formicidae
50	Braconid wasp**	*Cotesia congregata*	Hymenoptera	Braconidae
51	Sawflies	*Tenthredo mesomela*	Hymenoptera	Tenthredinoidae
52	Needle waisted paper wasp**	*Belonogaster spp*	Hymenoptera	Vespidae
53	Black cockroach-wasp**	*Dolichurus spp*	Hymenoptera	Ampulicidae
54	Cicada killer**	*Sphecius speciosus*	Hymenoptera	Crabronidae
55	Common black ants	*Lasius niger*	Hymenoptera	Formicidae
56	Army worm	*Spodoptera spp*	Lepidoptera	Noctuidae
57	Beet webworm moth	*Spoladea recurvalis*	Lepidoptera	Crambidae
58	Cotton looper	*Anomis flavus*	Lepidoptera	Erebidae
59	Cucumber moth	*Diaphania indica*	Lepidoptera	Crambidae
60	Light brown apple moth (LBAM)	*Epiphyas postvittana*	Lepidoptera	Tortricidae
61	Sweet potato butterfly	*Acraea acerate*	Lepidoptera	Nymphalidae
62	Okra leafroller	*Sylepta derogata*	Lepidoptera	Crambidae
63	Okra shoots and fruit borer	*Earias vittella*	Lepidoptera	Noctuidae
64	White plume moth	*Pterophorus pentadactyla*	Lepidoptera	Pterophoridae
65	Okra fruit borer	*Helicoverpa armigera*	Lepidoptera	Noctuidae
66	Clostera moth	*Clostera spp*	Lepidoptera	Notodontidae
67	Fall cankerworm	*Alsophila pometaria*	Lepidoptera	Geometridae
68	Painted tiger moth	*Aegocera rectilinea*	Lepidoptera	Noctuidae
69	Snout Moth	*Euzophera perticella*	Lepidoptera	Pyralidae
70	Indian cabbage moth	*Pieris canidia*	Lepidoptera	Pieridae
71	Tropical white butterfly	*Appis drussila*	Lepidoptera	Pieridae
72	Common hedge blue	*Acytolepis puspa*	Lepidoptera	Lycaenidae

****beneficial insects, *non-insect pest**

S/N	Common name	Scientific name	Order	Family
	butterfly			
73	Handmaiden moth	*Syntomoides imaon*	Lepidoptera	Erebidae
74	Praying mantids**	*Mantis religiosa*	Mantodea	Mantoididae
75	Slant faced grasshopper	*Orphulella speciosa*	Orthoptera	Acrididae
76	Green stripped grasshopper	*Chortophaga viridifasciata*	Orthoptera	Acrididae
77	Katydids	*Tettigonia viridissima*	Orthoptera	Acrididae
78	Angle-Wing Katydid	*Microcentrum rhombifolium*	Orthoptera	Tettigoniidae
79	Slant faced grasshopper	*Orphulella speciosa*	Orthoptera	Acrididae
80	Variegated grasshopper	*Zonocerus variagatus*	Orthoptera	Pyrgomorphidae
81	Locust	*Austracris guttulosa*	Orthoptera	Acrididae
82	Black field cricket	*Teleogryllus commodus*	Orthoptera	Gryllidae
83	Mole cricket	*Gryllotalpa spp*	Orthoptera	Gryllotalpidae
84	Stick insect	*Phasmida spp*	Orthoptera	Phasmatodae
85	Short-horned grasshopper	*Oxya japonica*	Orthoptera	Acrididae
86	Red headed bush cricket	*Phyllopalpus pulchellus*	Orthoptera	Trigonidiidae
87	Coneheads	*Conocephalus dorsalis*	Orthoptera	Tettigoniidae
88	Halush (digger water dog)	*Gryllotalpa gryllotalpa*	Orthoptera	Gryllotalpidae
89	Garden Snail*	*Limicolaria flammea*	Stylommatophora	Achatinidae
90	Land snails*	*Limicolaria aurora*	Stylommatophora	Achatinidae
91	Caddisflies	*Tricoptera spp*	Tricoptera	Leptoceridae
92	Red Spider mite*	*Tetranychus telarius*	Trombidiformes	Tetranychidae

****beneficial insects, *non-insect pest**

3.2 Vegetative Damage

Tables 2 and 3: show mean number of leaves, perforated leaves and leaves harbouring garden snails. Figure 3: show perforated leaves and feeding activities of garden snails on leaves. The mean number of infested leaves characterised by severe perforations and folding by leafrollers were statistically different in all the sampling periods and seasons. Several species of grasshoppers, leafrollers, beetles and garden snails were identified as the major leaf feeders of okra in all the study locations and in both seasons. Mean number of leaves harbouring snails were recorded as 2.52 ± 1.85 and 2.50 ± 2.00 in both seasons respectively (Tables 2 and 3). A total of 35 snails was recorded on Plot C during both sampling years (2022 and 2023) respectively. A comparable pattern was observed on Plot A across the same period. Snail populations exhibited a progressive increase with each sampling, reaching their peak during the second and third sampling periods in both years, corresponding to plant ages of 56 and 70 days, respectively. In contrast, Plot B consistently recorded the lowest snail population in the second year of observation (Fig. 2).

First Year Sampling (2022)

Table 2
a: showing the level of damage on okra leaves at different sampling time

Sampling periods	Number of leaves	Number of leaves infested by leafroller	Number of perforated leaves	Leaves harbouring garden snails
	Mean ± Std error	Mean ± Std error	Mean ± Std error	Mean ± Std error
First sampling	7.2 ± 1.93^{a}	3.23 ± 2.96^{a}	5.50 ± 2.67^{a}	1.70 ± 1.60^{a}
Second sampling	10.02 ± 1.85^{b}	5.27 ± 2.33^{b}	6.70 ± 1.95^{b}	2.63 ± 1.80^{b}
Third sampling	12.63 ± 2.02^{c}	7.23 ± 2.40^{c}	8.47 ± 2.05^{c}	3.23 ± 1.87^{c}
Total	9.98 ± 2.92	5.24 ± 3.03	6.89 ± 2.54	2.52 ± 1.85

Values with similar alphabets; a, b, c along rows were not statistically different

Table 2

b: showing the level of damage on okra leaves in all the locations

Locations	Number of leaves	Number of leaves infested by leafrollers	Number of perforated leaves	Leaves harbouring garden snails
	Mean ± Std error	Mean ± Std error	Mean ± Std error	Mean ± Std error
Location A	8.87 ± 2.37[a]	4.93 ± 2.70[b]	6.07 ± 2.03[c]	2.27 ± 1.74[d]
Location B	9.90 ± 2.78[a]	5.43 ± 3.15[b]	6.77 ± 2.44[c]	2.23 ± 1.75[d]
Location C	11.16 ± 3.16[a]	5.36 ± 3.28[b]	7.83 ± 2.83[c]	3.07 ± 1.98[d]
Total	9.98 ± 2.92	6.89 ± 2.54	5.24 ± 3.03	2.52 ± 1.85

Values with similar alphabets; a, b, c along rows were not statistically different

Second Year Sampling (2023)

Table 3

a: showing the level of damage on okra leaves at different sampling time

Sampling periods	Number of leaves	Number of leaves infested by leafrollers	Number of perforated leaves	Leaves harbouring garden snails
	Mean ± Std error	Mean ± Std error	Mean ± Std error	Mean ± Std error
First sampling	8.77 ± 2.66[a]	4.57 ± 2.545[a]	5.13 ± 2.62[a]	1.76 ± 1.65[a]
Second sampling	11.87 ± 2.57[b]	6.90 ± 2.52[b]	7.20 ± 3.13[b]	2.67 ± 1.75[ab]
Third sampling	15.33 ± 2.78[c]	10.93 ± 2.99[c]	10.16 ± 3.20[c]	3.07 ± 2.34[c]
Total	11.99 ± 3.77	7.47 ± 3.75	7.50 ± 3.62	2.50 ± 2.00

Values with similar alphabets; a, b, c along rows were not statistically different

Table 3
a: showing the level of damage on okra leaves in all the locations

Locations	Number of leaves	Number of leaves infested by leafrollers	Number of perforated leaves	Leaves harbouring garden snails
	Mean ± Std error	Mean ± Std error	Mean ± Std error	Mean ± Std error
Location A	11.03 ± 4.18[a]	7.77 ± 4.25[a]	8.00 ± 4.10[ab]	2.83 ± 2.20[d]
Location B	11.03 ± 3.42[a]	6.17 ± 3.60[a]	6.53 ± 3.26[c]	1.80 ± 1.61[d]
Location C	13.90 ± 2.98[b]	8.47 ± 3.06[b]	7.97 ± 3.36[ab]	2.87 ± 2.01[d]
Total	11.99 ± 3.77	7.47 ± 3.75	7.50 ± 3.62	2.50 ± 2.00

Values with similar alphabets; a, b, c along rows were not statistically different

Damage on fruits

Damages such as scrapping and shrinking of fruits were recorded on invaded fruits by beetles and cotton stainer bugs, but the level of damages were not quantified (Fig. 4: A, B and C).

Okra fruits were severely infested by two major insects' larvae; *Earais* spp and *Helicoverpa armigera*. The later attacked newly forming fruits the most (Fig. 5: A, B and C). Both insect larvae burrow into fruits; creating openings that cause rotting of fruits and damaged seeds in dry pods. The number of damage fruits were express in percentage of the total number of fruits and reaches 23 percent in location A and 21 percent in location C in 2022 and 2023 respectively. The least level of damage was recorded in location B (10 percent) in 2022, followed by location A- 17 percent and location C-17 percent in 2022 and 2023 respectively (Table 4).

Table 4
Damage level on fruits

Sampling periods	Locations	Percentage fruits infestation by fruit borers
First Year (2022)	Location A	15
	Location B	10
	Location C	21
Second Year (2023)	Location A	23
	Location B	17
	Location C	19

4.0 DISCUSSION

The results of this two-year study in the South-South agroecological region of Nigeria revealed a complex community of insect and non-insect pests affecting okra at various growth stages. Notably, we report for the first time the damaging behaviour of garden snails (*Limicolaria* spp.) on vegetative parts of okra plants. In total, 92 pest species across 13 orders and 58 families were documented.

Our species diversity aligns broadly with global findings and recent reports by (Qunis *et al*., 2024; Rivers et al., 2024). However, the density of gastropods and overall damage levels were significantly higher, likely due to the favourable local climatic and soil conditions. During the study, okra was the sole crop in many fields, intensifying pest attraction and colonisation.

Beetles, grasshoppers and lepidopteran larvae inflicted heavy perforation, webbing and skeletonisation on vegetative parts, while hemipterans caused curling and discolouration through sap-sucking. A beneficial insect group, comprising predators and parasitoids, accounted for 21.7% of all specimens. Among these, the braconid parasitoid *Cotesia congregata* was the most abundant across all plots. According to van Huis et al. (2013), parasitoids alone account for about ten percent of all insect species.

Non-insect members, including garden snails and mites, represented approximately 3.3% of the total pest population. Lepidopteran larvae, particularly *Sylepta derogata* and *Anomis flavus*, folded leaves into silken tunnels and deposited characteristic frass, reducing the photosynthetic area similar to coleopteran damage. Although no local data exist for direct comparison, similar injury caused by *Sylepta derogata* has been reported elsewhere to reduce okra yield (Anioke, 1988; Zia and Haseeb, 2019).

Dipterans such as *Hermetia illucens* and odonates were also observed. *H. illucens* is known for its larvae's ability to recycle organic waste and its potential as an animal feed ingredient (Astuti and Wiryawan, 2022). Their presence highlights the field's biodiversity and potential for ecological biocontrol roles.

Garden snails caused severe skeletonisation of okra leaves, travelling nocturnally across plants and leaving visible trails and greenish frass. These snails are known generalist pests in Southern Nigeria (Borisade et al., 2021), but detailed feeding behaviour was poorly documented until now. Two *Limicolaria* species were consistently found, suggesting a strong host preference for Malvaceae.

Pod and stem borers, especially *Earias* spp. and *Helicoverpa armigera*, showed stage-specific preferences: *Earias* infested mature pods while *H. armigera* preferred tender fruits. This pattern, though previously observed in *Amaranthus* (Borisade et al., 2017), is newly reported for okra in this region. Stem borers may impair vascular function and predispose plants to fungal infections (Oyewale, et al., 2020).

This study provides critical insight into pest species composition, seasonal patterns and plant–pest interactions. The marked nocturnal activity of garden snails suggests that hand-picking at night may be an effective control strategy, though health risks due to possible zoonotic parasites (Okafor-Elenwo and Imade, 2019) warrant caution.

We also recommend conservation of predatory beetles such as *Drilus* spp. and enhancement of beneficial parasitoids like *Cotesia congregata* via mass-rearing and strategic field releases. Selective biocontrol may reduce reliance on synthetic inputs and support sustainable okra production.

This study has shown that the okra varieties evaluated, even within their relatively short growing season, are vulnerable to a diverse range of insect and non-insect pests. While Coleoptera had the highest species count, larval Lepidoptera inflicted the most damage on both leaves and fruits. The presence of beneficial insect species highlights the possibility of integrating biological control into pest management strategies.

We also recommend further investigation into the pest status and behavioural ecology of *Limicolaria* species on other crops. These findings offer a robust foundation for designing effective, environmentally friendly integrated pest management strategies tailored to smallholder okra production in Nigeria.

5.0 CONCLUSION

This study has shown that the okra varieties evaluated, even within their relatively short growing season, are vulnerable to a diverse range of insect and non-insect pests. While Coleoptera had the highest species count, larval Lepidoptera inflicted the most damage on both leaves and fruits. The presence of beneficial insect species highlights the possibility of integrating biological control into pest management strategies.

We also recommend further investigation into the pest status and behavioural ecology of *Limicolaria* species on other crops. These findings offer a robust foundation for designing effective, environmentally friendly integrated pest management strategies tailored to smallholder okra production in Nigeria.

Declarations

COMPETITING INTEREST

The authors declare that they have no competing interests.

FUNDING

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Author Contribution

Uwaidem, Y.I. – Conceptualization, Field Work, Data Analysis, Writing – Original DraftEssien, R.A. – Literature Search, Insect Identification and Logistic supportBorisade, O.A. – Methodological Supervision,

Manuscript EditingShehu, M. – Insect Identification and Logistics SupportAll authors read and approve the final copy of manuscript

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Figures

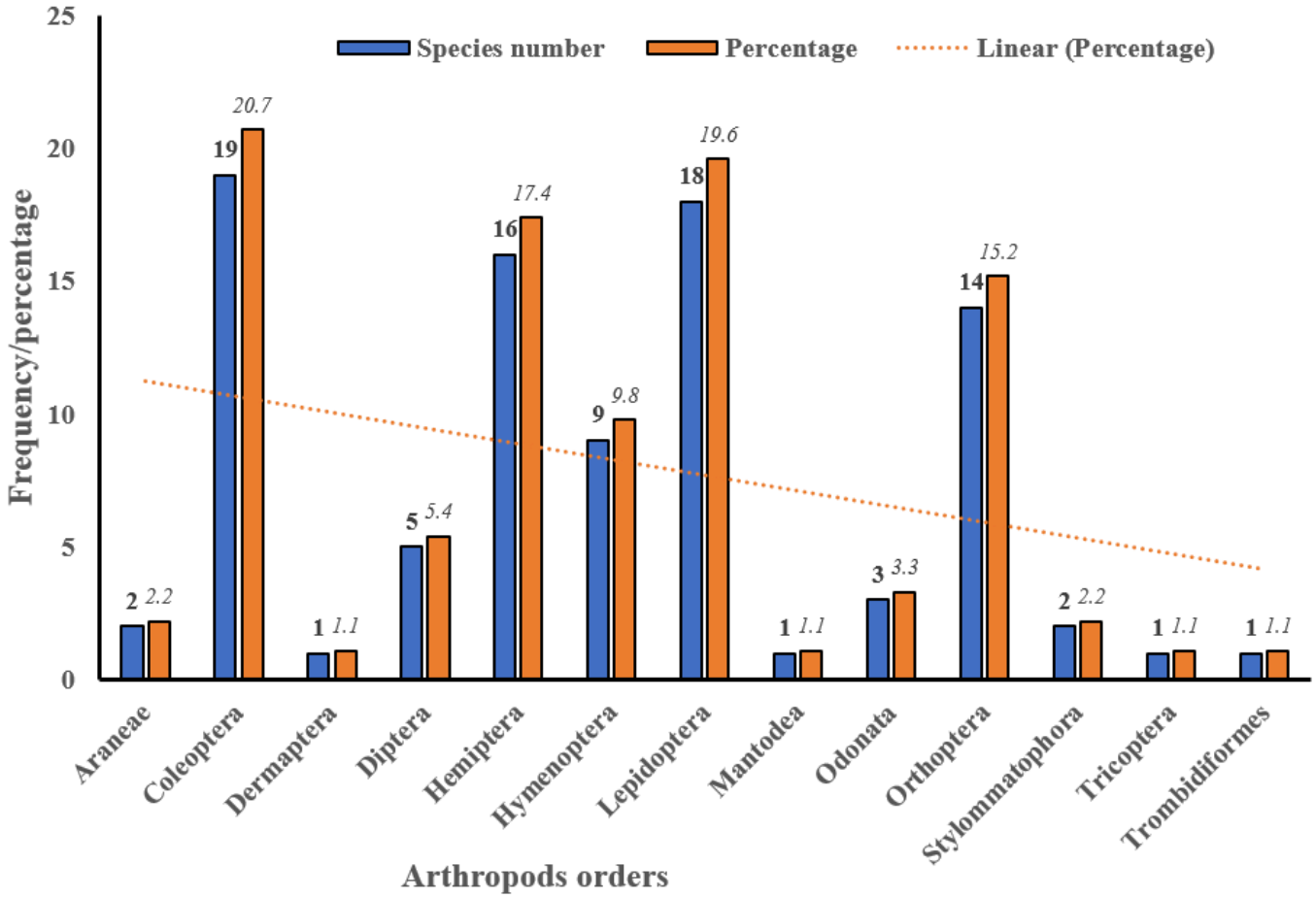

Figure 1

Orders of insect and non-insect pests

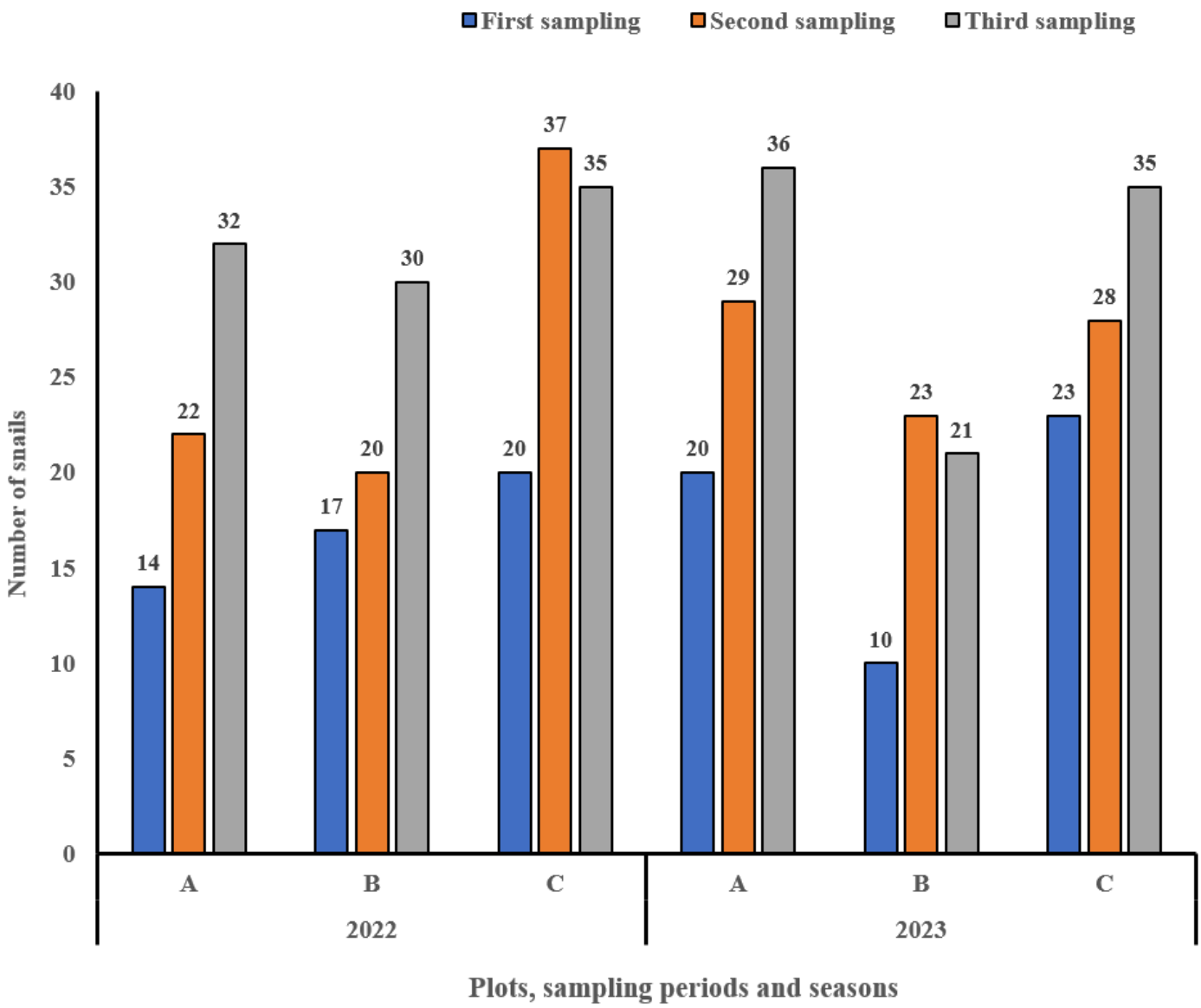

Figure 2

showing number of snails per plots in each observation and sampling year

Figure 3

Okra leaves infested with leaf feeding insect and non-insect pests

Figure 4

Okra flowers and fruits infested with (A); *Mylabris variabilis, Belonogaster spp*(B) *Oxycarenus hyalinipennis, Alsophila pometaria* (C) *Dysdercus koenigii*

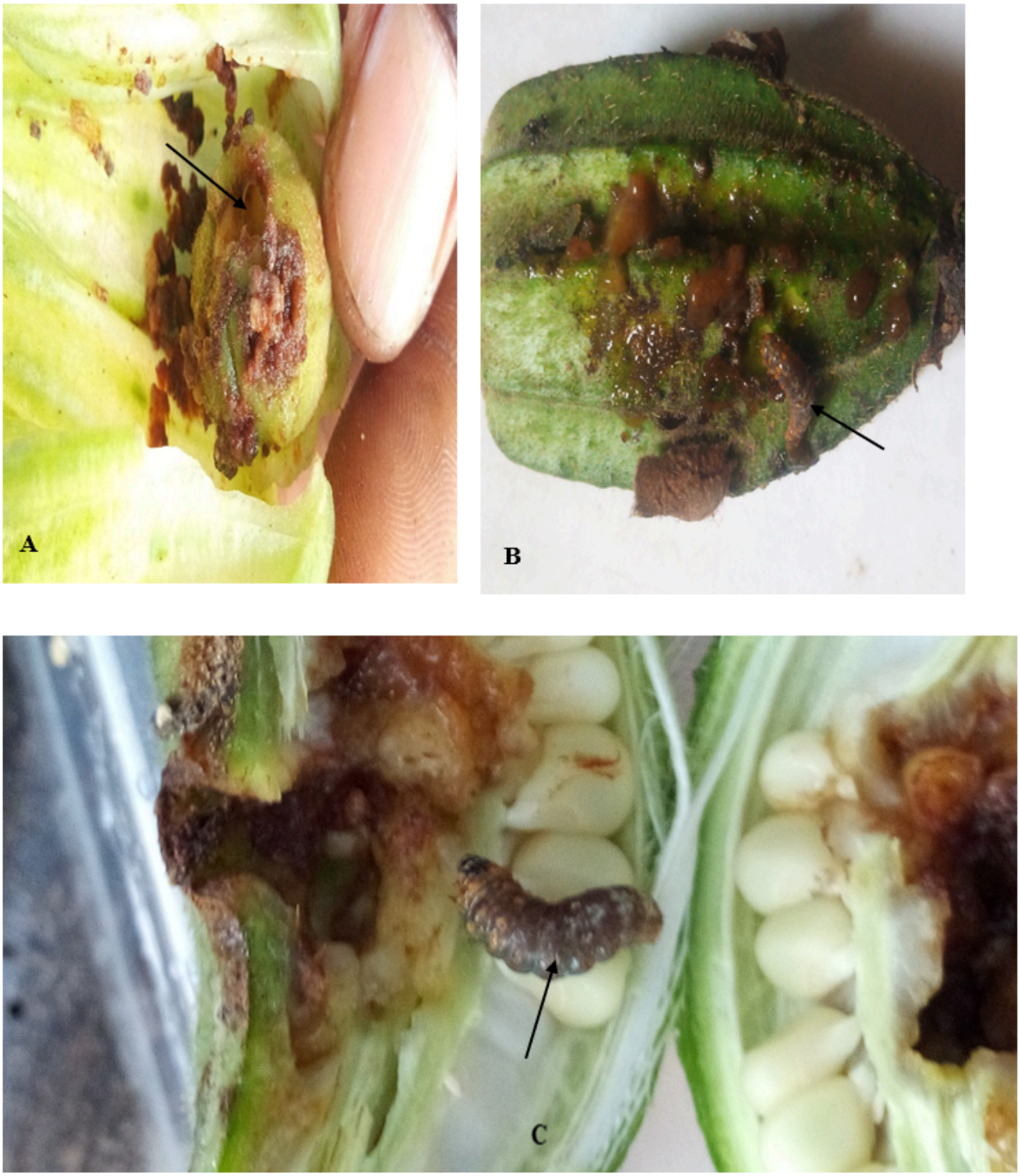

Figure 5

Okra pods infested by pod borer (*Earias spp*)