

A SPATIAL ANALYSIS OF PEST INFESTATION ON FLUTED PUMPKIN IN THREE FARMING COMMUNITIES IN LAGOS STATE

By

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ABSTRACT

*The study investigated the pest infestation activities on fluted pumpkin (*Telfairia occidentalis*) in three farm locations in Lagos State (Ojo, Badagry and Ikorodu). It evaluated the spatial differences in the insect pest infestation affecting fluted pumpkin plant in selected farms in Lagos state. A field inspection was carried out in wet and dry season to identify dominant insect pest and their seasonal variation, part and growth stage of fluted pumpkin affected. Insect pest was identified by carefully examining the collected insect pest specie. Parts of fluted pumpkin affected were determined by assessing physically the feeding point of insect pest on the fluted pumpkin plant. Damaged growth stage was determined by carefully assessing the growth stage of fluted pumpkin damaged by insect pest while dominant insect pest population was determined by quadrant method. A visual count of all insect pest collected in the quadrant was done. The result revealed that black garden ant was the most dominant insect pest that affects fluted pumpkin in all the study locations with estimated population (1067/100m² Ojo, 1700/100m² Ikorodu, and 1200/100m² Badagry) in wet season while 933/100m² Ojo, 1300/100m² Ikorodu and 1,033/100m² Badagry in dry season with more impact on Ikorodu farms in wet season. Insect pest affects all parts of fluted pumpkin but the leaf is the mostly affected part with the majority of the identified insect feeding on it. Five out of the seven identified insect pests feed on the leaf (leaf caterpillar-666, grasshopper-1100, black garden ant-1700, field cricket and bush cricket-433). Insect pest affects vegetative growth (seedling stage, young plant stage and adult fluted pumpkin plant stage) with the majority of the identified insect pests (6 out of 7) infesting on this stage. The study therefore recommends the development of an effective method for controlling black garden ant and other insect pests at the vegetative growth stage.*

Key words: Farming communities, Fluted pumpkin, Pest infestation, Spatial analysis

INTRODUCTION

In Africa, indigenous vegetables remain popular in rural areas where they are considered to have more nutritive value than exotic vegetables. Fluted pumpkin (*Telfairia occidentalis*) is an important leaf and seed vegetable indigenous to Southern Nigeria and grown in the forest zone of West and Central Africa. Other countries like Benin Republic, Cameroon, Angola and Uganda in East Africa also cultivate this crop (Horsfall and Spiff, 2005).

The seed and leaf of fluted pumpkin is of high nutritional, medicinal and industrial values (Akanbi et al., 2007). Seeds and leaves are used for feeding livestock, for human consumption and industrial purposes (Grubben and Denton, 2004). Despite the importance of fluted pumpkins to man, there is dearth of information on its methods of production and some of the constraints experienced by its producers such as pest infestation and management.

One significant challenge facing leafy vegetable farmers in Lagos state and Nigeria has been the incidence of pests and diseases which reduces the quality and market value of vegetables products (Ellis et al., 2008; Iwuchukwu and Uzoho, 2009). Insect pests create a myriad of problems for leafy vegetable farmers. These problems include the skeletonization of leaves of vegetables, holes or notches in foliage and plant parts, cutting plants off at the soil surface, consumption of roots (Cranshaw, 2004; Pedigo and Rice 2006), secondary rots at the site of feeding and the introduction of disease-causing organism (Agrios, 1997; Meyer, 2003) such as virus into plant sap as they feed on the host leading to low quality yield, crop disease, death of crop in extreme infestation and subsequently decline in farmers' income.

In Ojo, Badagry and Ikorodu Local Government Areas (LGAs), efficient pest control has been a major challenge facing fluted pumpkin farmers due to the fact that, pests affects fluted pumpkin at different stages of their development and also at different parts of fluted pumpkin plant. Also, there are issues of different insect pest affecting fluted pumpkin plant at a time and even at different seasons. Farmer's inadequate knowledge of insects as pest is also a contributing challenge because most farmers do not have in-depth knowledge of insect pest that affects their crop (Obopile et al., 2007). In addition, vegetable farmers rely heavily on the use of chemical pesticides to combat these insects' pests. These chemical pesticides have residual effect on the plant itself and the surrounding agro environment (Youdeowei, 2002; Asian Vegetable Research and Development Centre [AVRDC], 2003). Thus, understanding and analyzing the seasonal variations of the insect pests that affects fluted pumpkin and variations of damages done to this crop at different locations becomes the concern of most agriculturist, geographers and spatial analysts. Such geographical knowledge and analysis, if well articulated, provides information on the distinctiveness and the peculiarity of fluted pumpkin in a location.

Good pest control practices enhances qualitative and quantitative crop yield which is central to sustainable vegetable production because farmers invest time, fund and subsequent returns. Therefore, a holistic approach and integrated pest control can therefore protect farmers' investments and present best methods of tackling the challenges of insect pest infestation. The greater demand for fluted pumpkin as source of vitamins and minerals for healthy living for both man and livestock and as a raw material for industries justifies the need for more effective pest control approach for its sustainable production and also in the quest to reduce food insecurity prompted this research.

The System concept (Heylighen, 1998) and the Integrated Pest Management (IPM) concept (Fliert et al., 1999) were adopted by this study. Several issues and ideas can be drawn from the system concept but relevant to this study, is the fact that food production process is a system which comprises of individual components such as animal production, feed production, arable crop production and vegetable production among others. These individual units of food

production are interrelated and work hand in hand to produce good food production process. Vegetable or crop production is a component of the entire food production system. Any influence or impact on the vegetable production component will affect the entire food production process.

Furthermore, the study visualizes the plant as a system which consist of different units that work together to achieve food production for the entire plant, any damage to a unit of the plant such as the root, leaves, stem, flower will affect the entire plant while the IPM for vegetable is concerned with dynamic system consisting of the plant environment/ecosystem and characteristics pest components, linked by information channels. The IPM concept is the practical manipulation of pest populations using ecology principle to keep pest population below level causing economic injury. For this to take place, full knowledge of the four elements (natural control, sampling economic level, insect biology and ecology) this study adapts the insect biology and ecology factor because the knowledge of these two factors is essential in establishing the role of each species in the system and to determine the amount of damage inflicted by each pest species. This concept uses the biology of the problem pest to plan control strategies. In this context; relationship between the crop and pest, crop life table, pest life table, mortality factors, biotic and abiotic factors which play a major role in determination of pest population dynamics.

The focal point for this research is to use the IPM concept and the System concept to determine the interaction between fluted pumpkin and pest affecting their well-being in three farming communities in Lagos State. This will be achieved by examining the dominant insect pests and their seasonal variations as well as determining the parts and stage of plant growth most affected by insect pest.

THE STUDY AREA

A diagnostic field survey was carried out in three farming communities in Lagos State namely; Ojo-Barracks which is located at Lat. $6^{\circ} 28' N$ and Long. $3^{\circ} 11' E$ in Ojo Local Government Area, Ajara, which is located at Lat. $6^{\circ} 32' N$ and Long. $2^{\circ} 40' E$ in Badagry Local Government Area and Gberigbe located at Lat. $6^{\circ} 36' N$ and Long. $3^{\circ} 30' E$ in Ikorodu Local Government Area. According to 2006 population census, Ojo LGA has a population of 941,523 which consist of 507,693 male, female 433,830 with 598,071 persons per sq.km. Badagry has 380,429 which consist of 187,427 male, female 192,993 with 241,093 persons per sq.km while Ikorodu has 689,045 which consist of 364,207 male, female 324,838 with 535,619 persons per sq.km. The area consists of coastal deposit, tertiary beds characterized by sand bars, Lagoons and creeks. Ajara and Gberigbe are 35m and 46m above sea level respectively, and have sandy and loamy soils.

The study area has tropical climate with wet season from April to November and dry season from December to March. It experiences two rainy seasons with the heaviest falling from April to July and the weaker rain in September to November. There is a brief relatively dry spell in August and a longer dry season from December to March. The average temperature is between $27.3^{\circ}C$ to $35^{\circ}C$ across the study sites. Vegetation is tropical Swamp forest consisting of Fresh

water and Mangrove swamp forests and they are influenced by double rainfall pattern of the state which makes the environment a wetland region (Iwena, 2012).

Ojo, Ikorodu and Badagry are suburban and have various government farm settlement situated in them. The three study locations share similar economic and agricultural activities which includes; crop cultivation, manufacturing, fishing, hunting, sand excavation, lumbering, trading and livestock farming. Major food crops include; cassava, coconut, plantain, maize and vegetables. The three study locations were chosen because of the large presence of fluted pumpkin farmers who cultivate the crop commercially and because of the disparity in location.

MATERIALS AND METHODS

Materials used were shovel, mattock, plastic bags, plastic sieve, ant trap, hand gloves and killing jars. Three (3) farm plots were visited in each of the locations. A total of nine (9) farms were visited. Three (3) fluted pumpkin beds were chosen from each farm plot. Five (5) fluted pumpkin plants were randomly selected from each fluted pumpkin bed and tagged. Selected plants were inspected to: collect insect specimen, assess parts of plant damaged by insect pest, and assess the developmental stage of plant growth damaged by insect pest and take insect pest population (Ericson, 1998).

Leaves, stems, flowers, fruits and roots on each of plant were inspected to collect insect pest. The following technique was used to collect insect specimen: Grasshoppers, bush cricket and leaf caterpillars were collected by hand picking. Field cricket and mole cricket was collected by digging them up from their hole with a hoe at the point of feeding at the base of the affected plant and then hand pick them. Termites were collected by digging up the ground with a shovel and then sieved them together with the soil which they were found with the aid of a plastic sieve. Ants were collected using bait in vial. A small amount of sugar biscuit was placed in a vial. Then, the open vial was placed on the ground until ants found them after some time (one hour). The vial was capped and picked up and the ants collected. All collected insects were stored in killing jars containing alcohol to preserve them. Insect pest were taken to biologist for identification.

Damaged part of plant was assessed by locating the feeding site of the insect pest on the tagged fluted pumpkin plant. Leaves, stems, flowers, fruits and roots on each of tagged plant were inspected while growth stage of plant affected was assessed physically by identifying each growth stage of the tagged fluted pumpkin plant and other fluted pumpkin plant affected by insect pest. The estimated population of each insect species was taken and recorded to make insect distribution map. The population of the insect pest was done through the quadrant method.

- Step 1: A tape was used to measure and mark a square of 10m x10m on each side to give an area (100m²). A stake was driven into the ground at each corner.
- Step 2: Each of the four stakes was looped with a string to mark the boundaries of the study site. Smaller size quadrant of 1m x1m was selected at random within the study site.

- Step 3: The number of organisms on each plant or insect species within the quadrant was recorded.
- Step 4: Step 3 was repeated to obtain data for two more quadrants within the site to obtain three quadrants within a site.
- Step 5: For each species, the number of organisms found in all three quadrants was divided by three to calculate the average population density per square meter.

For each species, the average population density was multiplied by 100m^2 to estimate the total number of organisms in study site. $\text{Number of species in Quad 1} + \text{Number of species in Quad 2} + \text{Number of species in Quad 3} / 3 = \text{average population in the study site}$. The result was used to multiply the ratio of the larger area of 100m^2 .

RESULTS AND DISCUSSION

Dominant Insect Pest in the Study Location and their Seasonal Variation

The study showed that, the dominant insect pest of fluted pumpkin in the study locations are black garden ant (*Lasius niger*), field cricket (Gryllinae), mole cricket (Gryllotalpidae), bush cricket (Tettigoniidae), grasshopper (*Zonocerus variegatus*), termite (Isoptera) and leaf caterpillars (Lepidoptera) and that, the insect pests of the same species are found in all three study locations (Table 1). There was no difference in the species of insect pest found in between the study locations but there were seasonal variations in the types of insect pests that affect fluted pumpkin within the study locations. The table reveals that there are differences in the estimated population of the various insect pests in and between locations. Black garden ant has the highest estimated population density, ($1067/100\text{m}^2$ -Ojo, $1700/100\text{m}^2$ -Gberigbe, and $1200/100\text{m}^2$ -Ajara) while mole cricket has the least population ($33/100\text{m}^2$ -Ojo).

Population size in particular is most sensitive to the degree of seasonal developmental rates of insect pest, host defensive behavior, female fecundity and interaction between host plants (Castanera et al., 2003). Differences in the microclimate and weather pattern between locations give rise to difference in agricultural conditions and activities between locations. Therefore, insect pest is likely to differ in its seasonal distribution between locations as well (Altaf et al., 2007).

Table 1: Seasonal Dominant Insect Pests in the Study Locations

OJO (Ojo Barracks)			IKORODU (Gberigbe)			BADAGRY (Ajara)		
Insect	Season	Population/100m ²	Insect	Season	Population/100m ²	Insect	Season	Population/100m ²
	Wet	1067		Wet	1700		Wet	1200
Black garden ant	Dry	933	Black garden ant	Dry	1300	Black garden ant	Dry	1,033
Field cricket	Wet	66	Field cricket	Wet	100	Field cricket	Wet	100
Bush cricket	Wet	400	Bush cricket	Wet	400	Bush cricket	Wet	433
Mole cricket	Wet	33	-	-	-	-	-	-
Termite	Wet	667	-	-	-	-	-	-
Grasshopper	Wet	900	Grasshopper	Wet	1100	Grasshopper	Wet	700
Leaf caterpillar	Dry	567	Leaf caterpillar	Dry	233	Leaf caterpillar	Dry	666

Source: Field survey, 2014

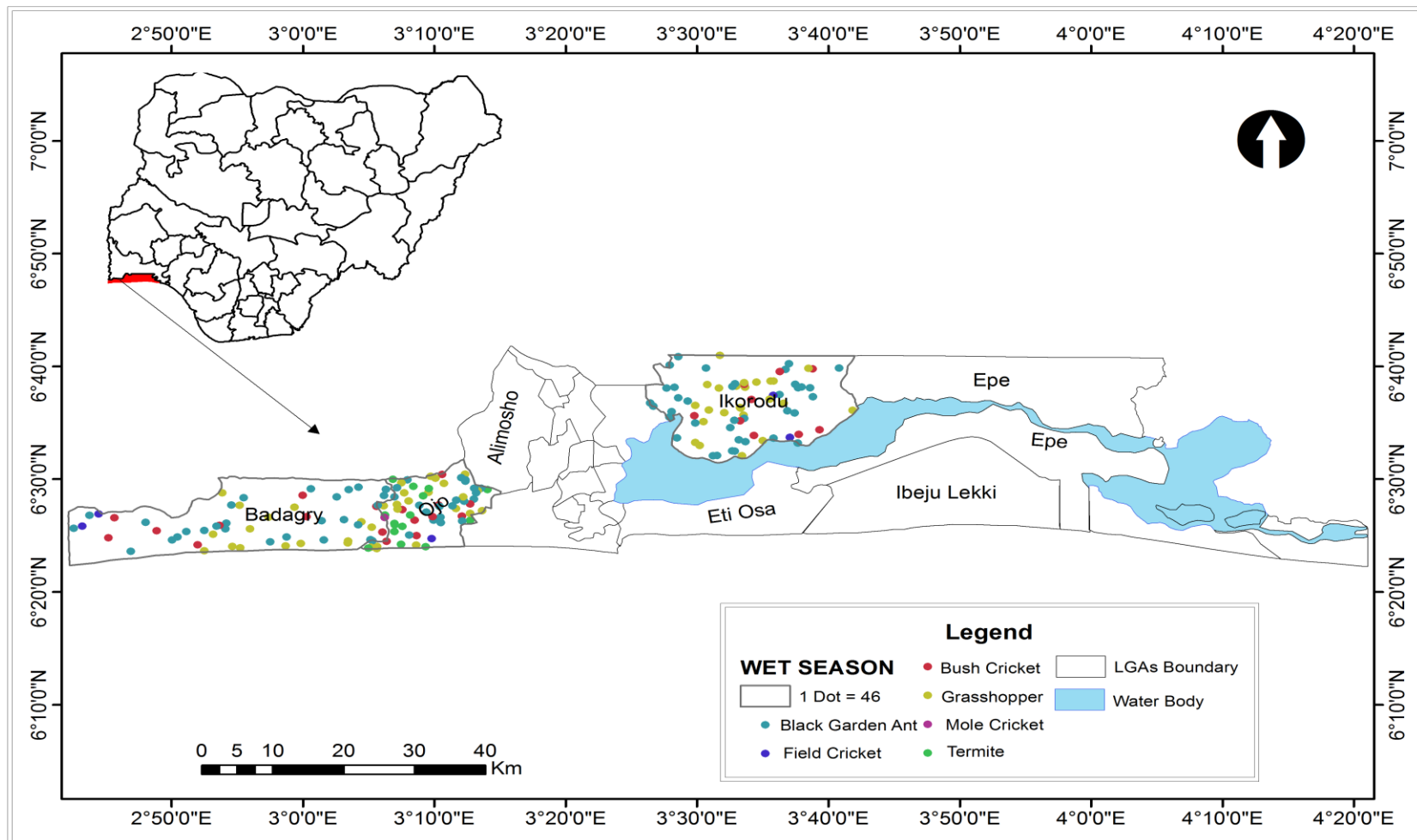


Figure 1 Insect Distribution Map for Wet Season

As shown in Figure 1, Black garden ant, grasshopper, bush cricket, termite, mole cricket and field cricket are dominant insect pest of fluted pumpkin in all study locations in wet season. Black garden ant (*Lasius niger*) and stinking grasshopper (*Zonocerus variegatus*) are the most abundant insect pest within and between the study locations by virtue of having the largest population size in all three locations than the other insect pests in the study locations but the population size is largest at Ikorodu farms therefore, Ikorodu farms are more pressured. Black garden ants are generally more active during the warm seasons. This is one of the contributing factors for its highest population during the wet season. Stinking grasshopper is also very active at the wet season July-August which is the mating season for it. At this time, feeding activities is high leading to more damaged crops/infestation level.

In addition, the increase of herbaceous fallows, deforestation and presence of more cassava farms in Ikorodu was a contributing factor to the high population of variegated grasshopper in Ikorodu. This is in agreement with the findings of Sevilor et al. (2006). Termite and mole cricket were found only in Ojo farms. This is because the soil type/soil texture found in Ojo is largely sandy soil which makes it easy for the insects to burrow through.

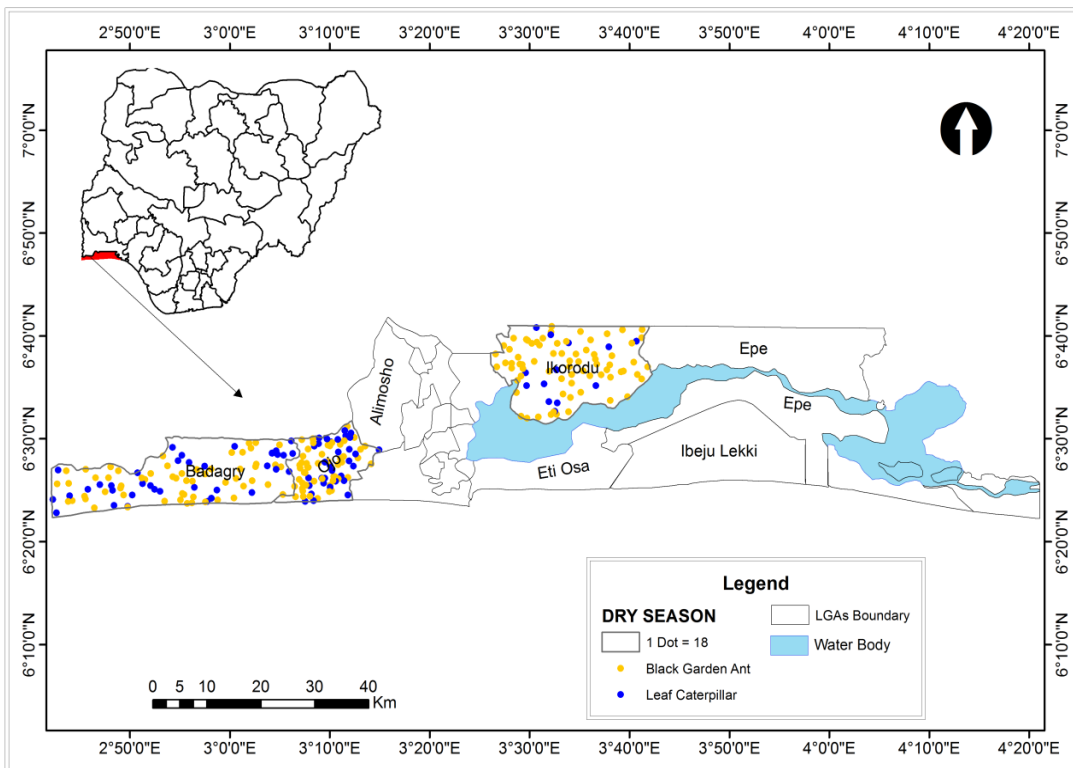


Figure 2 Insect Distribution Map for Dry Season

As shown in Figure 2, two insect pests were identified; Black garden ant and leaf caterpillar in the dry season. These two insect pests are found in all three locations Ojo, Badagry and Ikorodu respectively. Leaf caterpillar has the most impact on Badagry farms with the highest estimated population ($666/100m^2$) while black garden ant exert more pressure on Ikorodu farms with

estimated populations (1300/100m²) than other farms. Leaf caterpillar has the least impact on Ikorodu with the lowest estimated population (233/100m²) while black garden ant was at lowest estimated population at Ojo farms (933/100m²). This is because insect pest distribution and population are dependent on biotic factors and abiotic factors such as climate, reproduction rate, presence of natural enemies and differences in location. The study also revealed that there is less number of insect pests infestation in dry season than in wet season with six insect pest species (black garden ant, field cricket, mole cricket, bush cricket, grasshopper, termite) in the wet and only two (black garden ant and leaf caterpillar) in the dry. During the dry season, the estimated population of insect pests was lower than the wet season. This is in agreement with the findings of Mathew et al. (2003) and Mossler et al. (2009) that increased rainfall and subsequent humidity is correlated with increased infestation level of insect pest.

Figure 3 depicts the seasonal distribution of black garden ant on fluted pumpkin in all study locations. The estimated population density is higher in wet season than in dry season in all three locations. On individual levels, Ikorodu farms has the highest level of infestation in both seasons (1700/100m² in wet season and 1300/100m² in dry season) than the two other farms; Ojo and Badagry. Therefore, Ikorodu farms are more pressured than other farms. Studies has shown that insect types, population size of insect and distribution is largely dependent on differences in the locations; such differences include: the micro climate, soil types, soil moisture, vegetation type, weather patterns, seasonal variations in insect biology and host quality (Oben et al., 2002; Meyer, 2003).

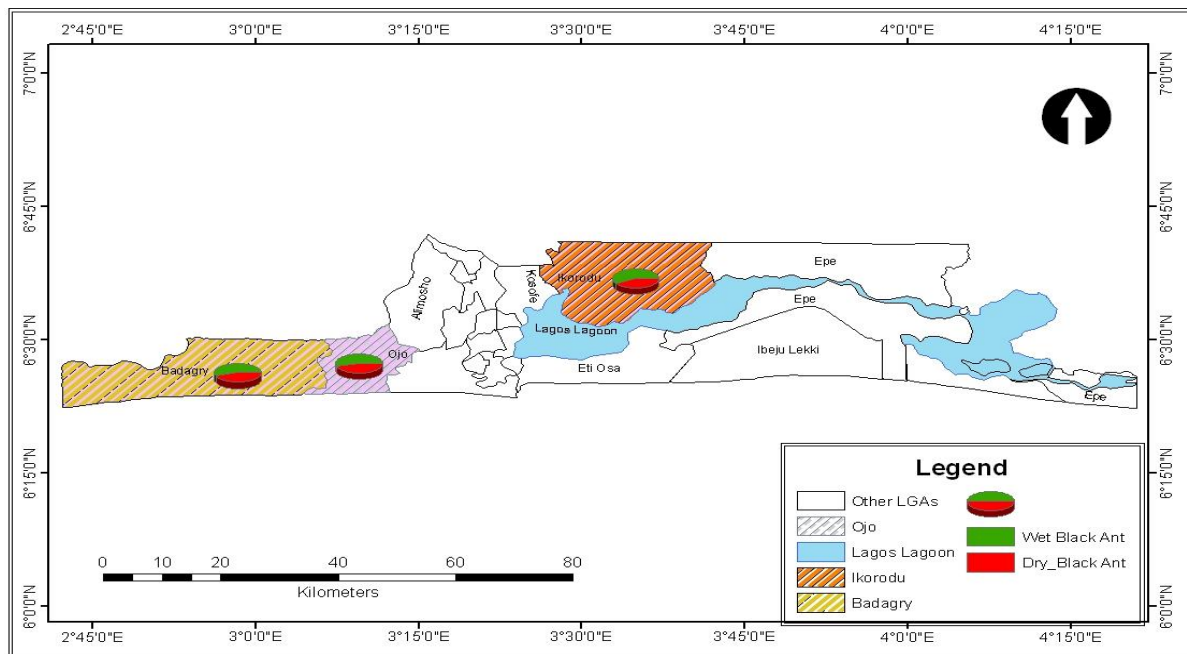


Figure 3 Distribution Map for Black Garden for wet and dry season

Parts of Fluted Pumpkin Plant affected by Insect Pest

The parts of fluted pumpkin plant affected by insect pests are presented in Table 2.

Table 2: Parts of Fluted Pumpkin Plant affected by Insect Pest

Insect Pest	Parts of Fluted Pumpkin affected
Field cricket (Gryllinae)	Feeds on shoot of adult and young shoot of fluted pumpkin Feeds on leaves of the fluted pumpkin
Leaf caterpillar (Lepidoptera)	
Stinking grasshopper (<i>Zonocerus variegatus</i>)	Feeds on the leaves of fluted pumpkin
Mole cricket (Gryllotalpidae)	Feeds on the root of adult and young fluted pumpkin plant
Black garden ant (<i>Lasius niger</i>)	Roll up the leaves of fluted pumpkin
Termite (Isoptera)	Feed on seeds of fluted pumpkin
Bush cricket (Tettigoniidae)	Feed on leaves on the leaves

Source: Field Survey, 2014

The study revealed that insect pest affects all parts of fluted pumpkin shoot, roots, stem and leaves but the leaf is the most affected because majority of the identified insects (leaf caterpillar, grasshopper, black garden ant and bush cricket) feed on the leaf while the shoot and root is the least affected as few insects feed on them (mole cricket and field cricket). Damages are done to plant by insects during their various activities like feeding.

The damage can be either direct or indirect. Direct damage is on the leaf which is the consumable parts and economic part while indirect damage is on the parts that are not consumed or not for sale. Grasshoppers, leaf caterpillars, black garden ants and the bush cricket cause direct damage on fluted pumpkin while the Mole cricket causes indirect damage on fluted pumpkin. Both damages lead to decline in the function of the entire plant or a section of the plant which will subsequently cause poor leaf coloration, dieback, retarded growth and yield loss. This is in agreement with the findings of (Cranshaw, 2004; Pedigo and Rice, 2006).

Stages of Fluted Pumpkin Growth affected by Insect Pests

The stages of fluted pumpkin affected by insect pests are presented in Table 3.

Table 3: Stages of Fluted Pumpkin affected by Insect Pests

Insect Pest	Stage of plant growth affected by insect pest
Field cricket (Gryllinae)	Seedlings, young and adult fluted pumpkin
Mole cricket (Gryllotalpidae)	Adult fluted pumpkin plant
Stinking grasshopper (<i>Zonocerus variegatus</i>)	Young and adult fluted pumpkin
Leaf caterpillar (Lepidoptera)	Feeds on leaves of fluted pumpkin
Black garden ant (<i>Lasius niger</i>)	Seedling, young and Adult fluted pumpkin
Termite (Isoptera)	Seeds
Bush cricket (Tettigoniidae)	Seedlings, young and adult fluted pumpkin.

Source: Field Survey, 2014

Table 3 shows that insect pests affect seeds, young and adult fluted pumpkin plants. The growth stages affected by Insect pests is the same in all three locations; Ojo, Ikorodu and Badagry. There is no variation in the growth stage affected by the insect pest. Growth stage of a plant is divided into vegetative, production, ripening and senescence stage (Bareja, 2015). The vegetative stage is the stage characterized by leaf production. Majority of the identified insect pests (Bush cricket, grasshopper, mole cricket, field cricket, leaf caterpillar and black garden ant) feed/destroy the leaf which is the vegetative growth stage. Heavy infestation at this stage can lead to reduction in the quality of economic part of the plant or the death of the plant (Cranshaw, 2004). During vegetative growth, the majority of photosynthate and nutrient produced by plant is used for development, root growth and stem elongations. Leaves destruction during the vegetative growth will result in decline in the functioning of the entire plant which will in turn result to shorter plants with fewer small leaves or death of the entire plant (Pedigo and Rice, 2006) and this will affect farmers' income.

CONCLUSION

Black garden ant is the major insect pest that affects fluted pumpkin in the study locations and it affects the leaf and vegetative growth stage. Based on the key findings, the study therefore suggests that for optimum fluted pumpkin yield, the following may be observed, an effective method for controlling black garden ant and other insect pests for fluted pumpkin at the vegetative growth stage should be developed, farmers should be trained by researcher and extension agents on how to control this pest population in the study area using ecology principles. Also, insect pest resistant varieties of fluted pumpkin should be developed by researchers and made available to farmers in the study areas.

REFERENCES

- Agrios, G.N. (1997). *Plant Pathology*. 4th edition, Academic Press. San Diego, CA.
- Akanbi, W.B, Adeboye, C.O., Togun, A.O., Ogunrinde, J.O. and Adeyeye, S.A. (2007). Herbage and Seed Yield and Quality of *Telfairia occidentalis* as Influenced by Cassava Peel Compost and Mineral Fertilizer. *Science*, 3(4), 508-516.
- Altaf, H., Chisti, M.Z., Bhroo, A.A. and Khan, M.A. (2007). Adult Population of *Aprionia germae* (*Coleoptera Cerambycidae*) Mulberry farms of Jammu and Kashmir State, India. *Pak. Entomy*, 29, 15-18
- AVRDC (2003). Effect of natural and synthetic pesticide in controlling diamond back moth in cabbage. Asian Vegetable Research and Development Center - The World Vegetable Center, Shanhua, Taiwan.
- Bareja, B.G. (2015). The Major Stages of Development in Plants: How Plants grow from Seed. Retrieved June 20, 2017 from www.cropsreview.com/development-in-plants.html
- Castanera, M.B., Aparico, J.P. and Gurtler, R.E. (2003). A stage structured Stochastic Model of Population Dynamics of *Triatoma* Infestation, the main vector of Chagas disease. *Ecological Modelling*, 165, 33-53
- Cranshaw, W (2004). *Garden Insects of North America*. Princeton University Press, Princeton.
- Ellis-Jones, J.J., Storehouse, H., Gridley, J.H. and Onim, M. (2009). Baseline study on vegetable production and marketing vegetable breeding and seed systems for poverty reduction in Africa. Retrieved 5th July, 2012 from aci.gov.aci/aifsc/veggie_scooping_study_report.
- Ericson, F. (1985). Qualitative Methods in Research on Teaching at Retrieved 31st October, 2017 from <https://eric.ed.gov/?id=ED263203>.
- Fliert, E., Van, D. and Braun, R. (1999). Farmer field school for integrated crop management of sweet potatoes field guide and technical manual. Bogor Indonesia: International potatoes center. Retrieved 29th November, 2017 from <http://www.eseap.cipotato.org/mf>
- Grubben, G.J.H and Denton, O.A. (2004). *Plant Resources of Tropical Africa 2 Vegetables*, p: 668. PROTA Foundation, Wageningen, Netherlands Backhuys Publishers, Netherlands.
- Heylighen, F. (1998). The Basic Concepts of Systems Approach Retrieved on 31 October, 2017 from <http://pespmc1.vub.ac.be/SYSAPPR.html>.

- Horsfall, M.J. and Spiff, A.I. (2005). Equilibrium sorption study AL_3 , CO_2 , and AG in aqueous solution by fluted pumpkin (*Telfaira occidentalis*) waste Biomass. *Acta Chim. Slov.* 52, 174–181.
- Iwena, O.A. (2012). *Essential Geography for Senior Secondary Schools*. Lagos: Tonad Publication.
- Iwuchuckwu, J.C. and Uzoho, U.C. (2009). Constraints to vegetable production among women in Enugu north agricultural zone, Enugu state. *Agric Extension Journal*, 13(1), 10-23.
- Matthews, G.T.W. and Baleguel, P. (2003). A survey of pesticide application in Cameroon. *Crop Protection. J* 22(5), 707-714.
- Meyer, J.R. (2003). Pest control tactics ENT425 home page Department of Entomology, North Carolina State University. Available at <http://www.cals.ncsu.edu/course/eat425>.
- Mosslar, M.A. and Dunn, E. (2009). Florida crop/pest management profile: Okra. University of Florida, IFAS Extension Publication, Gainesville, Florida.
- NPC (2006). *Nigeria National Population Census Report*. Abuja: Nigeria Population Commission.
- Oben-ofori D., Owusu E.O. and Kaiwa E.T. (2002). Variation in the level of carboxyl esterase activity as an indicator of insecticide resistance in populations of the diamond back moth *plutellaxyl obtella* (L) attacking cabbage in Ghana. *Ghana Journal Science Association*, 4(2), 52-62.
- Obopile, M., Munthale, D.C. and Matilo, B. (2007). Farmers' knowledge, perceptions and management of vegetable pests and diseases in Botswana. Department of Crop Science and Production, Botswana College of Agric, Gaborone, Botswana.
- Pedigo, L.P. and Rice, M.E. (2006). *Entomology and Pest Management*. 5th edition, Pearson Prentice Hall. Columbus, OH.
- Sevilor, K., Stephan, W. and Manuel, T. (2006). Farmers' perception on the importance of variegated grass hopper (*Zonoceros variegatus*) in the agricultural production system of the forest zone of Southern Cameroon. *Journal of Ethnobiology and Ethomedicine*, 2:17.
- Youdeowei, A. (2002). Integrated pest management practices for the production of vegetables. Integrated Pest Management Extension Guides 4, Ministry of Food and Agriculture (MOFA), Plant Protection and Regulatory Service Directorate (PPRSD), Ghana with German Development Cooperation, Accra, Ghana.