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Effect of Okra Varieties and Intercropping Systems on Insect Pest Populations and Yield of Okra in Uyo, Akwa Ibom State

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ABSTRACT: A field experiment conducted at the University of Uyo teaching and research farm, Uyo, Nigeria, during 2020 and 2021 cropping seasons to evaluate the effect of okra varieties and intercropping systems on the management of insect pests and yield of okra was arranged in a 3 x 2 split plot design arrangement of treatments, fitted in a randomized complete block design (RCBD), replicated three times. The okra varieties (Clemson spineless, NH47-4 & Local variety (Idok)) and intercropping systems (sole okra and okra-ginger intercrop) constituted the main plot and sub-plot respectively. Data were subjected to Analysis of Variance (ANOVA) and means were separated using LSD. Result of the study showed that the three varieties of Okra had significant ($P \leq 0.05$) effect on the populations of the insect pests except for aphids. However, Clemson spineless significantly ($P \leq 0.05$) had the lowest populations of flea beetles (88.81 and 91.26 in the two years respectively) and Whiteflies (51.48 & 55.22 in the two years respectively) while local variety (idok) significantly ($P \leq 0.05$) had lowest populations of leafhoppers (12.26 & 11.33 respectively for 2020 &2021) and cotton bugs (6.56 & 11.78 in 2020 & 2021 respectively). The populations of the entire insect pests were significantly ($P \leq 0.05$) lower in okra-ginger intercrop compared to sole okra. Interaction effect revealed that Clemson spineless intercrop with ginger significantly ($P \leq 0.05$) had the lowest populations of flea beetles, whiteflies, leafhoppers and aphids while local variety (idok) intercrop with ginger still had the lowest populations of cotton bug. Highest okra yield (39.93 & 49.91 t/ha for 2020 & 2021, respectively) was obtained from clemson spinless and ginger intercropping system followed by NH47-4 and ginger intercropping system.

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KEYWORDS: Okra, varieties, Clemson spineless, NH47-4, Idok, Ginger, intercropping, insect pest management, yield

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INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench], previously known as *Hibiscus esculentus* (L.) is an important fruit vegetable commonly cultivated in the tropics and warmer temperate regions of the world (Mkhabela *et al*., 2022). Okra is the most vegetable crop of importance in the Malvaceae family (Welbaum, 2024). It is a self-pollinated crop (Dhakne *et al*., 2024) with multipurpose and economic uses such as; the sale of immature fresh leaves, fresh, and dried fruits, which are made into diverse soup products, the mature fruits and stems are used in the paper industries, it is rich in dietary fiber, minerals (Sodium, Calcium, Sodium, Potassium, Zinc, and Iron), vitamins (A, B, and C), antioxidants, and folate. Okra seed is rich in proteins (15–26%), the seed oil is edible (20–40%), and rich in unsaturated fatty acids like the linoleic acid essential for human nutrition (Romdhane *et al.*, 2020). Okra mucilage can be used as food additives, natural emulsifier, a stability-promoting agent in local foods and as a traditional medicine for different illnesses (Dantas *et al.*, 2021; Kalkan & Maskan, 2023; Fatima *et al.*, 2024, Uwiringiyimana *et al.*, 2024).Okra production globally is estimated to be around 9.96 million tons, India leading with 6.18 million tons followed by Nigeria with 1.82 million tons (FAOSTAT, 2020).

In Akwa Ibom state, Okra is locally referred to as "Etighi" and it holds a central place in the diet and livelihoods of the people of Akwa Ibom State, the popular okra soup known as "Efere Etighi" is often cooked with fresh seafood (such as fish, prawns and periwinkles), beef, or goat meat. The soup is usually spiced with crayfish, pepper, onions and seasoning cubes. It is also enriched with palm oil giving it a vibrant colour and rich taste. Some variations may include the use of waterleaf or fluted pumpkin leaves for added flavour and nutritional value. Okra is also used in other traditional dishes such as Afang and Editan soup due to its mucilaginous texture providing thickening properties. Nutritionally, it provides essential vitamins and minerals, contributing to the health and well-being of consumers. Economically, okra cultivation supports smallholder farmers, with women playing a significant role in its production and trade. Given the Akwa Ibom state's favourable climate and the crop's short maturity period, okra is a reliable income source and a key component of food systems in the region. This cultural, nutritional, and economic importance underscores the relevance of sustainable pest management strategies to improve okra yields and enhance livelihoods in Akwa Ibom.

A survey conducted across six Agricultural Development Programme (ADP) zones in Akwa Ibom State identified a high diversity and abundance of insect species attacking okra in the state, including flea beetle (*Podagrica uniforma* and *P. jostedti*), whitefly (*Bemisia tabaci*), leafhopper (*Amrasca biguttula*), aphid (*Aphis gossypi*), cotton bug (*Dysdercus superstitiosus*), blister beetles (*Mylabris pustulata*), dusky cotton bug (*Oxycarenus hyalinipennis*), fruit borer (*Helicoverpa armigera*), leaf roller (*Sylepta derogata*), , solenopsis mealy bug (*Phenacoccus solenopsis*), red spider mite (*Tetranychus urticae*), and many others, with the two flea beetle species —*Podagrica uniforma* and *P. sjostedti*—causing the majority of harm to okra through significant defoliations in Akwa Ibom State (Rivers *et al*, 2024). Synthetic pesticides have proven effective in controlling these insect pests, and they are currently the principal method of insect control (Sinha & Ray, 2024). However, the indiscriminate use has raised concerns due to the harmful effects on human beings and the environment. The effects include pest resistance, destruction of beneficial organisms, environmental contamination, contamination of nearby water bodies (Curl *et al.*, 2020; Pathak *et al*., 2022). This has led to research on alternative techniques that could be less harmful to humans such as use of resistant varieties; intercropping, use of natural pesticides etc, are becoming more popular as farmers seek alternatives to synthetic pesticides. Different varieties exhibit varying levels of resistance or susceptibility to insect pests, factors like leaf morphology, plant height, and chemical compounds influence how a variety tolerates pest infestation, resistant varieties may have tougher leaves or trichomes that deter pests while susceptible varieties attract more pests, leading to higher pest damage and reduced yield. Intercropping is the growing of two or more crops close together for a variety of reasons, such as resource optimization, enhanced yield, and pest control making it a sustainable agricultural technique and practice. Natural pesticides also known as bio pesticides are derived from natural materials like plants, bacteria, and minerals which are applied to crops to kill pests (Chowdhury *et al.*, 2023). They are easily degraded, cheap, eco-friendly and sustainable. Plant-based pesticides have become more popular in recent years as eco-friendly alternatives to synthetic pesticides. They help control pests populations at various stages of their growth. Plant species such as Neem, Garlic, Ginger, Onion, Papaya, Leucas, are the most commonly used biopesticides (Balasubramanian *et al.*, 2008). They are composed of materials such as flavonoids, alkaloids, trepenoids and phenols which help reduce pest activities by disrupting their metabolic pathways and triggering rapid mortality (Hamada *et al.,* 2018). Ginger has characteristics that help reduce pest population. The presence of active compounds like zingiberene, gingerol, and shogaol in ginger alters insect metabolic processes resulting in insect death (Sowely & Kankam, 2020).

Ginger (*Zingiber officinale*) from the family Zingiberaceae originated from Southeast Asia. It is extensively grown for its edible rhizome, which is utilized as a flavouring, spice, and traditional medicine. The plant has alternating rows of linear leaves placed on its stem, growing to a height of 2–4 feet. The rhizome is brown, with a core that is pale yellow in color and a corky outer layer. Parts of the rhizome are planted to propagate ginger, which grows best in warm, humid climates with well-draining soil. Ginger is selected as an intercrop component due to its well-documented pest-repellent properties, attributed to bioactive compounds such as zingiberene, which has been demonstrated to have an impact on a variety of insect pests, such as those conducted by Asawalam and Chukwu (2012), who reported significant decrease in the population of flea beetles and whiteflies on okra when intercropped with ginger, Muthomi *et al*. (2017), demonstrated the effectiveness of ginger in significantly reducing populations of whiteflies and thrips, resulting in a 50% increase in bean plant (*Phaseolus vulgaris*) production, Siregar *et al* (2024), utilized ginger as a botanical insecticide to manage Army worm (*Spodoptera frugiperda*) pests in maize crops. In addition, the spatial complementarity of ginger as a root crop, with okra as a surface crop, allows for efficient use of soil nutrients and reduces interspecies competition. This biological advantage is particularly important in Akwa Ibom State, where okra cultivation is often challenged by insect pests that diminish yield. The humid tropical climate of the region favours the growth of both okra and ginger, enhancing the practical feasibility of this intercropping system. Moreover, ginger is a high-value crop with expanding market demand, providing economic incentives for farmers while reducing dependency on chemical inputs. Given the socio-economic conditions and environmental challenges faced by farmers in Akwa Ibom, integrating ginger into okra cultivation presents a sustainable approach to pest management that aligns with state and national agricultural policies promoting integrated pest management (IPM).

There is scanty research on the specific interactions between different okra varieties and ginger in intercropping systems, particularly in Akwa Ibom State. This study will fill a critical knowledge gap, providing empirical data to guide agricultural extension services and policymakers in promoting sustainable intercropping practices hence contribute to sustainable agricultural development by improving pest management strategies, optimizing yields, enhancing economic returns, and supporting environmentally friendly farming systems tailored to the local agro-ecological conditions in Akwa Ibom State.

The objective of the study therefore is to evaluate the effect of different varieties of okra in an intercropping system with ginger on insect pests' population and yield of okra for sustainable agriculture in Uyo, Akwa Ibom State.

MATERIALS AND METHODS

The research was conducted in a continuous cropped arable experimental plots located at the University of Uyo Teaching and Research Farm (UUTRF), Use-Offot, Uyo, Nigeria. Uyo is located between latitudes 4º 30' and 50 3'N and longitudes 7º 31' and 8º 20' E and altitude 65 m from the sea level (Dennis *et al*., 2013)

Source of plant material

The plant materials used for this experiment were;

(i) Clemson spineless (Okra Variety 1), NH47-4 (Okra variety 2) and Local okra variety popularly called giant sp. (Etighe idok in Ibibio) were gotten from seeds unit of Akwa Ibom state ministry of Agriculture, uyo,

(ii) Ginger variety called UG was gotten from the National Root Crop Research Institute, Umudike, Abia State, was used for the intercrop.

Preparation of Plant materials for planting

The Okra seeds were soaked in water overnight to break seed dormancy and enhance germination before planting. The ginger rhizomes were cut into setts with at least two nodes and were spread on a jute bag and sprinkle water on them allowed for one week to sprout before taken to the field for planting.

Land preparation and Experimental design

A land area measuring 10m x 10m (100m^2) was slashed, ploughed, harrowed mechanically and laid out in a 2 x 3 split plot design replicated three times. The main plot consisted of the cropping system - Sole okra and Ginger with okra while the sub – plot consisted of three Okra varieties – Clemson spineless, NH47-4 and Local variety (Giant sp.). Each plot measured 4m x 3m with 1m furrow spacing.

Planting and Cultural Operations

Planting was done in April, 2020 and 2021. Ginger rhizome was cut into setts and spread on a jute bag, sprinkled water on them and left for about 1week to sprout then taken to the field for planting and at 4 weeks after planting ginger, Okra seeds were planted (after soaking in water overnight and filtering out the floated seeds by morning) three seeds per hole at about 2cm dept. Well decomposed poultry manure at the rate of 10 t ha-1 was applied to each plot two weeks after planting okra. Thinning was done to maintain two plant stands per hill after two weeks of seedlings emergence, hoe weeding was done when necessary and there was no chemical control of insect pests in the experimental plot during the period of the experiment.

Data collection

(i) The population density of the major insect pests of okra (Flea beetles, Whitefly, Leaf hooper, Aphids and cotton stainer) was done on five (5) randomly selected plants tagged in each plot by none destructive visual counting once a week beginning at three weeks after planting (WAP) and it lasted till the 12th week. This period of data collection covered the seedling/vegetative (3-4 WAP), reproductive (5-9 WAP) and postharvest (10-12 WAP) stages of okra. The aphid abundance on okra crops were recorded as follows; the leaves and stems were carefully examined for the presence of aphids by using visual scoring rating from 0–5; where 0 meant no aphid, 1 meant few individuals, 2 meant few isolated small colonies, 3 meant several small colonies, 4 meant large isolated colonies and 5 meant large continuous colonies (Murovhi *et al.*, 2020). Counting was done between 7:00 am – 8:30 am when the flea beetles were less active and the number of each species was recorded separately.

(ii) Yield: Fruits were harvested from five randomly selected stands on each plot. A total of 6 harvests were made. The mean weight of Okra harvested per plot was recorded as yield. The determination of yield was done with a Meter weighing balance of 0.01g sensitivity.

Statistical analysis of data

Data obtained from the experiment were analysed using analysis of variance (ANOVA) and means will be separated using least significant difference (LSD) at 5% probability level (P≤0.05)

RESULT

Table 1 shows the main effect of Okra varieties in okra-ginger intercropping systems on the populations of Flea beetles, whitefly, leaf hopper, aphids and cotton bug on okra. The three varieties of Okra had significant (P≤0.05) effect on the populations of the insect pests except for aphids. However, Clemson spineless had the lowest populations of flea beetle (*Podagrica sp.*) (88.81 and 91.26 in year 2020 and 2021 respectively), followed by local variety (111.52 & 112.89 in year 2020 & 2021 respectively), the highest population of flea beetles was found on NH47-4 with 134.07 & 135.07 in year 2020 & 2021 respectively. The population of White fly (*Bemisia tabaci*) was also significantly (P≤0.05) lowest on Clemson spineless (51.48 & 55.22 in 2020 & 2021 respectively), closely followed by NH47-4 (53.37 & 56.48 in 2020 & 2021 respectively), making local variety highest in whitefly population significantly (P≤0.05) with 61.93 and 62.48 respectively in both years. For leaf hopper (*Amrasca biguttula*) population, local variety significantly (P≤0.05) was lowest with population value – 12.26 & 11.33 respectively for 2020 &2021, followed by NH47-4 (13.11 and 12.70 for 2020 and 2021), leaving clemson spineless with highest population value of 23.48 in 2020 and 27.37 in 2021. Local variety was significantly (P≤0.05) lowest in cotton bug populations (6.56 & 11.78 in 2020 & 2021), followed by NH47-4 (16.52 and 17.22 in both years respectively), leaving Clemson sp. significantly (P≤0.05) highest in cotton bug populations (17.37 & 18.60 in 2020 & 2021 respectively). The populations of the entire insect pest were significantly (P≤0.05) lower in the intercrop compared to the sole okra.

The interaction effect of varieties and intercropping systems showed significant difference (P≤0.05) in the populations of the insect pest (Table 2), with populations of pests significantly (P≤0.05) lower in the interaction of variety x intercrop compared to variety x sole crop. Clemson spineless was observed to be the variety with the least population of other insect pests in the intercrop exception of local variety with least population of cotton bug.

In the main effect of varieties in intercropping system on yield of okra as presented in table 3, Clemson spineless significantly (P≤0.05) produced highest yield (22.15 t/ha in 2020 and 26.57 t/ha in 2021), followed by NH47-4 (15.15 t/ha in 2020 and 18.18 t/ha in 2021), least yield was recorded in local variety (2.21t/ha and 2.99 t/ha in both years respectively). Amongst the cropping systems, intercrop system significantly (P≤0.05) produced higher yield (24.91t/ha and 29.90 t/ha in both years respectively) compared to sole crop system (14.59t/ha and 17.51 t/ha in both years). Significant interactions (P≤0.05) were recorded between okra varieties and intercropping systems on okra yield (**table 4**). It was also observed that generally, all the interactions between each variety x intercrop system produced better yield than interactions between each variety x sole crop, hence highest okra yield (39.93t/ha & 49.91t/ha in 2020 & 2021 respectively) was produced significantly (P≤0.05) from interaction between Clemson spineless x intercrop followed by NH47-4 x intercrop (30.19 t/ha and 36.23t/ha in both years respectively). Local variety was significantly least in yield.

Table 1: Main effect of okra varieties in okra-ginger intercropping system on the population of fleabeetles, whiteflies, leafhoopers, aphids and cotton bugs on okra in 2020 and 2021

Treatment	**Fleabeetles (2020)**	**Fleabeetles (2021)**	**Whitefly (2020)**	**Whitefly (2021)**	**Leaf hooper (2020)**	**Leaf hooper (2021)**	**Aphids (2020)**	**Aphids (2021)**	**Cotton bug (2020)**	**Cotton bug (2021)**
Varieties										
Clemson sp.	88.81	91.26	51.48	55.22	23.48	27.37	8.22	8.52	17.37	18.60
NH47-4	134.07	135.07	53.37	56.48	13.11	12.70	7.11	6.70	16.52	17.22
Local var.	111.52	112.89	61.93	62.48	12.26	11.33	8.00	7.44	6.56	11.78
LSD (P≤0.05)	19.49	18.87	7.90	6.75	5.30	4.56	NS	NS	2.60	2.64
Cropping system										
Sole okra	287.85	289.00	140.44	145.81	43.56	48.11	20.96	18.87	31.00	36.97
Okra-ginger intercrop	46.56	50.22	26.33	28.37	4.30	3.30	2.67	3.89	9.44	10.63
LSD (P≤0.05)	**19.49**	**18.87**	**7.90**	**6.75**	**5.30**	**4.56**	**1.65**	**2.80**	**2.60**	**2.64**

Table 2: Interaction effect of okra varieties in okra-ginger intercropping system on the population of fleabeetles, whiteflies, leafhoopers, aphids and cotton bugs on okra in 2020 and 2021

	Fleabeetles (2020)	Fleabeetles (2021)	Whitefly (2020)	Whitefly (2021)	Leaf hooper (2020)	Leaf hooper (2021)	Aphids (2020)	Aphids (2021)	Cotton bug (2020)	Cotton bug (2021)
Clemson sp. X Sole okra	225.89	227.22	129.00	139.89	66.33	77.67	22.22	23.67	40.78	43.89
NH47-4 x Sole okra	352.22	352.11	133.22	138.44	37.33	36.44	18.56	17.67	39.22	40.44
Local var. x Sole okra	285.44	287.67	159.11	159.11	27.00	30.22	22.11	15.00	13.00	26.56
Clemson sp. x intercrop	40.55	46.56	25.44	25.79	1.11	4.44	2.44	1.89	11.33	11.89
NH47-4 x intercrop	50.00	53.11	26.89	31.00	2.00	1.67	2.78	2.40	10.33	11.22
Local var. x intercrop	49.11	51.00	26.67	28.33	9.78	3.78	2.78	7.33	6.67	8.78
LSD (P≤0.05)	**33.75**	**32.68**	**13.68**	**11.70**	**9.19**	**7.90**	**2.86**	**4.84**	**4.51**	**4.57**

Table 3: Main effect of okra varieties in okra-ginger intercropping on the yield of okra in 2020 and 2021

Treatment	Yield (t/ha) 2020	Yield (t/ha) 2021
Varieties		
Clemson Spineless	22.15	26.57
NH47-4	15.15	18.18
Local variety	2.21	2.26
LSD (P≤0.05)	2.48	2.99
Cropping system		
Sole okra	14.59	17.51
Okra-ginger intercrop	24.91	29.90
LSD(P≤0.05)	2.48	2.99

Table 4: Interaction effect of okra varieties in okra-ginger intercropping system on the yield of okra in 2020 and 2021

Treatment	Yield (t/ha) 2020	Yield (t/ha) 2021
sole okra x Clemson sp.	26.50	31.81
Sole okra x NH47-4	15.25	18.30
Sole okra x Local variety	2.02	2.42
intercrop x Clemson sp.	39.93	49.91
intercrop x NH47-4	30.19	36.23
intercrop x Local variety	4.62	5.54
LSD($P \leq 0.05$)	4.30	5.16

DISCUSSION

The result of this study has shown that intercropping system is an effective alternative to the use of synthetic insecticides in the management of insect pests and yield enhancement, This agrees with the findings of Rakotomalala *et al* (2023), who reported of reduced arthropods population in intercrop field compared to sole crop through biodiversity effect, promotion of beneficial arthropods and their services etc. Dangia *et al* (2021), also reported of better yield in soybean – maize intercrop system compared to sole soybean system. According to the study result, intercropping okra with ginger significantly ($P \leq 0.05$) suppressed the populations of okra insect pests (flea beetles, whiteflies, leaf hoppers, aphids, cotton bugs) and also improved yield of okra more than sole okra, this could be attributed to the positive allelopathy and biodiversity effect of ginger on okra. This finding aligns with the work of Asawalam and Chukwu (2012), that intercropping okra and ginger was more effective in suppressing the population of flea beetles and whiteflies on okra, at the same time improved yield compared to sole okra. This is also consistent with the work of Salau *et al* (2021), who recorded improved yield in okra when intercropping okra with cassava compared to sole okra.

Varietal effect on pest population and yield of okra showed that Clemson spinelsess variety had the lowest susceptibility to insect pests and also produced highest yield. This could be due to the inherent genetic traits, (like biochemical compounds that deter feeding or oviposition by insects), physical traits (like fewer spines, smoother stems, tougher leaves can reduce pests infestation), production of secondary metabolites (flavonoids or tannins, that act as natural pest repellents) and better adaptation ability to the agro-ecological conditions of Akwa Ibom State making it more resilient to the prevalent insect pest populations and enhanced yield exhibited by Clemson spineless . This agrees with the work of Aderolu and Madu (2023), who reported of reduced population of fleabeetles, whiteflies, aphids etc on clemson spineless variety and better yield than other varieties of okra studied. NH47-4 also exhibited lower susceptibility to whiteflies and fleabeetles insect pests on okra and also recorded higher yield in the work of Asawalam and Chukwu (2012). The work of Norman *et al* (2020), agrees with the finding that clemson spineless variety has low susceptibility to fleabeetles attack and infestation.

CONCLUSION AND RECOMMENDATION

The present study evaluated the effect of different okra varieties (clemson spineless, NH47-4 & local variety (Idok)) in an intercropping system on insect pests (Fleabeetles, whiteflies, leafhoppers, aphids & cotton bugs) populations and yield of okra in Uyo, Akwa Ibom state, Nigeria. From this study, it can be concluded that Clemson spinesless exhibited lowest susceptibility to the major insect pests of okra in Akwa Ibom state and also recorded highest yield. It is therefore considered and recommended as the desirable variety in intercropping system with ginger for the management of Flea beetles, whiteflies, leafhoppers, aphids and cotton bug and yield optimization in okra in Uyo, Akwa Ibom State thereby offering a sustainable approach to pest management that aligns with state and national agricultural policies promoting integrated pest management (IPM).

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