https://doi.org/10.62587/AFRJBS.3.1.2026.13-27 ISSN: 3006-7464

African Research Journal of Biosciences

Journal homepage: http://www.afrjbs.com

Research Paper Open Access

Community structure of arthropods associated with golden melon (*Cucumis melo* L.) in Wukari, Taraba State, Nigeria

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Article Info

Volume 3, Issue 2, July 2026
Received : 26 March 2026
Accepted : 02 July 2026
Published : 25 July 2026
doi: 10.62587/AFRJBS.3.2.2026.13-27

Abstract

Arthropod community structure of golden melon was investigated wherein arthropods were sampled weekly using a modified portable 2-stroke gasoline-powered leaf-blower and vacuum machine (Model number: EBV260E; Power: 0.7 KW/7500 Min.) with a 5 cm diameter inlet cone. Relative Abundance (RA), Frequency of Occurrence (FO), and pest: natural enemy ratio of the specimens were documented. Diversity indices were computed, and spatial distribution patterns of dominant species were determined using Taylor's and Iwao's regression models. Forty-eight species belonging to 30 families and 10 orders were recorded. Coleopterans and Hymenopterans were the most diverse orders. Chrysomelid beetles and sap sucking Hemipterans constituted the major pest. Natural enemies; particularly ants, coccinellid beetles, wasps, and spiders were abundant and widely distributed. Dominant pest species (RA $\geq$ 1.0% and FO $\geq$ 25.0%) included *Aphis gossypii, Aulacophora africana* and *Bactrocera cucurbitae.* Population densities of pests and natural enemies largely peaked within the vegetative to flowering stages. Spatial distribution analyses for the dominant arthropods largely show a tendency to aggregation. Community diversity was high (H = 3.361) with high species richness (R = 6.650) and moderately high evenness (E = 0.600). Pest-natural enemy ratio was 0.78:1. These findings highlight effective biological regulation and ecological stability of the golden melon agro-ecosystem and underscore the need for conservation based integrated pest management strategies.

Key words: *Buzas and Gibson's evenness, Golden melon, Iwao's patchiness regression, Shannon-Weiner index, Taylor's power law, Spatial distribution*

1. Introduction

Golden melon also commonly called sweet melon (*Cucumis melo* L.) is a fruit vegetable crop which belongs to

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the family *Cucurbitaceae* with distinctive features such as an extensive rooting system, an aerial stem, simple leaves, and a trailing creeping growth habit which provides essential nutrients such as vitamins A and C, minerals, and dietary fiber. It contributes significantly to food security and rural livelihoods in Nigeria and other tropical and subtropical regions (Filani *et al.*, 2024). The fruit is globular in shape with a smooth, waxy yellow to golden edible skin/rind with creamy white flesh, typically reaching sizes of 12-16 cm and spherically elongated seeds (often discarded as agro-waste) which can be dried, roasted and used as additives in animal feeds or pressed into high quality seed oil. Its pleasant taste, rich flavor, coupled with the growing awareness of its nutritional and health benefits is triggering its increased production and consumption in Nigeria, and particularly in Wukari, Taraba State (Khalid *et al.*, 2021).

The golden melon is reportedly high in biologically active substances like phenols, flavonoids, vitamins, as well as carbohydrates, minerals, and especially potassium. It is also low in fat and calories, high in dietary fiber, and has a pleasant aroma (Tamer *et al.*, 2010; Olubunmi *et al.*, 2019). The health benefit of golden melon is attributable to its nutritional characteristics and bioactive compounds, its low in calories (≈ 17 kcal/100 g) and high water content (90% composition). It has considerable amounts of proteins, omega 3 and 6 fatty acids, carotenoids, phenolics, vitamins (e.g., A, B_1, B_5, B_6, C) and minerals (e.g., calcium, iron, potassium, and zinc) (Khalid *et al.*, 2021). Intake of the fruit helps keep the body hydrated, regulates nerves and muscles contractions within the body, and prevents constipation and cardiovascular diseases, healthy weight management and cholesterol control. It is a powerful source of natural antioxidant and good for improved sight and general immunity. It also supports digestion, bone/teeth strength and haemoglobin formation (Shang *et al.*, 2020).

Despite its nutritional, health and economic benefits, the diversity of insects associated with golden melon is not well documented in Nigeria. Previous studies have reported a range of species, including pollinators such as bees (Hymenoptera: Apidae) and flies (Diptera: Syrphidae), as well as pests such as aphids (Hemiptera: Aphididae), whiteflies (Hemiptera: Aleyrodidae), and fruit flies (Diptera: Tephritidae) (Okrikata *et al.*, 2022; Egbon *et al.*, 2025). These studies however, are largely focused on specific insect groups of pest species, rather than providing a comprehensive assessment of the insect community structure of golden melon.

Arthropods, and Insects, in particular, play critical roles in the ecology and production of melons as besides serving as pollinators, and crop pests; they also serve as natural enemies of pests (Okrikata and Ogunwolu, 2017). Understanding their diversity, abundance, temporal and spatial spread vis-à-vis a crop is essential for developing effective Integrated Pest Management (IPM) strategies needed to minimize the use of synthetic chemical pesticides and to maintain ecological balance (Okrikata *et al.*, 2022; Filani *et al.*, 2024). Noting that a detailed arthropod community structure of *C. melo* has hardly been studied in Nigeria; and aware that the insect fauna of a crop can be influenced by factors including, agricultural practices, climate, and geographical location, we thus investigated and herein document a comprehensive list of arthropods, insects in particular, associated with golden melon (*C. melo*), their diversity, richness, evenness, guilds, dispersion and temporal spread in Wukari which is located in the Southern Guinea Savanna of Nigeria.

2. Materials and methods

2.1. Study location

The arthropod survey was conducted in the Research Farm of the Federal University of Wukari, Taraba State, Nigeria which is located in the Southern Guinea savanna zone of the north eastern Nigeria lying within Latitude 7°51'N and Longitude 9°47'E during the planting season of 2025. Wukari has an average annual temperature of 26.8 °C. The study area experiences a warm tropical climate characterized by dry and wet seasons with the wet season lasting from April to October peaking in June and September (Okrikata and Yusuf, 2016). Common weeds in the study area includes; *Ipomoea triloba* Linn., *Gomphrena celosoides* Mart., *Imperata cylindrica* L. Raeuschel, *Digitaria horizontalis* Willd., *Rottboellia cochinchinensis* (Lour.) Clayton, *Andropogon gayanus* Kunth, *Tridax procumbens* L., *Commelina benghalensis* L. and *Cyperus rotundus* L.

2.2. Field layout and crop cultural management

The experimental land was ploughed and harrowed after which a 0.034 hectare of land was demarcated into 12 sub-sampling plots each measuring 4 m by 4 m (16 m^2) during the 2025 cropping season. Seeds of Golden melon (*C. melo*); variety "F1 Delta" was obtained from a reputable agrochemical dealer in Kano, Nigeria. These were sown on raised beds at three seeds/hole to a depth of about 2 cm. The crop spacing was 1 m between rows and 1 m within; thinning to one plant/stand was done at 10 days after planting giving 9 plants/plot (10,000 plants/ha). NPK (15:15:15) fertilizer was applied at the rate of 200 kg/ha (Gichimu *et al.,* 2008) at 3 Weeks After Planting (WAP) using the side band method. A residual and systemic fungicide; RiddomilGold® (40 g/ ha Metalaxyl-M, 640 g/ha Mancozeb) was applied at the rate of 2.5 kg/ha at the vegetative, flowering and fruiting stages. The field was subjected to natural arthropod infestation while manual weeding was done when necessary.

2.3. Arthropod sampling procedure

The sampling of arthropod species commenced at 70% emergence stage [2 Weeks After Planting (WAP)] and proceeded at weekly intervals until fruit maturity. Collection was made between 1600 and 1800 h but was made between 0700 and 0900 hr at the flowering stage for effective sampling of pollinating insects as the melon flowers usually opens in the morning and close by noon. A modified *Bragadin Giardinaggio* portable 2-stroke gasoline-powered leaf-blower and vacuum machine (Model number: EBV 260 E; Power: 0.7 KW/7500/ Min.; Made in: China) with a 5 cm diameter inlet cone was used to sweep through 4m length of the middle row at an approximate walking speed of 1 m/sec (Figure 1). Visual observation complemented suction sampling. The arthropods collected were killed in ethyl acetate killing jar and then preserved in 70% ethanol. Butterflies and moths were dried and preserved in an airtight container containing silica gel to preserve their wing morphology. Immature stages of insects collected were reared to adult in the laboratory for identification. All insects collected were identified by comparing samples with online pictorial resources with a further confirmation by entomology experts at Federal University Wukari, Nigeria after which they were categorized into feeding guilds (Okrikata *et al.*, 2019).

Figure 1: Arthropod suction sampling on golden melon plots at seedling crop stage using a modified bragadin giardinaggio portable 2-stroke gasoline-powered leaf-blower and vacuum machine at Wukari

2.4. Data analysis

The Frequency of Occurrence (FO) and Relative Abundance (RA) of arthropods retrieved were computed. Taxa/species with FO $\geq$ 25% and RA $\geq$ 1% were regarded as dominant while, those with FO < 25% and/or, RA < 1% were regarded as rare following the scale outlined by Okrikata *et al*. (2019). The dominant taxa/species were used to compute the natural enemies to pests' ratio (calculated as the sum of natural enemies divided by sum of the pests). Temporal spread and weekly fluctuations of dominant arthropods were graphically illustrated.

2.4.1 Diversity indices

Shannon-Weiner diversity index, Margalef's species richness index and, Buzas and Gibson's Evenness index were computed using the Paleantological Statistical Tool–Past$_3$ (Hammer *et al.*, 2001).

2.4.2 Dispersion indices

The variance to mean ratio (S^2/m) was used to form a tentative opinion on dispersion patterns of the dominant taxa/species. Linear regression models (Taylor's power law and Iwao's patchiness regression) were used to confirm the spatial distribution of the dominant insects (pests and Beneficial's) as recommended by Mollet *et al*. (1984) and Okrikata *et al*. (2019).

The variance to mean ratio (S^2/m) proposed by Myers (1978) is such that; S^2/m = 1, < 1 and > 1 indicates random, regular and aggregated dispersion, respectively.

Taylor's power law states that the variance (S^2) of a population is proportional to the fractional power of the arithmetic mean (m): $S^2 = am^b$

To estimate a and b, the values of log (S^2) were regressed against log (m) using the formula:

$$\log (S^2) = \log(a) + b\log(m)$$

Where the intercept (a) is the sampling/computing factor which changes with sampling unit, and the slope (b) is an index of aggregation that indicates a uniform, random or aggregated dispersion when b < 1, = 1 or > 1, respectively (Southwood, 1978; Okrikata *et al*., 2019).

The Iwao's patchiness regression on the other hand, quantifies the relationship between the mean crowding (m^*) and the mean (m) using the formula:

$$m^* = \alpha + \beta m$$

Where m^* is the mean crowding (Lloyd, 1967). The intercept (α) is the index of basic contagion of a population.

where;

$\alpha = 0$ (the basic unit of a population is a single individual/random dispersion).

$\alpha > 0$ (there is a positive association between individuals/aggregated dispersion).

$\alpha < 0$ (there is a negative/repulsive association between individuals/regular dispersion).

The slope (β) is the density contagiousness coefficient interpreted in the same manner as b of Taylor's regression (Iwao and Kuno, 1968).

3. Results

3.1. Diversity, abundance and feeding guilds of arthropods associated with golden melon at Wukari

A total of 1,174 arthropod samples sorted into 1 order (*Araneae*) of the class Arachnida and 6 orders of the class Insecta which made up 48 species, 28 families and 10 orders (Tables 1 and 2). The results show high species diversity (Shannon-Wiener's Index – 3.361), high species richness (Margalef's Richness Index - 6.65), and high evenness (Buzas and Gibson's Evenness Index of - 0.600) of the arthropod community (Table 2). The insect order Coleoptera was the most diverse (16 species, 474 individuals and 2.245 Shannon index), followed by Hymenoptera (10 species, 386 individuals and 1.992 Shannon index). And of the 21 dominant (FO $\geq$ 25.0% and RA $\geq$ 1%) taxa, 7 each were Coleoptera and Hymenoptera even though the Coleopterous insects were 1.6x more abundant than hymenopterans. While, Araneae, Blattodea, Dermaptera and Mantodea were made up of a single species each with maximum species evenness values, Diptera; made up of 5 species has the least (0.492) Table 1.

The dominant arthropod species included the leaf feeding beetles; *Asbecesta nigripennis* Weise, *A. transversa* Allard, *Aulacophora africanna* Weise, *Epilachna chrysomelina* Fab. and *Monolepta nigeriae* Bryant. Others included in the list are; *Bracon hebetor Say*., *Apis mellifera* L., *Aphis gossypii* Glove., Ant species, Spiders, *Philanthus triangulum* Fab. and *Rhynocoris nitidulus* Fab. (Tables 3 and 4). Table 3 also shows that, among the Coleoptera, the Chrysomelidae were clearly the most abundant phytophagous family, as species such as *Monolepta nigeriae* (7.08% RA; 90.9% FO), *Aulacophora africana* (6.91% RA; 100% FO), *Asbecesta transversa* (6.48% RA; 90.9% FO), and *Asbecesta nigripennis* (6.31% RA; 90.9% FO) were both numerically dominant and consistently present. A total of 55.32% of the collection were rare or scarce (RA < 1.0% and/or FO < 25.0%). Of the 21 dominant species, 8 were herbivores, 3 parasitoids, 9 predators and a pollinator (*A mellifera*). The approximate natural enemy to pest ratio is 0.88 (Tables 3 and 4).

Tephritidae were represented mainly by *Bactrocera cucurbitae* Coq. (4.95% RA; 72.73% FO) which more abundant and wide spread than *Bactrocera invadens* Drew, Tsuruta and White (0.43% RA; 45.45% FO). The economically important pest groups within the Hemiptera such as *Bemisia tabaci* Genn. (3.07% RA; 90.9% FO) and the *A. gossypii* (3.33% RA; 72.73% FO) were frequently encountered which indicates continuous colonization

Table 1: Diversity, richness, and evenness of the taxa collected on golden melon at Wukari in 2025 cropping season

Arachnid/Insect Order	S	N	H	R	E
Araneae	1	37	0.000	0.000	1.000
Blattodea	1	5	0.000	0.000	1.000
Coleopteran	16	474	2.245	2.435	0.581
Dermaptera	1	18	0.000	0.000	1.000
Diptera	5	78	0.900	0.918	0.492
Hemiptera	6	115	1.552	1.054	0.787
Hymenoptera	10	386	1.992	1.511	0.733
Lepidoptera	2	16	0.693	0.361	1.000
Mantodea	1	17	0.000	0.000	1.000
Orthoptera	5	28	1.399	1.200	0.810

Note: All species of spiders were treated as a taxon; S = Number of species/taxa; N = Number of individuals/specimens; H = Shannon-Weiner diversity index; R = Margalef's species richness index; E = Buzas and Gibson's evenness.

Table 2: Diversity indices of arthropods collected from golden melon field plots at Wukari in 2025 cropping season

Diversity Index	Values	Inference
Shannon-Weiner Index (H)	3.361	Indicates high arthropods diversity, suggesting a complex and stable arthropods community with minimal dominance by a single species
Buzas and Gibson's Evenness Index (E)	0.600	Shows high evenness. Individuals are fairly well distributed among the species present.
Margalef's Richness Index (R)	6.650	Reflects high species richness, indicating the presence of a large number of arthropod species in the golden melon ecosystem.
48 species of arthropods, 28 families and 10 orders were collected		

of the crop while their moderate RA suggests chronic rather than outbreak level infestations. Rare and occasional species included several taxa such as *Pseudolynchia canariensis* Macq., and *Lycus corniger* Dalm (Table 3).

Table 3: Relative abundance and frequency of occurrence of arthropod specimens collected on golden melon at Wukari in 2025 cropping season

Arachnid/Insect Order	Family	Species	RA (%)[1]	FO (%)[2]
Araneae	Various families	Spiders	3.16	81.81
Blattodea	Termitidae	*Odontotermes* sp.	0.43	27.27
Coleoptera	Carabidae	*Platymetopus vestitus* Dej.	0.60	18.18
	Chrysomelidae	*Aphthona whitfieldi* Bryant	0.42	36.36
		Asbecesta congoensis Lab.	0.34	27.27
		Asbecesta nigripennis Lab.	6.31	90.90
		Asbecesta transversa Allard	6.48	90.90
		Aulacophora africana Weise	6.91	100.0
		Monolepta goldingi Bryant	0.34	18.18
		Monolepta nigeriae Bryant	7.08	90.90
	Coccinellidae	*Cheilomenes lunata* Fab.	2.13	72.73
		Cheilomenes sulphurea Oliv.	2.73	81.81
		Epilachna chrysomelina F.	4.35	72.73
		Exochomus flavipes Thumb.	0.85	45.45
	Lycidae	*Lycus corniger* Dalm.	0.34	9.09
	Tenebrionidae	*Gonocephalum* sp.	0.34	27.27
		Omotrachelus togoanus Mshl.	0.60	36.36
	Nitidulidae	*Carpophilus dimidiatus* F.	0.60	36.36
Dermaptera	Chelisochidae	*Chelisoches flavipennis* Fab.	1.54	72.73
Diptera	Hippoboscidae	*Pseudolynchia canariensis* Macq.	0.17	9.09
	Muscidae	*Morellia prolectata* Walk.	0.43	27.27
		Musca domestica L.	0.68	36.36
	Tephritidae	*Bactrocera cucurbitae* Coq.	4.95	72.73
		Bactrocera invadens Drew, Tsuruta and White	0.43	45.45
Hemiptera	Aleyrodidae	*Bemisia tabaci* Genn.	3.07	90.9
	Alydidae	*Riptortus* sp.	0.77	63.64
	Aphididae	*Aphis gossypii* Glove	3.33	72.73
	Pentatomidae	*Agonoscellis versicolor* F.	0.51	36.36
	Pyrrhocoridae	*Odontopus nigricornis* Stal.	0.68	45.45
	Reduviidae	*Rhynocoris nitidulus* Fab.	1.45	63.64
Hymenoptera	Apidae	*Apis mellifera* L.	4.27	63.64
	Braconidae	*Apanteles syleptae* Fer.	0.77	54.55
		Bracon hebetor Say	2.30	81.81
		Cardiochiles niger W&H.	2.30	63.64
	Chrysididae	*Chrysis convexifrons* Mocs.	0.68	36.36
		Philanthus triangulum Fab.	1.54	63.64
	Formicidae	*Camponotus* spp.	7.68	90.9
		Crematogaster sp.	4.18	63.64
		Pheidole sp.	8.36	100
	Vespidae	*Antodynerus* sp.	0.85	63.64
Lepidoptera	Nymphalidae	*Acraea eponina* Cr.	0.68	63.64
	Lycaenidae	*Zizeeria* sp.	0.68	45.45
Mantodea	Mantidae	*Miomantis* sp.	1.45	54.55
Orthoptera	Acrididae	*Acrida bicolor* Thunberg	0.77	63.64
		Gastrimargus amplus Sjost.	0.26	27.27
		Oedaleus nigeriensis Uvarov	0.17	18.18
	Gryllidae	*Gymnogryllus* sp.	0.26	36.36
	Pyrgomorphidae	*Pyrrgomorpha* sp.	0.94	63.64

Note: Spider species were treated as a single taxon; RA (%) [1] – Relative abundance; FO (%) [2] – Frequency of occurrence.

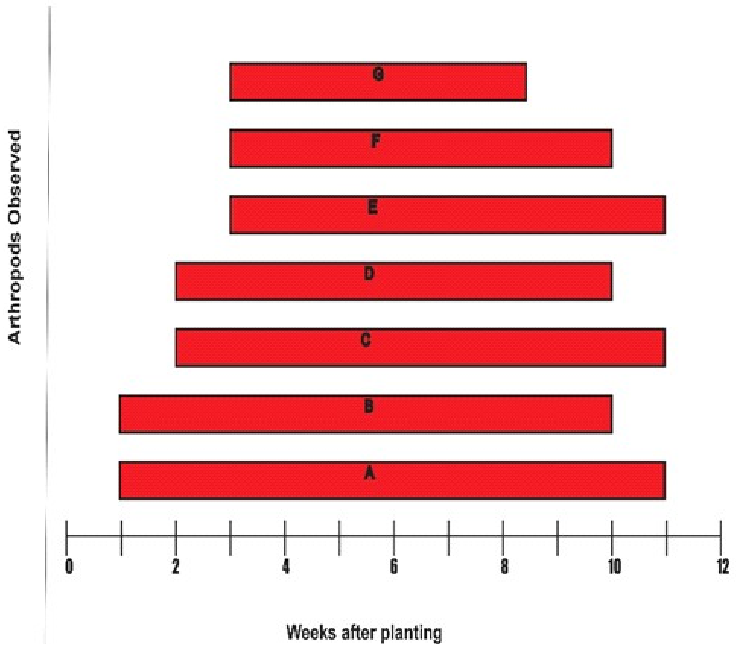
Table 4: Feeding guilds of the dominant arthropods collected on golden melon at Wukari in 2025 cropping season

Guild	Species	Plant Part Attacked	Host/Prey
Hb	*Aphis gossypii* Glove	Le, Vi, Fr	-
	Asbecesta nigripennis Lab.	Le,	-
	Asbecesta transversa Allard	Le,	-
	Aulacophora africana Weise	Le, Fl, Fr	-
	Bactrocera cucurbitae Coq.	Le, Fl,	-
	Bemisia tabaci Genn.	Le, Vi, Fr	-
	Epilachna chrysomelina F.	Le	-
	Monolepta nigeriae Bryant	Le, Fl, Fr	-
Pa	*Bracon hebetor* Say	-	Lepidopteran larvae
	Cardiochiles niger W&H.	-	Lepidopteran larvae
	Cheilomenes lunata Fab.	-	Aphids and whiteflies
Po	*Apis mellifera* L.	-	Nectar/pollen
Pr	*Camponotus* sp.	-	Insects, honeydew
	Crematogaster sp.	-	Small arthropods
	Cheilomenes sulphurea Oliv.	-	Aphids and whiteflies
	Chelisoches flavipennis Fab.	-	Eggs and larvae
	Miomantis sp.	-	Various insects
	Pheidole sp.	-	Small insects
	Philanthus triangulum Fab.	-	*Apis* spp.
	Rhynocoris nitidulus Fab.	-	Polyphagous
	Spiders	-	Insects

Note: Hb — Herbivore (include defoliators, sap suckers, flower/fruit feeders); Pr — Predator; Pa — Parasitoid; Po— Pollinator; Fr = Fruit; Vi = vine. Arthropod taxa with frequency of occurrence $\geq$ 25.0% and relative abundance $\geq$ 1%. Le – Leaf; Fl – Flower; Fr – Fruit; Vi – Vine.

3.2. *Temporal distribution of dominant arthropods associated with golden melon at Wukari*

The temporal spread of the dominant arthropods associated with golden melon shown in Figures 3 and 4 reveals that the leaf-eating beetles commenced infestation from the seedling stage, except *E. chrysomelina* which commenced at the vegetative stage, and they all spanned through to the fruiting stage, peaking (0.67-0.83/4 m-row) largely daring the late-vegetative to flowering period. The dominant pollinator, *A. mellifera*, commenced visit at the vegetative stage (3rd week after planting) in low densities, peaking during the flowering period and terminated with sharp decline in number during the mid-fruiting period. The hemipterous, sap-sucking insects (*A. gossypii* and *B. tabaci*) were visible commencing from the 2nd week after planting spanning into the 11th week after planting, peaking within the late-flowering into the early-fruiting period. Aside *B. hebetor*, *C. lunata* and *C. flavipennis* which commenced visit at the vegetative stage, all other dominant natural enemy species were in the crop agro-ecosystem during the seedling stage in comparatively lower densities (0.17-0.75/4 m-row).



G. *A. mellifera*
F. *E. chrysomelina*
E. *B. cucurbitae, B. hebetor, C. niger, Crematogaster* sp.
D. *C. sulphurea*
C. *A. gossypii, A. transversa, B. tabaci, P. trangulum, R. nitidulus, M. nigeriae* and spiders.
B. *A. nigripennis*
A. *A. africana, C. flavipennis, Camponotus* sp., *Miomantis* sp., *Pheidole* sp., *C. lunata*

NB.,
1st – 2nd WAP (Seedling stage)
3rd – 4th WAP (Vegetative stage)
5th – 7th WAP (Flowering stage)
8th – 11th WAP (Fruiting stage)

Figure 2: Temporal spread of dominant arthropods associated with golden melon during the 2025 cropping season at Wukari

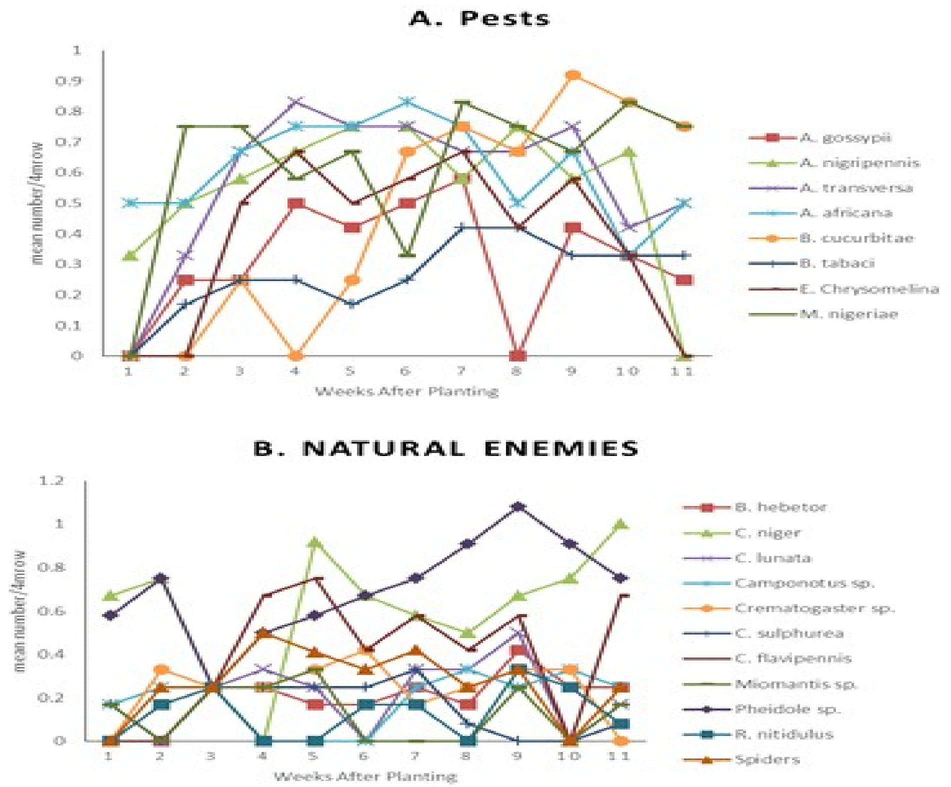


Figure 3: Weekly fluctuations in density of dominant arthropod species collected from golden melon at Wukari in 2025 cropping season A. Pest B. Natural enemies

Figure 4 shows that, the trend in weekly fluctuation of natural enemy species generally followed that of the pest species as they both appeared in comparatively lower densities during the seedling stage (0.83-2.50/4 m-row); peaking during the flowering stage (3.83-5.25/4 m-row), and declining during the fruiting stage (3.25-4.92/4 m-row). Overall, the natural enemy to pest ratio was 0.78:1.

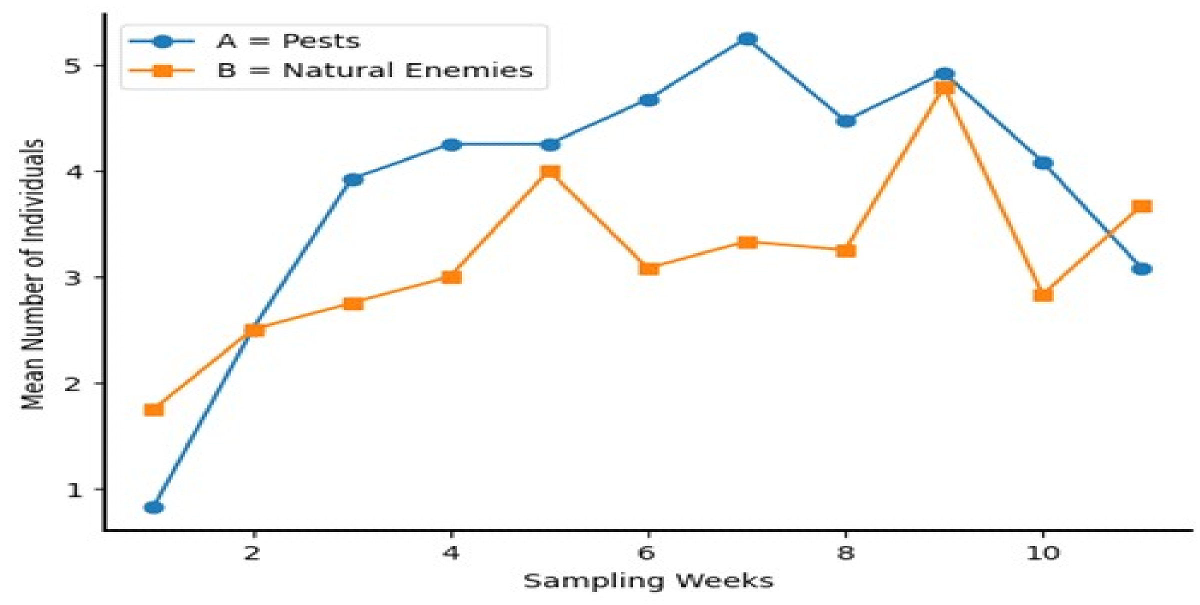


Figure 4: Pooled mean weekly fluctuations in density of dominant pest and natural enemy species on golden melon at Wukari in 2025 cropping season (pooled ratio of natural enemy to pest abundance = 0.78:1)

3.3. Spatial distribution of dominant arthropods associated with golden melon at Wukari

Table 5 shows an inconsistent pattern of fluctuation of population density and dispersion across the growth stages of the crop in the study area. The population density of some dominant pest (*A. gossypii*, *A. nigripennis*, *A. africanna*, *B. tabaci*, *E. chrysomelina*) and beneficial (*A. mellifera*, *C. sulphurea*, *C. flavipennis* and *Crematogaster* sp.) species progressively increased across the growth stages with a decline at the fruiting stage. This trend, however, was not observed in these pest (*A. transversa*, *B. cucurbitae*, *M. nigeriae*), and beneficial (*B. hebetor*, *Camponotus* sp., *C. niger*, *C. lunata*, *Miomantis* sp., *Pheidole* sp., *R. nitidulus*) and spiders in which case population densities did not follow a defined order across the crop growth stages.

The variance to mean ratio (S^2/m) which gave us a tentative opinion of the spatial distribution of the dominant arthropods indicates aggregated dispersion (>1) at the seedling stage for all the dominant arthropods except for *B. cucurbitae* and *Crematogaster* sp. which were absent at that crop growth stage. The arthropods, however, largely assumed a regular/uniform distribution (<1) during the vegetative stage except for *A. gossypii*, *B. cucurbitae*, *E. chrysomelina*, *A. mellifera*, *Camponotus* sp., *C. lunata*, *Crematogaster* sp. and *R, nitidulus* which maintained aggregated dispersion (Table 5). Of interest is that while *A. transversa*, *A. africana*, *B. tabaci*, *B. hebetor* and *Pheidole* sp. maintained same dispersion pattern (regular) during the vegetative, flowering and fruiting stage; *R. nitidulus* correspondingly maintain aggregated distribution (Table 5).

Regression analyses (Taylor's power law and Iwao's patchiness models) were used to confirm the dispersion patterns of the dominant arthropods. Taylor's power law shows aggregation ($b > 1$) of all the dominant arthropods (pest and beneficial) except for *A. gossypii*, *B. cucurbitae*, *A. mellifera*, *B. hebetor*, *C. lunata*, *C. flavipennis*, *Miomantis* sp. and *R. nitidulus* which showed uniform dispersion ($b < 1$). All arthropods with uniform pattern in Taylor's model shows same in Iwao ($\beta < 1$). Conflicting outcomes were however seen as all arthropods that were aggregated ($b > 1$) by Taylor's model appeared uniform ($\beta < 1$) in Iwao's model. However, because the R^2 values of Taylor's model were higher in *A. nigripennis*, *A. transversa*, *B. tabaci*, *M. nigeriae*, *Camponotus sp.* and *Crematogaster* sp., they were claasified as aggregated. Of interest however, is that, the Iwao's intercept (α) values were > 0 in all the dominant arthropods except in *A. africana* and *Pheidole* sp. which indicates that the populations largely have a group of individuals as their basic which infers a positive association between individuals and a tendency to crowding/aggregation (Table 6).

Table 5: Population density (m ± SE)/4 m row and variance to mean ratio (S^2/m) of dominant arthropods collected on golden melon at Wukari in 2025 cropping season

Species	Seedling Stage		Vegetative Stage		Flowering Stage		Fruiting Stage	
	m ± SE	S^2/m	m ± SE	S^2/m	m ± SE	S^2/m	m ± SE	S^2/m
Pest								
Aphis gossypii Glove	0.08±0.08	3.000	0.31±0.16	2.820	0.50±0.05	0.170	0.32±0.13	1.760
Asbecesta nigripennis Lab.	0.47±0.07	2.650	0.67±0.05	0.130	0.69±0.06	0.160	0.52±0.13	2.050
Asbecesta transversa Allard	0.33±0.19	6.930	0.75±0.05	0.110	0.72±0.03	0.040	0.60±0.06	0.380
Aulacophora africana Weise	0.56±0.06	2.000	0.72±0.03	0.040	0.78±0.03	0.040	0.55±0.07	0.580
Bactrocera cucurbitae Coq.	0.00±0.00	0.000	0.0±0.08	3.000	0.78±0.16	1.55	0.78±0.04	0.140
Bemisia tabaci Genn.	0.17±0.10	3.460	0.25±0.05	0.330	0.28±0.07	0.700	0.37±0.02	0.070
Epilachna chrysomelina F.	0.17±0.17	12.00	0.56±0.06	1.333	0.58±0.05	0.140	0.04±0.12	2.020
Monolepta nigeriae Bryant	0.50±0.25	9.000	0.67±0.05	0.130	0.61±0.15	1.270	0.77±0.03	0.080
Beneficial								
Apis mellifera L.	0.11±0.11	4.000	0.64±0.17	1.610	0.78±0.10	0.460	0.28±0.13	3.620
Bracon hebetor Say	0.11±0.11	4.000	0.25±0.05	0.330	0.19±0.03	0.140	0.27±0.04	0.370
Camponotus spp.	0.81±0.10	3.600	0.64±0.32	5.780	0.72±0.10	0.500	0.70±0.09	0.630
Cardiochiles niger W&H	0.11±0.11	4.000	0.31±0.03	0.090	0.19±0.10	1.860	0.27±0.09	1.630
Cheilomenes lunata Fab.	0.22±0.03	1.000	0.08±0.08	3.000	0.08±0.08	3.000	0.28±0.02	0.090
Cheilomenes sulphurea Oliv.	0.19±0.10	3.600	0.28±0.28	0.100	0.31±0.07	0.640	0.22±0.06	1.080
Chelisoches flavipennis Fab.	0.08±0.04	1.730	0.19±0.06	0.570	0.28±0.03	0.100	0.10±0.06	2.250
Crematogaster sp.	0.00±0.00	0.000	0.47±0.24	4.290	0.58±0.10	0.570	0.45±0.12	1.910
Miomantis sp.	0.14±0.07	2.650	0.28±0.03	0.100	0.11±0.11	4.010	0.08±0.05	2.000
Pheidole sp.	0.67±0.04	1.000	0.58±0.05	0.140	0.67±0.05	0.130	0.88±0.06	0.260
Rhynocoris nitidulus Fab.	0.14±0.07	2.650	0.08±0.08	3.000	0.11±0.06	1.000	0.17±0.06	1.250
Spiders	0.19±0.10	3.600	0.42±0.05	0.200	0.39±0.03	0.070	0.25±0.07	1.170

Table 6: Comparison of dispersion of dominant arthropods collected on golden melon at Wukari in 2025 cropping season using Taylor's power law ($\log S^2 = \log a + b\log m$) and Iwao's regression ($m^* = \alpha + \beta m$) models

Species	Taylor's Power Law				Iwao's Patchiness Regression			
	a	b^1	SE_b	R^2	A	β^1	SE_β	R^2
Pest								
Aphis gossypii Glove	-0.185	0.668	0.932	0.019^{NS}	2.948	0.444	0.217	0.677^{NS}
Asbecesta nigripennis Lab.	-3.870	3.659	3.261	0.413^{NS}	5.221	0.274	0.986	0.037^{NS}

Table 6 (Cont.)

Asbecesta transversa Allard	-4.065	3.696	1.160	0.860*	26.786	-2.290	0.828	0.793NS
Aulacophora africana Weise	-6.158	5.405	1.754	0.860NS	-0.306	0.923	0.062	0.992NS
Bactrocera cucurbitae Coq.	-0.027	0.551	0.864	0.001NS	2.428	0.672	0.064	0.991*
Bemisia tabaci Genn.	-2.984	1.562	1.231	0.746NS	2.203	0.237	0.290	0.251NS
Epilachna chrysomelina F.	-1.849	1.774	0.891	0.683NS	48.835	-6.191	1.728	0.865NS
Monolepta nigeriae Bryant	-9.251	8.680	2.354	0.885*	52.325	-5.270	2.779	0.643NS
Beneficial								
Apis mellifera L.	0.063	0.847	0.435	0.010NS	3.853	0.553	0.052	0.983**
Bracon hebetor Say	-1.843	0.761	1.541	0.417NS	4.973	-0.930	0.765	0.425NS
Camponotus spp.	-9.585	9.856	4.927	0.654NS	137.369	-14.089	9.297	0.534NS
Cardiochiles niger W&H	-1.818	1.110	1.683	0.368NS	21.467	-5.427	1.890	0.805NS
Cheilomenes lunata Fab.	-2.003	0.468	0.172	0.985**	11.879	-3.151	0.743	0.900*
Cheilomenes sulphurea Oliv.	-3.074	1.680	3.125	0.326NS	6.448	-1.075	0.953	0.389NS
Chelisoches flavipennis Fab.	-1.051	0.274	0.801	0.463NS	3.232	-0.339	1.205	0.038NS
Crematogaster sp.	-5.117	4.976	4.086	0.611NS	10.071	-0.463	1.643	0.074NS
Miomantis sp.	-1.858	0.633	0.928	0.667NS	3.019	-0.169	0.744	0.025NS
Pheidole sp.	2.749	-2.415	0.751	0.870NS	-1.167	1.039	0.013	1.000 NS
Rhynocoris nitidulus Fab.	-0.084	0.356	0.824	0.005NS	2.835	-0.448	1.076	0.080NS
Spiders	-2.867	1.762	1.122	0.765NS	2.230	0.358	0.096	0.874*

Note: NS = Non-significant; * = Significant at 5% level; ** = Significant at 1% level. Hypothesis H_0: $b = 1$ (random distribution); H_1: $b \neq 1$.

4. Discussion

The arthropods assemblage was highly diverse revealing that Golden melon agro-ecosystems in the study area support a complex arthropod community. This level of diversity agrees with earlier studies on cucurbits in the tropical agro-ecosystem where crop structural complexity and continuous availability of plant resources promote arthropod colonization (Alao *et al*., 2017; Okrikata *et al*., 2019). Among herbivorous taxa, Chrysomelid leaf-feeding beetles dominated both in RA and FO, particularly *A. Africana, A. transversa, A. nigripennis* and *M. nigeriae* posing a sustained threat throughout the cropping season. Their high RA (6.31-7.08%) and very high FO (>90%) reflect strong host adaptation and continuous availability of suitable feeding site on the crop's foliage. Similar dominance of chrysomelid beetles on cucurbits has been reported across sub-Saharan Africa where leaf beetles are consistently identified as key defoliators of cucurbit crops (Ofuya *et al*., 2023). This observation also agrees with the findings of Haber *et al*. (2021) and Okrikata *et al*. (2022) who reported Chrysomelid beetles as the most destructive insect pests of cucurbits. The Relative Abundance (RA) indicates the numerical dominance of each species within the total arthropod community while the Frequency of Occurrence (FO) reflects the temporal consistency of the species across the sampling periods.

The relatively moderate abundance of *A. gossypii* and *B. tabaci* in this study is at variance with the report of Aleem *et al*. (2025) which showed that aphids are the most dominant cucurbit pest. This discrepancy may be attributed to seasonal variation, planting date, or differences in rainfall regime, which strongly influence aphid population dynamics. Their persistence across sampling periods is typical of phloem feeders with rapid reproductive cycles and strong dispersal ability, particularly under warm tropical conditions (Liu *et al.*, 2021; Li *et al.*, 2023). Their presence is specifically significant because of their role as sap-suckers and vectors of plant pathogens. Tephritidae were represented mainly by *B. cucurbitae* (4.95% RA; 72.73% FO) which were more abundant and wide spread than *B. invadens* (0.43% RA; 45.45% FO). This identifies *B. cucurbitae* as the primary fruit fly pest of golden melon in the study area with direct implications for fruit damage and yield loss as widely documented in recent cucurbit IPM studies (Opoku *et al.*, 2025).

Ant (*Camponotus* sp., *Crematogaster* sp. and *Pheidole* sp.) dominance in tropical agro-ecosystem is increasingly recognized as an indicator of tropical complexity and ecological stability (Diamé *et al.*, 2018). They likely exploited food resources like honeydew from sap-sucking insects. Their dominance implied indirect effects on pest population dynamics through predation. Spiders were among the dominant arthropods retrieved and recent studies confirm spiders as key stabilizers of pest populations in low-input vegetable systems (Rao and Kanaujia, 2023). The arthropods were functionally diverse comprising herbivores, predators, parasitoids and pollinators indicating a well-structured food web. Herbivores constituted the most species rich guild attacking leaves, vines, flowers and fruits with foliar feeders being dominant. This pattern aligns with cucurbit crop phenology and expansive leaf area which supports early and mid-season herbivore (Theis *et al.*, 2014).

The dominance of *A. mellifera* (4.27% RA; 63.64% FO) starting from the vegetative stage highlights the availability of pollinators within the golden melon field. This is ecologically important as cucurbits are pollinator dependent crops and the presence of honey bees likely contributes directly to the fruit set and quality. However, the abundance *P. triangulum* (a key parasitoid of bees) highlights the need to devise a management strategy as highlighted by Sarwar (2016) and Okrikata *et al*. (2019) as it has been shown to have the capacity to reduce local bee population. Several taxa including *Pseudolynchia canariensis*, *Lycus corniger* and some orthopterans recorded low RA and FO, and are categorized as rare/occasional species, and as such are transient or opportunistic visitors, with minimal direct impact on the golden melon production. Recent literature emphasizes that maintaining such functional diversity enhances yield stability and ecosystem resilience (Steffan-Dewenter *et al.*, 2024).

The presence of parasitoids within Braconidae notably *B. hebetor* and *C. niger* with dominant status confirms the existence of a functional parasitoid guild capable of regulating lepidopteran and other insect pests. Generally, the natural enemies showed density increases that lagged behind pest densities, indicating a numerical response. That the pest populations and were followed by a substantial natural enemy populations with a natural enemy to pest population ratio of 0.78:1 suggests that the pest populations are partially regulated by biological control agents. This agrees with classical predator–prey theory (Solomon, 1949) and field observations by Hawkins *et al.* (1993) and supports the adoption of the IPM rather than indiscriminate chemical.

The arthropod population density largely increased progressively from the seedling to vegetative and flowering stages with population decline in the later part of fruiting stage coinciding with increased vegetative biomass and reproductive structures. This trend is in agreement with Okrikata *et al.* (2019) who reported that pest abundance peaks during flowering and fruiting due to increased food availability. Variance to mean ratios indicated predominantly aggregated distributions especially during early growth stages. Aggregated distributions are characteristic of phytophagous insects due to legalized oviposition and clumped host resources (Southwood and Henderson, 2000). The shift towards near random distributions during later stages suggests dispersal as population pressure increases, consistent with findings by Taylor (1984).

Overall, Taylor's power law and Iwao's regression revealed predominantly aggregated spatial patterns for pests and beneficial arthropods. Aggregation is ecologically advantageous allowing insects to exploit patchy resources efficiently (Taylor, 1961; Iwao, 1968). Significant departures from randomness observed in *A. africana* and *E. chrysomelina* align with observations by Fenemore and Prakash (1992) on beetle spatial behavior. The agreement between Taylor's and Iwao's models for some species strengthens confidence in the dispersion interpretations. However, the lack of significance for certain taxa contrasts with findings by Okrikata *et al*. (2019), possibly due to differences in sampling intensity and spatial scale.

Coleoptera and hymenoptera exhibited the highest diversity and richness reflecting their ecological versatility. Similar dominance of these orders in vegetable systems has been reported by Perfecto *et al*. (2009) and Okrikata *et al*. (2022). Moderately to high evenness values indicate limited dominance by single species suggesting community stability as described by Cuza *et al*. (2026). The Shannon–Wiener index (H = 3.361) indicates high arthropod diversity comparable to values reported for stable tropical agro-ecosystems (Magurran, 2004). The evenness value (E = 0.600) reflects moderately equitable species distribution, agreeing with Rajabpour and Yarahmadi (2024) who suggested that such values indicates resilience against pest outbreaks. However, this value is lower than those reported by Okrikata *et al*. (2019) in unmanaged vegetable fields a difference that may be attributed to sampling technique and intensity.

5. Conclusion

This study demonstrates that golden melon in the study area supports a highly diverse, functionally rich arthropod community dominated by coleopteran herbivores and hymenopteran natural enemies. The pest population was strongly influenced by crop phenology with peaks largely during the vegetative and/or flowering stages. The dominant natural enemies exhibited close temporal and spatial coupling with their prey as spatial analyses revealed predominantly aggregated distributions reflecting resource heterogeneity and trophic interactions. Diversity indices confirmed a stable and resilient ecosystem characterized by high species richness and moderately high evenness. The pest-natural enemy balance observed throughout the season indicates substantial potential for conservation, biological control, and reducing reliance on chemical pesticides. These findings provide rich ecological evidence to support IPM strategies that prioritize habitat conservation and natural enemy enhancement in golden melon production system in the study area.

Acknowledgment

The study is funded by the Nigerian Government's Tertiary Education Trust Fund (TETFund) under its Institutional Based Research (IBR) programme. The authors gratefully acknowledge the management of Federal University Wukari (FUW), Nigeria for recommending the proposal for TETFund's approval with an award letter: FUW/REG/T.5/Vol.5/T019 on 26th June, 2025. Many thanks to Mr. Ahmed Mohammed of the Research Farm of FUW for his support during the field work. Sincere thanks to Dr. Ogunmola Adeniyi of Statistics Department of FUW for his assistance in statistical analyses.

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Cite this article as: Agere Hemen Ityodugh James, Okrikata Emmanuel, Biyabra Ibrahim Markus, Mohammed Kasimu and Atsu Patrick Begiangbegwubende (2026). Community structure of arthropods associated with golden melon (*Cucumis melo* L.) in Wukari, Taraba State, Nigeria. *African Research Journal of Biosciences*. 3(2), 13-27. doi: 10.62587/AFRJBS.3.2.2026.13-27.