



RESEARCH ARTICLE

Farmers' perception of insect pests of sweet melon (*Cucumis melo* L.) and their management practices in Bauchi and Gombe State, Nigeria

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ABSTRACT

Sweet melon (*Cucumis melo* L., family Cucurbitaceae) is an economically important cucurbit worldwide; information on farmers' perceptions of its insect pests and their management in the Sudan Savannah is limited. This study assessed farmers' perceptions of insect pests affecting sweet melon production and documented the pest management practices employed in Bauchi and Gombe States, Nigeria. Structured questionnaires were administered to 150 randomly selected respondents across three Local Government Areas in Gombe and Bauchi States; the data were analyzed using descriptive statistics. The results revealed that all respondents identified insect species (aphids, beetles, and fruit flies) as the most abundant and damaging insect pests, causing significant reductions in fruit quality and yield. All farmers relied heavily on synthetic pesticides for insect pest control; most were aware of the risks associated with pesticide misuse, and most had not received formal training in any insect pest management practice. Furthermore, 89% of the respondents expressed willingness to adopt alternative insect pest management methods. The study recommends strengthening agricultural extension services to promote safe pesticide use and sustainable pest management, thereby increasing sweet melon production while reducing human health and environmental impacts.

Keywords: aphids, bauchi, beetles, cucurbits, fruit flies, gombe, insect, pesticide

INTRODUCTION

The golden melon (*Cucumis melo* L.) from the family Cucurbitaceae is an important crop cultivated worldwide (Zhang et al., 2023). It is known for its rich, dense white flesh and bright golden yellow color (Filani et al., 2024). Common names globally include Winter melons, Crenshaw, Casabas, Honeydews, Juan canary, Santa Claus, Golden melon, sweet melon, or culinary melons (Vinutha et al., 2017). The melon is native to Africa, while the Middle East and Asia were believed to be the site of domestication, which was later introduced to Europe and

North America (Choudhary et al., 2017). Although melons are warm-season crops, they can be successfully grown in tropical, subtropical, and temperate regions (Rana, 2018). China is the world's largest producer of melons, followed by Turkey (Grumet, 2021). Statistics on production and marketing in Africa are not available for most countries. There is no current export and import data on sweet melon for Nigeria, where it is mostly grown in the Northern part of the country. *C. melo* has various culinary and medicinal uses (Manchali et al., 2021). The fruits are rich in iron, vitamins, proteins, minerals, water, and dietary fiber; the seeds have antitussive, digestive, febrifuge, and vermifuge properties; while the roots are diuretic and emetic (Rana & Manoj, 2018; Rana & Nalla, 2018).

Despite its economic importance, sweet melon production, particularly in Northern Nigeria, is constrained by several biotic and abiotic factors, among which insect pests are the most important yield-limiting factor. Globally, 20-80% of cucurbits are lost to insect pests alone in various melon-growing regions. In Nigeria, it is estimated that 20-70% of cucurbit crops are lost to insect pests, affecting farmers' livelihoods and productivity (Olaniran et al., 2024). Cucurbits are susceptible to insect pest attacks from seedling emergence until fruit maturity. Major insect pests associated with cucurbits globally include aphids (*Aphis gossypii*), melon fruit flies (*Bactrocera cucurbitae* Coquillett and *Bactrocera tau*), melon thrips (*Thrips palmi*), melon beetles (*Acalymma* spp.), white flies (*Bemisia tabaci*), melon fruitworms (*Diaphania* spp.), red pumpkin beetle (*Aulacophora foveicollis* Lucas), spider mites (*Tetranychus* spp.), cucumber beetles (*Diabrotica* spp.) and caterpillars (*Helicoverpa* spp.) (Filani et al., 2024), they inflict damage by feeding, transmitting plant pathogens, reduce photosynthetic capacity through defoliation, and rendering fruits unmarketable (Srivastava & Joshih, 2021).

Farmers' perceptions and knowledge of insect pests are important for the successful adoption of pest management practices. Farmers who can identify economically important pests and understand their occurrence are more likely to implement effective pest management practices. Conversely, poor knowledge often leads to misuse and abuse of pesticides. Recent studies in Africa and Asia revealed that vegetable farmers generally recognize major insect pests; they continue to rely predominantly on synthetic pesticides because of their rapid effectiveness and limited access to alternative management options. Adoption of integrated pest management practices remains low and is largely influenced by farmers' access to extension services, training, and technical support (Zhang et al., 2018; Parajuli et al., 2023).

Although several studies have documented insect pests of cucurbit crops in Nigeria, information on farmers' perceptions, indigenous knowledge, the perceived severity of insect pest infestations, associated yield losses, and current management practices specific to sweet melon production remains limited. Such information is essential for developing farmer-centered pest management programs and promoting sustainable integrated pest management practices. Therefore, this study was conducted to assess farmers' perceptions of insect pests affecting sweet melon production, identify the major insect pests recognized by farmers, evaluate the perceived impacts of insect pests on yield and fruit quality, and document the pest management practices currently employed by sweet melon farmers in Bauchi and Gombe States, Nigeria.

MATERIALS AND METHODS

Study area

The study was carried out in Bauchi State (latitudes 9° 30' and 12° 30' N and longitude 8° 45' and 11° 0' E) and Gombe State (latitudes 9° 30' and 12° N and longitudes 8° 45' and 11° 45' E), located in the northeastern zone of Nigeria. The zone is characterized by distinct wet and dry seasons, with annual rainfall of about 800 to 1,300 mm, mainly between April and October, and a mean annual temperature of about 25 to 35°. The soil type is predominantly sandy loam soil. Farming is the major occupation among the inhabitants.

Questionnaire Development

Before the main survey, the questionnaire was pre-tested among fifteen sweet melon farmers outside the selected study communities to assess its clarity, consistency, and relevance. Feedback obtained from the pre-survey was used to revise and improve the questionnaire. A local interpretation of the questionnaire in Hausa was provided for farmers who do not understand English. Most questions centered on farmers' awareness of insect problems and their severity, their estimates of yield loss, pest management options, if any, and their willingness to adopt other management options if available. The objectives of the study were explained before each interview, and respondents participated voluntarily.

Sampling Period, Procedure, and Size

The survey was conducted during the 2023 cropping season. Primary data were collected through questionnaires administered to 150 respondents from 3 Local Government Areas (LGAs) in Bauchi and Gombe States. A multistage sampling technique was used; the first stage involved selecting three Local Government Areas (LGAs) from each of Bauchi and Gombe States (Figure 1). These LGAs were selected because of massive sweet melon production. In the second stage, five villages were selected from the LGAs. The final stage was the random selection of 5 farmers from each village, yielding a total sample of 150 respondents.

Data analysis

Data were coded and analyzed using IBM SPSS Statistics version 19 (SPSS Inc., Chicago, Illinois). Descriptive statistics (frequencies, percentages, and means) were used to summarize respondents' socioeconomic characteristics and their perceptions of insect pests and pest management practices. Similarly, results were presented to facilitate comparison between Bauchi and Gombe States.

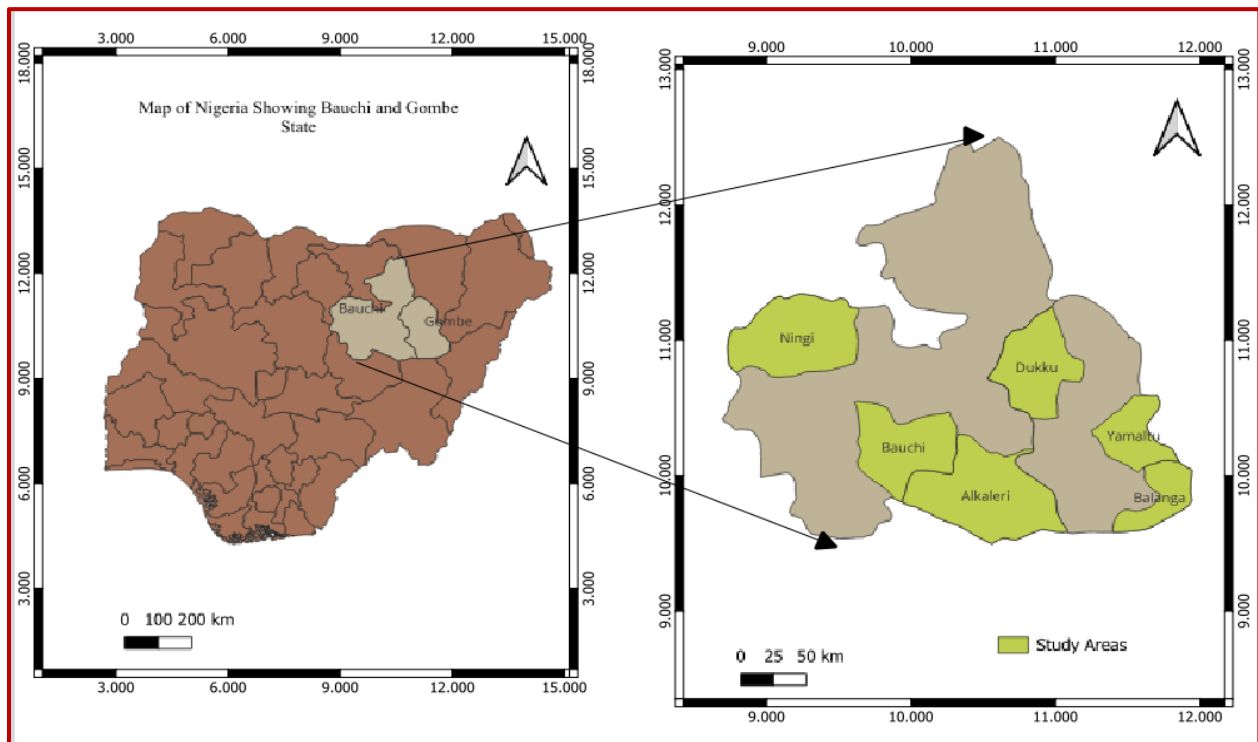


Figure 1. Map of Nigeria showing Bauchi and Gombe States with the Local Government Areas surveyed.

Socio-economic characteristics and cropping system of sampled sweet melon farmers

The demography of sweet melon farmers in Bauchi and Gombe states revealed that the majority were 30- to 50-year-olds, accounting for 68% and 76% in Bauchi and Gombe, respectively (Table 1). All respondents were male, indicating male dominance in sweet melon production. The majority of the respondents (71% in Bauchi and 73% in Gombe) were married. About 54% of the farmers had no formal education; similarly, 83% regarded farming as their primary occupation. Vegetables and other horticultural crops were the dominant crops cultivated in the two states; 77% of farmers in Bauchi and 69% in Gombe practiced sole cropping. A farm size of 1 hectare was the most commonly cultivated, recorded at 43% in Bauchi and 30% in Gombe. Respondents had moderate farming experience, which may influence their knowledge and proficiency in sweet melon production.

Table 1. Socioeconomic characteristics of sweet melon farmers in Bauchi and Gombe states

Variables	Bauchi state	Gombe state	Mean (%)
Age of respondent			
<30 years	13(17) #	18(23)	20
30-50 years	45(60)	57(76)	68
>50 years	17(23)	0(0)	11
Gender			
Male	75(100)	75(100)	100
Female	0(0)	0	0
Marital Status			
Single	13(17)	20(27)	22
Married	52(69)	55(73)	71
Divorced	2(3)	0(0)	1
Widow	8(11)	0(0)	5
Educational level			
No formal education	43(57)	38(50)	54
Primary education	7(9)	8(10)	10
Secondary education	20(27)	25(33)	30
Tertiary education	5(7)	5(7)	7
Occupation			
Civil servant	2(3)	13(17)	10
Farming	64(85)	60(80)	83
Business	9(12)	3(3)	8
Others	0(0)	0(0)	0
Type of crop grown			
Cereal	40(32)	30(28)	30
Veg./Horticultural	70(56)	65(60)	58
Legumes	15(12)	13(12)	12
Others	0(0)	0(0)	0
Cropping system			
Sole	63(84)	52(69)	77
Mixed	12(16)	23(31)	24
Farm size			
<1ha/Small	16(21)	13(17)	19
One ha/Medium	42(56)	23(30)	43
>1ha/Large	17(23)	40(53)	38
Years of farming			
<5years	20(27)	8(11)	19
5-10years	35(47)	55(56)	60
>5years	20(27)	12(16)	21

#Percentage of respondents

Table 2. Source of planting materials and varieties of sweet melon farmers

Variables	Bauchi state	Gombe state	Mean (%)
Source of planting materials			
Seeds from the previous season	70(93) ^c	60(80)	90
Certified dealers	5(7)	15(20)	10
Others	0(0)	0(0)	0
Variety Planted			
Improve	13(17)	25(33)	25
Local	62(83)	50(67)	75
Reason for variety selection ^x			
Resistance to insect pest attack	0(0)	10(9)	4
Ease of cultivation/marketability	50(31)	40(35)	33

Early Maturity	50(31)	30(27)	29
Fruit Size	45(28)	18(15)	22
Acceptability	15(9)	15(13)	11
Others	0(0)	0(0)	0

*Percentage of respondents, multiple choice allowed

Source of planting materials and varieties

In Table 2, about 93% and 80% of farmers in Bauchi and Gombe states, respectively, obtained their planting materials from seeds saved from previous seasons; 7% in Bauchi and 20% in Gombe obtained their seeds from certified dealers. This means that most farmers do not rely on formal seeds. The adoption of improved sweet melon varieties is relatively low, with only about 17% of farmers in Bauchi and 33% in Gombe state. Farmers cited various reasons for selecting specific sweet melon varieties, with ease of cultivation/marketability being the most commonly cited factor in both Bauchi and Gombe, accounting for 31% and 35% of responses, respectively. Interestingly, resistance to insect pest attack was not a significant factor influencing respondents' variety selection, as all varieties are susceptible to insect pests.

Knowledge of insect pests and their impact on sweet melon production

In >90% of farmers in Bauchi and Gombe states, insects were identified as the major constraint to sweet melon production. All surveyed farmers (100%) reported observing insects in their sweet melon farms, thus indicating some level of awareness of insect presence and their potential impact on crop health and yield. Farmers reported encountering various insect species; aphids and leaf beetles were the most frequently encountered and damaging insect pests in both states, causing significant crop damage. White flies and fruit flies were also cited, albeit to a lesser extent; however, Fruit flies were also considered damaging, particularly in Gombe State (Table 3 and Figure 2). Farmers identified all stages of crop growth as susceptible to insect attack. This means that there is a need for pest management interventions throughout the crop's growing. Fruit damage emerged as the most commonly observed symptom of insect infestation; thus, the economic impact of insect pests on crop yield and quality is significant (Table 3).

Farmers' perceptions of the severity of insect pest attacks vary. This assessment is particularly pronounced in Gombe State, where more than 60% of farmers perceive insect pest attacks as extremely severe. Similarly, >40% in both states assessed the severity of insect pest attacks as severe. Respondents attributed insect infestations to various factors, including climatic conditions and poor agronomic practices. A notable proportion of respondents in Gombe state (49%) expressed uncertainty about the source of infestation, highlighting the complexity of the factors influencing insect pest dynamics. The farmers unanimously agreed that insect pests decrease the market value of sweet melons, highlighting the economic ramifications of pest damage on market outcomes (Table 4).

Table 3. Farmers' knowledge on insect pests of sweet melon

Variables	Bauchi State	Gombe State	Mean (%)
<i>Major constraint</i>			
Insects	70(93) [#]	68(91)	92
Weeds	3(4)	5(7)	5
Disease	2(3)	2(3)	3
<i>Insect observation</i>			
Yes	75(100)	75(100)	100
No	0(0)	0(0)	0
<i>Frequent insect pest^x</i>			
Aphids	70(38)	73(39)	39
Whiteflies	15(8)	18(10)	9
Fruitfly	15(8)	23(12)	10
Grasshopper	8(4)	8(4)	4

Beetles	75(41)	65(35)	38
<i>Presence of insect</i>			
Rarely	0(0)	0(0)	0
Frequently	8(11)	0(0)	5
Always Present	67(89)	75(100)	95
<i>Susceptible stage</i>			
Seedling	13(17)	3(4)	11
Vegetative	17(23)	8(11)	17
Flowering/fruiting	5(7)	8(11)	9
All stages	40(53)	56(75)	64
<i>Symptom of infestation*</i>			
Stunted growth	30(21)	10(7)	14
Wilting	5(3)	0(0)	2
Fruit Damage	75(52)	75(52)	52
Leaf damage	35(24)	58(40)	32

Note: #Percentage of respondents, *multiple choice allowed

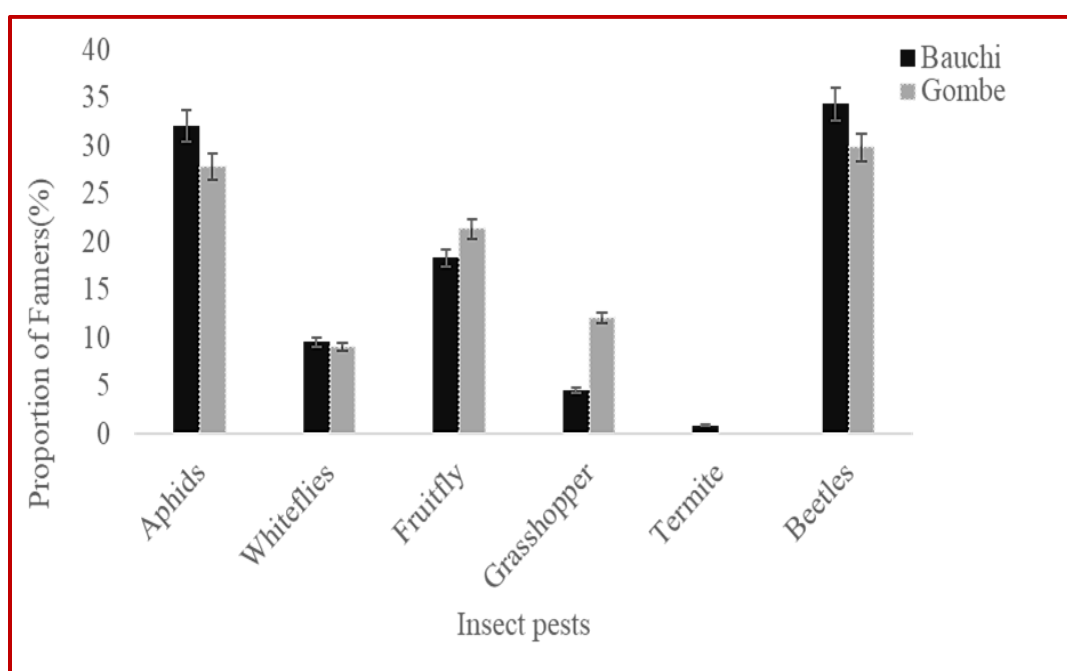


Figure 2. Farmers' perception of the most damaging insect pests of sweet melon in Bauchi and Gombe States

Table 4. Farmers' perception on insect pest severity and its impact on sweet melon production

Variables	Bauchi state	Gombe state	Mean (%)
<i>Changes in severity of insect pests</i>			
Yes	74 (99) #	75(100)	99
No	1(1)	0(0)	1
<i>Severity of the insect pest</i>			

Decreased	0(0)	0(0)	0
Same	2(3)	0(0)	1
Increased	73(97)	75(100)	99
<i>Severity/prevalence of pest attack</i>			
Not severe	1(1)	0(0)	1
Severe	34(45)	30(40)	43
Extremely severe	40(53)	45(60)	57
<i>Possible source of insect infestation^x</i>			
Seeds	5(7)	0(0)	3
climatic condition	35(47)	38(50)	48
Poor agronomic practices	18(24)	0(0)	12
I don't know	17(23)	37(49)	36
<i>Impact of insect pests on yield loss</i>			
<10%	0(0)	0(0)	0
10-25%	7(9)	18(23)	16
25-50%	44(59)	23(30)	44
>50%	24(32)	35(47)	39
<i>Differences in quality of infested melon</i>			
Yes	75(100)	75(100)	100
No	0(0)	0(0)	0
<i>Effect of insect pests on market value</i>			
Decreases market value	75(100)	75(100)	100
No effect on market value	0(0)	0(0)	0

#Percentage of respondents, *multiple choice allowed

Effectiveness of different methods of insect pest control in Bauchi and Gombe states, Nigeria

Chemical pesticides were the most widely used method (100%) across Bauchi and Gombe states (Table 5). Similarly, 53% of respondents in Bauchi reported that their chosen control is very effective; in Gombe state, however, 64% reported that chemical pesticides are very effective, and 68% of farmers in Bauchi and 93% in Gombe use pesticides at rates higher than the manufacturers' recommended rates. Furthermore, 51% of the farmers apply pesticides at all stages of growth, while 7 and 18% of respondents, however, make applications during the vegetative and flowering/fruiting stages, respectively,

The frequency of pesticide application is also an important aspect of pest management; 70% of the farmers reported that they apply pesticides every week, while 29% apply chemical pesticides every two to three days, especially during the fruiting stage, as shown in Figure 3.

The majority (>95%) of the farmers in both Bauchi and Gombe states have not received any formal training on insect pest management. A greater proportion of farmers (91%) were aware of the dangers associated with chemical pesticide misuse; only about 9% of the total farmers reported being unaware of these dangers. It is surprising to note that about 9% of farmers in Bauchi and 33% in Gombe states are not concerned at all about the negative impact of these chemical pesticides. Furthermore, 89% of the farmers expressed a willingness to adopt alternative pest management practices (Table 6).

Table 5. Adopted methods of insect pest control on sweet melon

Variables	Bauchi state	Gombe state	Mean (%)
<i>Method/s of insect pest control</i>			
Chemical pesticides	75(100)#	75(100)	100

Biopesticides	0(0)	0(0)	0
Physical control	0(0)	0(0)	0
Others specify	0(0)	0(0)	0
<i>Effectiveness of pest management</i>			
Very effective	53(71)	64(85)	78
Somewhat effective	22(29)	11(15)	22
Not effective	0(0)	0(0)	0
<i>Formulation rate used</i>			
>Manufacturers recommended rate	51(68)	70(93)	81
Manufacturer's recommended rate	24(32)	5(7)	19
<Manufacturers recommended rate	0(0)	0	0
<i>Stage of growth of pesticide application</i>			
Seedling	20(27)	15(20)	23
Vegetative	6(8)	5(7)	7
Flowering/fruiting	7(9)	20(27)	18
All stages	42(56)	35(47)	51

#Percentage of respondents, *multiple choice allowed

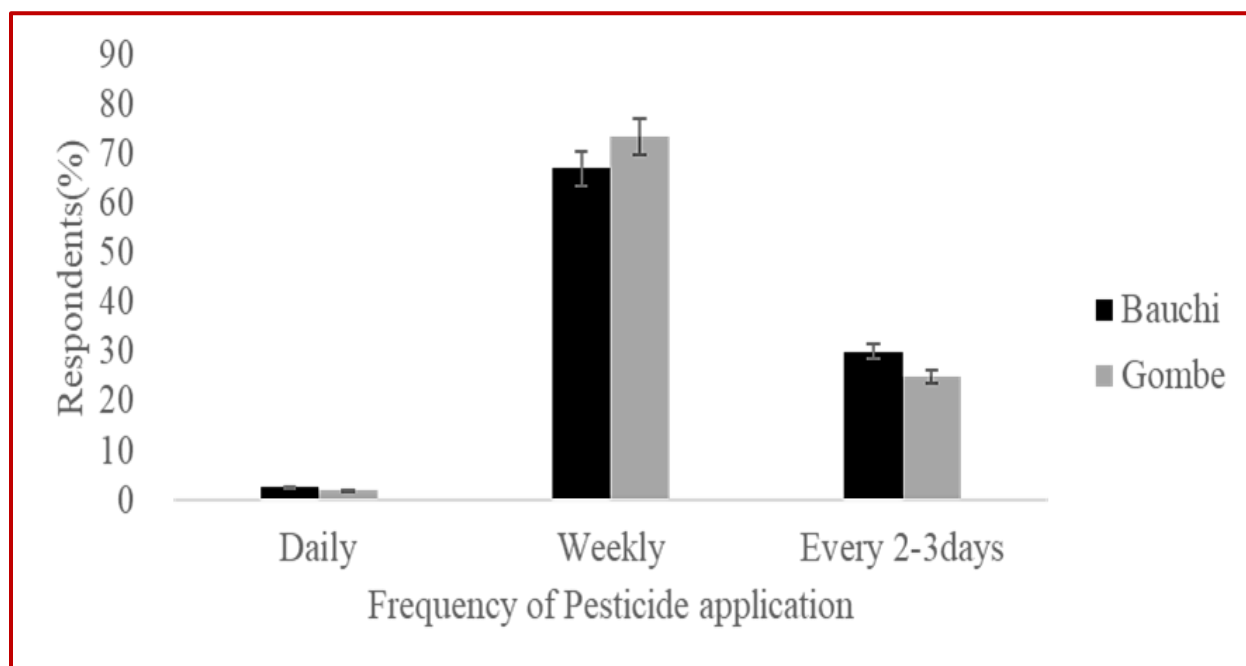


Figure 3. Frequency of pesticide application by sweet melon farmers in Bauchi and Gombe States, Nigeria.

Table 6. Farmers' sources of information on pest control and their awareness of the potential risks associated with chemical pesticides in Bauchi and Gombe states, Nigeria.

Variables	Bauchi state	Gombe state	Mean (%)
<i>Any training received on insect pest management?</i>			
Yes	1(1)#	2(3)	2
No	74(99)	73(97)	98

<i>If yes, name source of pest management decision?</i>			
Other farmers	1(1)	2(3)	2
Agrochemical dealers	0(0)	0(0)	0
Radio/television	0(0)	0(0)	0
Extension agents	0(0)	0(0)	0
None	74(99)	73(97)	98
<i>Awareness of risks associated with chemical pesticides?</i>			
Yes	67(89)	70(93)	91
No	8(11)	5(7)	9
<i>Any concern about the negative impacts of chemical pesticides?</i>			
Very concerned	43(57)	33(44)	50
Somewhat concerned	24(32)	18(24)	28
Not concerned at all	7(9)	24(32)	21
<i>Willingness to adopt alternative pest management practices?</i>			
Yes	68(91)	65(87)	89
No	7(9)	10(13)	11
<i>Willingness to adopt alternative pest management, even if they are less effective in managing insect pests?</i>			
Yes	53(71)	60(79)	75
No	22(29)	17(22)	25

DISCUSSION

The present study confirms that insect pests are the most important production constraint perceived by sweet melon farmers in Bauchi and Gombe States. All respondents reported experiencing insect pest problems throughout the sweet melon (*Cucumis melo*) growing period, indicating that insect pest pressure is widespread across the two states. This high level of awareness is expected given the extent of insect damage, which directly reduces both yield and marketability and, in turn, affects farmers' income. The widespread occurrence of insect pests observed in this study is consistent with recent reports that insect pests remain a major biotic constraint on cucurbit production in Nigeria and elsewhere (Ofuya et al., 2023; Filani et al., 2024). The continuous cultivation of *C. melon* in these areas ensures that food, mates, favorable environmental conditions, and suitable shelter are always available; similarly, inadequate insect pest management practices may have contributed to their increased numbers.

Farmers identified aphids, beetles, and fruit flies as the most economically important insect pests. These insect species occur throughout the crop growth cycle; they cause fruit and leaf damage and are the most common symptoms observed in farmers' fields. Aphids (locally referred to as "Mando" secrete honeydew, which affects the photosynthetic ability of the plants. The predominance of these insect groups is not surprising because aphids multiply rapidly under warm conditions and are efficient vectors of viral diseases; beetles feed extensively on foliage and young plant tissues, whereas fruit flies directly damage developing fruits through oviposition and larval feeding. Similar insect pest complexes have recently been reported on cucurbit crops in southwestern Nigeria and other tropical production systems (Filani et al., 2024). Their occurrence throughout the crop-growing stages (Alao et al., 2016; Gupta et al., 2017; Okrikata & Ogunwolu, 2017) indicates that effective insect pest management should start immediately after seed emergence and continue until harvest.

Most farmers perceived that insect pest infestations have become more severe over time and associated them with substantial yield losses, poor fruit quality, and reduced market value, as perforated fruits were less attractive to consumers. These perceptions corroborate the increasing pest challenges reported in vegetable production systems (Okrikata and Emmanuel, 2017; Ofuya et al., 2023). The farmers opined that insect pests threaten both productivity and profitability of sweet melon production in the study areas.

Another important finding of this study was that many farmers applied pesticides more frequently. At doses exceeding manufacturers' recommendations, these practices may provide short-term insect population

reduction, which can lead to pest resurgence, development of insecticide resistance, increased pesticide residues on harvested produce, destruction of beneficial arthropods such as pollinators and natural enemies, and even soil and water contamination (Oke et al., 2020). Okrikata and Ogunwolu (2017) reported that chemical control is the dominant pest management strategy among vegetable farmers. Similar findings were reported: the misuse of pesticides has become an important challenge to sustainable vegetable production across sub-Saharan Africa and highlights the need for improved pesticide stewardship and farmer education (Ofuya et al., 2023; Tripathi et al., 2020). Reducing unnecessary pesticide applications would not only lower production costs but also improve environmental and food safety.

Despite the widespread use of synthetic pesticides, almost all respondents reported never receiving formal training in insect pest management, and extension support was virtually absent. Nevertheless, the majority expressed willingness to adopt alternative pest management strategies if effective and practical options were made available. This willingness represents an important opportunity for government agencies, research institutions, and extension organizations to promote integrated pest management programs that combine cultural practices, botanical pesticides, biological control, field scouting, and judicious use of synthetic insecticides. Strengthening extension services and farmer capacity-building would significantly reduce pesticide misuse while improving the sustainability and profitability of sweet melon production in northeastern Nigeria.

CONCLUSION

This study demonstrated that insect pests are the major biotic constraint affecting sweet melon production in Bauchi and Gombe States, Nigeria. Farmers were highly aware of the detrimental effects of insect pests and identified beetles, aphids, and fruit flies as the most abundant and economically damaging species. Although farmers possessed adequate knowledge of these pests, management practices relied almost exclusively on frequent applications of synthetic pesticides, often exceeding recommended application rates. The widespread dependence on chemical pesticides, coupled with limited access to training and extension services, poses significant risks to human health, beneficial organisms, and the environment.

The findings highlight the urgent need to strengthen agricultural extension services by providing regular farmer training in integrated pest management (IPM), safe pesticide handling, and responsible pesticide application. Promoting the adoption of sustainable pest management strategies, including cultural, biological, and botanical control methods alongside the judicious use of synthetic insecticides, will enhance sweet melon productivity while minimizing environmental and public health risks. Such interventions are essential for achieving sustainable sweet melon production in northeastern Nigeria.

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AUTHORS' CONTRIBUTIONS

Lilian Dada Simon: Writing –original draft, Visualization, Methodology, Investigation, Formal analysis, Micheal Mamman Degri: Supervision, reviewing and editing. Musa Buba: Review & editing; Habiba Ismaila, Caleb Iliya Jidere: Writing –review & data collection.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL APPROVAL

Not applicable.

CONSENT FOR PUBLICATION

Not Applicable.

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AVAILABILITY OF DATA AND MATERIALS

All datasets analyzed and described during the present study are available from the corresponding author upon reasonable request

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