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A Survey on the Diversity of Field Insect Pests of Okro (*Abelmoschus Esculentus)* within the Six ADP Zones in Akwaibom State

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ABSTRACT: A survey was conducted to determine the diversity and abundance of insect pests associated with okra (*Abelmoschus esculentus*) across the six Agricultural Development Programme (ADP) zones in Akwa Ibom state namely; Uyo, Abak, Eket, Ikot ekpene, Etinan and Oron using multi – stage random sampling technique, swoop nets for flying insects, aspirators for collecting tiny insects, pair of forceps and hand picking for larvae and slow moving insects. A total of 634 insects were collected across the six zones and identified into 4 orders, 13 families and 15 species. The dominant order by specie was Hemiptera having (6/40%) followed by Lepidoptera (4/26.67%), Coleoptera (3/20%) and the least was Orthoptera having (2/13.33%) while dominant order by individuals was Coleoptera having 279/44.01%), followed by Hemiptera (244 /38.49%), Lepidoptera (68/10.73%) and the least was Orthoptera (43/6.78%). Dominant insect specie across the six zones was Flea beetle (*Podagrica sp.*) with total population of 185 followed by Aphids (*Aphis gossypii* - 98) and the least was Cabbage looper (*Trichoplusia ni* – 7). Diversity index result showed that Eket zone had the highest no. of individuals (122) with the least no. of species (12) and least Shannon index value (H_ 2.11) followed by Oron zone with 112 individuals, no. species (13) and shannon index (H_2.31). Uyo zone had the least no. of individuals (93), no. species (13) and Shannon index (H_2.21) while Ikot ekpene zone had the highest Shannon index value (H_2.34) and highest no. of species (14) with no. of individual (101). This study reveals that there is high diversity and abundance of insect species attacking okra in Akwa Ibom State hence drastic control measures is imperative for successful and profitable production of Okra.

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INTRODUCTION

Okra (*Abelmoschus esculentus*), known in many English-speaking countries as ladies' fingers or ochro, is a flowering plant in the mallow family. It is valued for its edible green seed pods. It is rich in minerals, vitamins, antioxidants, and fiber (Alegbejo, 2004). Okra fruits or pods contains round seeds and it is cultivated throughout the tropical and warm temperate regions of the world. It is known as a heat- and drought-tolerant vegetable species in the world and will tolerate soils with heavy clay and intermittent moisture, but frost can damage the pods (Abidi *et al.*, 2018). In cultivation, the seeds are soaked overnight prior to planting to a depth of 1-2cm (0.39-0.79 inches).

It prefers a soil temperature of at least 20 °C (68 °F) for germination. As a tropical plant, it also requires a lot of sunlight, and it should also be cultivated in soil that has a pH between 5.8 and 7, ideally on the acidic side. Seedlings require ample water. The seed pods rapidly become fibrous and woody and, to be edible as a vegetable, must be harvested when immature, usually within a week after pollination (Abidi *et al.*, 2018). The first harvesting will typically be ready after about 2 months of planting, and it will be approximately 2-3 inches long (FAO 2020).

Okra crop is highly susceptible to attacked by numerous insect pests from seedling to the stage of harvest (Kedar *et al*.. 2014), they include but not limited to ; The shoot and fruit borer (*Earias vittella*), flea beetle (*Podagrica uniforma* and *P. jostedti*), whitefly (*Bemisia tabaci*), leafhopper (*Amrasca biguttula*), dusky cotton bug (*Oxycarenus hyalinipennis*), fruit borer (*Helicoverpa armigera*), leaf roller (*Sylepta derogata*), aphid (*Aphis gossypi*), solenopsis mealy bug (*Phenacoccus solenopsis*), red cotton bug (*Dysdercus koenigi*), red spider mite (*Tetranychus urticae*), etc., are some of the more important ones. In West Africa, most damage to okra is, however, inflicted by the two flea beetle species, *Podagrica uniforma* and *P. sjostedti* which are responsible for heavy defoliation

(Ojiako *et al*., 2019) and important yield losses in Nigeria, Ghana and Burkina Faso (Obeng-Ofori and Sackey, 2003). *Podagrica sp.* transmit the okra mosaic virus, causing significant fruit yield reduction of about 18 - 50% (Alegbejo, 2004; Ogunlana *et al*., 2008; Pitan *et al*., 2011). The insects have been observed to commence their infestation on Okra plants from the stage of germination and throughout all stages of its growth (Fasunwon., 2010). Insects attacking the leaves, flowers and pods have been reported to be responsible for yield losses of 30-65% in regions that cultivate okra worldwide. Insect pests have been recorded to be a severe burden to crop production as over 1000 species of insect have been identified attacking crops. Collectively, they cause an estimated loss amounting to $100billion dollars per year. (Huşsain Muhammad *et al*, 2011).

Considering the economic importance of okra as well as the destructive nature of insect pests to these crops, it becomes imperative to generate an Okra inventory.

Therefore, the main objective of this study was to provide baseline information as well as identify the insect pests associated with okra in six Agricultural Development Programme (ADP) zones in Akwa Ibom State. The information would be useful in advisory and development of pest-resistant cultivars through breeding and improvement of the available cultivars and of pesticides for increased okra crop yield, food security, increase biodiversity and sustainable development. It is therefore the intention of this research to bridge the gap in knowledge of okra insect pests and their dominance within the ecological zones.

MATERIALS AND METHODS

Survey Area

Akwa Ibom State falls within the tropical rainforest zone of Nigeria and is between latitudes 4°32'N and 5°33N, and longitudes 7°25'E and 8°25'E at an altitude of 65 meters above sea level. The mean annual temperature is 26.9°C. The mean annual relative humidity is 78.8% with mean annual rainfall of 270.1mm (Meteorological Garden, 2008).

The state has 31 LGAs divided into six (6) Agricultural Development Programme (ADP) zones namely; Oron, Abak. Ikot Ekpene, Etinan, Eket, and Uyo (see Figure1). The survey was conducted using a multistage sampling technique where two local government areas (LGA) were randomly selected from each of the ADP zones, making a total of 12 LGAs where small to medium farms were present. Three farms were randomly selected from each of the Local Government Areas and total of 36 farms were surveyed in the 6 ADP zones visited. The farms sizes studied ranged between 0.1 ha and 0.5 ha.

Akwa Ibom State has consistent temperatures year-round, but there are also two distinct seasons: the wet season and the dry season. The dry season in Akwa Ibom typically runs from November to March, while the wet season in Akwa Ibom state is from April to October. The average annual rainfall within the survey area is 3033 mm while the average annual temperature is 25.7°C.

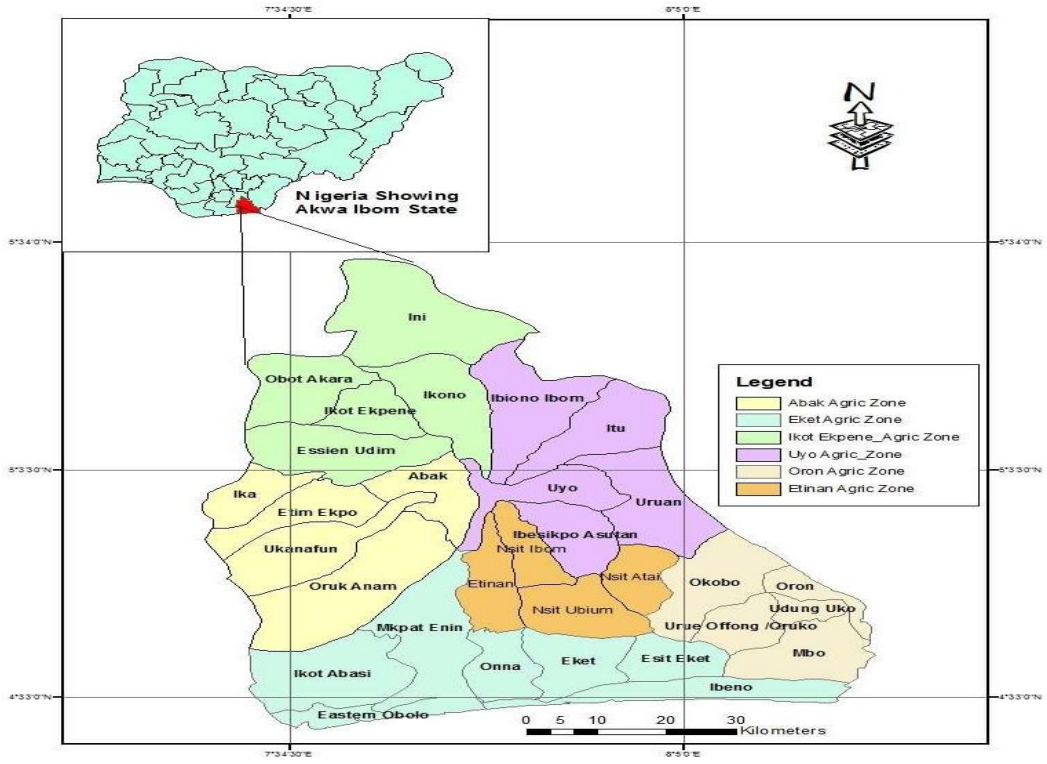

Figure 1: Map of Akwa Ibom State showing the six Agricultural zones

Sampling Techniques for the Insect Pests

Each farm selected for the survey was divided into four quadrants and from each part; four plants were selected at random within the square meter. Population density of insect pests was achieved by visual Counting of the insects on the plants, after which they were then captured from those plants and taken to the laboratory for identification.

The following materials were used to collect insect samples: swoop nets for flying insects, aspirators for collecting tiny insects, pair of forceps and hand picking for larvae and slow moving insects. Polythene bags and rearing jars were used to transfer the insects to the laboratory and alcohol (70%) was used to preserve them for identification. The plants were sampled at fruiting stage and samples collection were conducted early in the morning and evening for four consecutive days from 21st to 24th July 2021.

Insect Pest Identification and Quantitative Assessment

Morphological identification of pest was done using hand lens, and utilizing Identification keys (Zim *et al*., 1987). A scale of 1 -3, where 1 = little or not important; 2 = cause little and occasional damage and 3 = common and causes serious damage was used to determine the pest status based on the degree of damage caused to plant (Adamu *et al*., 2000).

Statistical analysis of the data obtained

Data obtained from the sampling sites were subjected to Contingency table and Chi-square Goodness-of-fit analysis in order to check for any significant difference or otherwise of the variables testing the Null hypothesis (Ho: there is no significant difference between insect pest density within the zones).

Microsoft Excel was used to calculate the percentage frequency of occurrence (i.e. frequency rating) and percentage population of insect pests, using the formula below:

Percentage frequency of occurrence = $\frac{n}{x}$ x 100

Where n is the number of times an individual insect pest occurred in all the samples and X is sample size.

Biological diversity

In order to study the biological diversity within the study area Shannon-Wiener index and Margalef richness was used. The following formulae were used.

Hmax =-n, Ln (Pi)

n_i=The number of individuals in each species; the abundance of each species

P_i = The relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community.

H_{max} = The maximum number of Shannon-Wiener index

Ln = Natural logarithm of a number.

For studying the diversity between the groups we use the one way Analysis of Variance (ANOVA) and for studying the Comparison between means, the LSD was used.

RESULTS

In the survey areas within the ADP zones, **table 1** showed that 15 insect species were identified and classified into 4 orders having 13 families based on their morphological characteristics. The highest no. of insects species were found in the order Hemiptera (6), followed by Lepidoptera (4), Coleoptera (3) and Orthoptera had the least no. of species (2).

The pest status of the species identified on okra was determined based on damage scale of 1 – 3 and presented alongside in **table 1.** Whitefly (*Bemisia tabaci*), Red Cotton Bug (*Dysdercus sp.*), Cotton Bollworm (*Earias vittella*), Blister beetle (*Mylabris pustulata*), and Flea beetle (*Podagrica spp*) were found to cause severe damage on scale 3, followed by Jassid (*Amrasca biguttula*), Aphids (*Aphis gossypii*) and Rice grasshopper (*Hieroglyphus banian*) which caused moderate damage on scale 2, while Pumpkin beetle (*Aulacophora foveicollis*), Fruit borer (*Helicoverpa armigera*), Sting bug (*Nezera viridula*), Dusky cotton bug (*Oxycarenus hyalinipennis*), Leaf roller (*Sylepta derogata*), Gabbage looper (*Trichoplusia ni*) and Bush cricket (*Tettigonia spp*) caused the least damage on scale 1.

The species population diversity across the six ADP zones is presented in **table 2.** At specie level, Flea beetle (*Podagrica spp*) was found in all the zones and had the largest total population of 185 across the zones followed by Aphids (*Aphis gossypii*) with total population of 98 across the zones and Cabbage looper (*Trichoplusia ni*) had the least population of 7 while at the zonal level, Eket zone had the largest species population of 122 followed by Oron zone (112), Etinan zone (106), Ikot ekpene zone (101), Abak zone (100) and Uyo zone had least (93). Table 2 also revealed that stink bug (*Nezera viridula*) was not found in three zones (Uyo, Abak and Ikot ekpene) and had a total of 8 across three zones, Fruit borer (*Helicoverpa armigera*) was not also found in these three zones (Eket, Etinan and Oron) with a total of 11 across three zones. Dusky cotton bug (*Oxycarenus hyalinipennis*) was not found in two zones (Eket and Oron) with a total pop. of 14 individuals across 3 zones. Bush cricket (*Trichoplusia ni*) which had the least total population of 7 individuals across the zones was not also found in 2 zones (Uyo and Eket).

Table 3 shows the frequency distribution of insect species encountered across the six zones based on their order. While the Hemiptera was the most dominant order with 6 species equivalent to 40% followed by Lepidoptera (4/26.67%), Coleoptera (3/20%) and Orthoptera had the least being 2/13.33% species, Coleoptera had the highest number of individuals - 279 equivalent to 44.01% followed by Hemiptera having 244 individuals equivalent to 38.49%, Lepidoptera had 68/10.73% individuals leaving Orthoptera with the least individuals of 43 equivalent to 6.78%.

Table 4 showed that Ikot ekpene zone had the highest value for species diversity by Shannon index (2.34) followed by Oron zone (2.31) while Oron zone had the highest value for specie equitability (0.90) followed by Ikot ekpene zone (0.85). Eket zone had the least for Shannon diversity H (2.11) while Etinan zone had the least for equitability.

Table 1: Insects Pests of Okra Identified and Their Pest Status

Order	Family	S/N	Species	Common name	Pest status
Hemiptera	Aphididae	1	*Aphis gossypii*	Aphids	2
	Aleyrodidae	2	*Bemisia tabaci*	Whitefly	3
	Cicadellidae	3	*Amrasca biguttula*	Jassids	2
	Pyrrhocoridae	4	*Dysdercus sp.*	Red cotton bug	3
	Pentatomidae	5	*Nezara viridula*	Stink bug	1
	Lygaeidae	6	*Oxycarenus hyalinipennis*	Dusky cot.Bug	1
Lepidoptera	Crambidae	7	*Sylepta derogata*	Leaf roller	1
	Nolidae	8	*Earias vittella*	Cotton bollworm	3
	Noctuidae	9	*Helicoverpa armigera*	Fruit borer	1
		10	*Trichoplusia ni*	Cabbage looper	1
Coleoptera	Chrysomelidae	11	*Podagrica spp.*	Flea beetles	3
		12	*Aulacophora foveicollis*	Pumpkin beetle	1
	Meloidae	13	*Mylabris pustulata*	Blister beetle	3
Orthoptera	Acrididae	14	*Hieroglyphus banian*	Rice grasshopper	2
	Tettigoniidae	15	*Tettigonia spp.*	Bush cricket	1

Damage scale:

1. Little to no damage
2. Moderate damages
3. Severe damage (could lead to wilting of crop)

Table 2: Insect Species Diversity Across The Six Adp Zones

S/N	Species	Uyo zone	Abak Zone	Eket Zone	Ikot Ekpene	Etinan Zone	Oron Zone	Total
1	*Aphis gossypii*	13	15	20	13	20	17	**98**
2	*Bemisia tabaci*	4	5	3	6	9	7	**34**
3	*Amrasca biguttula*	10	13	6	11	7	5	**52**
4	*Dysdercus sp.*	3	8	9	5	3	10	**38**
5	*Nezara viridula*	-	-	2	-	2	4	**8**
6	*Oxycarenus hyalinipennis*	4	3	-	5	2	-	**14**
7	*Sylepta derogata*	3	3	5	4	4	3	**22**
8	*Earias vittella*	4	2	6	3	3	10	**28**
9	*Helicoverpa armigera*	4	3	-	4	-	-	**11**
10	*Trichoplusia ni*	-	2	-	1	1	3	**7**
11	*Podagrica spp.*	30	25	39	26	36	29	**185**
12	*Aulacophora foveicollis*	5	7	10	9	4	4	**39**
13	*Mylabris pustulata*	7	10	14	9	8	7	**55**
14	*Hieroglyphus banian*	4	2	5	3	4	8	**26**
15	*Tettigonia spp.*	2	2	3	2	3	5	**17**
	Total	**93**	**100**	**122**	**101**	**106**	**112** =	**634**

Table 3: Frequency distribution of insect species encountered across the ADP zones

S/N	Order	No. of species	Specie %	Individual	Individual %
1	Hemiptera	6	40	244	38.49
2	Lepidoptera	4	26.67	68	10.73
3	Coleoptera	3	20	279	44.01
4	Orthoptera	2	13.33	43	6.78

Table 4: Diversity indices of insect species found across the six ADP zones

Variables	Uyo Zone	Abak zone	Eket Zone	Ik.Ek Zone	Etinan Zone	Oron Zone
Number of Species	13	14	12	14	14	13
Individual	93	100	122	101	102	112
Shannon _(H)	2.21	2.29	2.11	2.34	2.13	2.31
Equitability_(J)	0.86	0.87	0.85	0.89	0.81	0.90

DISCUSSION

The array of insect species found in this study attacking Okra crop is in line with the findings of many researchers such as idowu *et al*., (2022), Asawalam and Chukwu, (2012), Kedar *et al* (2014), Adebola and Gana, (2016), Oyewale *et al*, (2018) and Rivers and Ewete, (2019), who reported that the above identified insect species are okra crop insect pests causing problems to its production. Flea beetles (*Podagrica spp.*), Aphids (*Aphis gossypii*), Blister beetles (*Mylabris pustulata*) and Jassids (*Amrasca biguttula*) were found to be predominant and prevalent across the six zones in this study, with the high population abundance/diversity and high pest status. This agrees with the study of Obeng-Ofori and Sackey, (2003), Alegbejo (2004), Ogunlana *et al*., (2008), Pitan *et al*., (2011) and Asawalam and Chukwu, (2012) that flea beetle, Blister beetle, Aphids and Jassids are major pest of okra causing serious and major damage to okra crop.

The lowest total population of species diversity which was recorded in Uyo zone compared to other zones could be attributed to the fact that Uyo is the capital city of Akwa Ibom State with more human/urban settlements, more anthropogenic activities, industrializations and less farm lands hence caused some species to migrate to more favourable locations. The findings of kemabonta *et al* (2019) supports this assertion that human settlements and anthropogenic activities affects species diversity. Eket zone which had the largest population diversity followed by Oron, Etinan, Ikot ekpene and Abak with high population diversity could be as a result of high farming activities and cultivation of okra in the zones, they are more rural communities in these zones whose major means of livelihood is farming hence cultivating crops that encourages the pest population. This agrees with the findings of Khaliq *et al.* (2014) who reported that both abiotic (temperature, humidity, light) and biotic factors (host, vegetative biodiversity, crowding and diets) significantly influence insects and their population dynamics. Furthermore, the reason for this disparity might be attributed to differences in study location and other environmental factors as reported by Alarapa *et al.* (2015) that the abundance of individual of a species at any given point on a temporal scale was again dependent on abiotic and biotic environmental factors.

In areas where intercropping okra with other Crops is predominantly practiced, majority of farmers reported that the practice has advantages to reduce insect pests. Our analyses showed that there was a significant difference ($P > 0.05$) between the populations of Insect pests across the ADP zones where okra was intercropped with other crops which is consistent with the findings of Asawalam and chukwu (2012) who reported that intercropping okra with ginger reduced the population of flea beetles (*Podagrica spp.*) and Whitefly (*Bemisia tabaci*).

The high Shannon (H) and Equitability (J) index recorded across the zones especially Ikot ekpene, Abak and Oron zones can be attributed to the long term monoculture practiced in the zones that lead to ideal conditions for insect pest survival and reproduction.

CONCLUSION

From the results of this survey, it is evident that a considerably large number of insect pest species infest Okra crop grown in this state and estimated values of biodiversity indices. The results revealed the significant prevalence of *Podagrica spp, Amrasca biguttula, Dysdercus cingulatus* and *Mylabris pustulata* as the most important insect pests on *Abelmoschus esculentus* in the sampled area. These species are known to cause severe damage and yield losses throughout most okra growing areas in the tropical and subtropical regions of the world and their distribution is very closely linked to altitude and temperature (Ezcurra., 1978). However, the current study is not exhaustive but provides baseline information upon which further studies can extend the investigations, for example, partitioning and quantifying damage caused to okra by individual insect pest species and, prioritizing and guiding development of management strategies.

RECOMMENDATION

The presence of insect pests could constitute serious impediments to the growth and yield of okra in Uyo, Abak, Eket, Ikot Ekpene, Etinan and Oron ADP zones, enlightenment programmes for farmers should therefore be embarked upon by the State Agricultural Development Programmes in the zones to inform and help the famers manage the presence of okra insect pests in their farms.

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