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Research Paper

Insect pests and weather factors associated with yam (*Dioscorea Spp*.) in Guinea Savanna zone of Nigeria

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Yam (*Dioscorea* spp.) is infested by a broad taxonomic diversity of insect pests. A total of 73 insect species have been associated with *Dioscorea* species. These insects have not been fully identified in Abuja. This study was carried out in 2012 to 2014 to determine the insect pests and incidence of virus symptoms associated with yam production in the University Research Farm, Abuja, Nigeria. Treatments consisted of six varieties comprising four local yam varieties and two accessions from International Institute of Tropical Agriculture (IITA), Ibadan. The trial was laid in Randomized Complete Block Design (RCBD) and replicated thrice. Insect traps were randomly set at 40 cm above ground level. Trays were one-quarter filled with solution of 70% ethanol and 15% teepol in water. Trapped insects were collected weekly for 10 weeks and identified. Insects in the order Hymenoptera were most prevalent, follow by those in order Coleoptera. The orders Heteroptera and Hemiptera were found in low numbers. Highest number of insects was trapped in July when there was inconsistent rainfall with intermittent dry spells and high temperature. The observed virus symptoms were consisted with those of *Yam mosaic virus* (YMV), *Yam mild mottle virus* (YMMV) and *Dioscorea alata bacilliform virus* (DaBV).

Key words: Dioscorea, virus, insect pests, weather.

INTRODUCTION

Yam production and marketing are affected by a wide range of insect pests on the foliage. For example, leaf beetles (*Crioceris lívida* Dalm), mealy-bug (*Planococcus* spp.), termites (*Amitermes*), scale insect (*Aspidiella hortii* Cockerell), tuber beetle (*Heteroligus* spp.) contribute to yield reduction and the deterioration of tuber quality in storage (Wood et al., 1980; Akinlosotu, 1985; Okoroafor, 2009). Tubers are attacked by borers, coleoptera larvae, especially in the soil and damage by these insects are intensified between harvesting and next planting season. The adult forms of Greater yam beetle (*Heteroligus meles* Billb), eat the planting setts and plants may wilt and die. They also make holes of varying shapes and sizes on yam tubers which reduce market value and predispose tubers to decay and may facilitate secondary fungal and bacterial attacks when the harvested tubers are stored (Coursey, 1967; Manyong et al., 1995). The lesser yam beetle, *H. appius*, exists in southern Nigeria and causes damage to tubers (Okoroafor, 2009). Yam scale insects (*Aspidiella hortii* Cockerell) damage tubers and sometime foliage, causing poor growth. Stored tubers are particularly susceptible to attack and large numbers cause shriveling (Palaniswamy, 1991). Pseudo-coccidae, with at least five genera, attacks yam tubers. They cause shriveling of tubers by sucking moisture from them. The species that seem to be the most invasive are Geococcus coffeae Green, which is

pantropical and *Planococcus citri* (Risso) which is cosmopolitan (Wood et al., 1980; Akinlosotu, 1984). The termites and scale insects can facilitate or help to establish other parasite attacks through the wound they create while feeding. They also transmit viral diseases (Wood et al., 1980; Palaniswamy, 1991). Aphids seem to be especially troublesome on plants that are in shaded areas. They suck saps of plant and cause leaves to curl or wrinkle. Their ability to transmit plant virus diseases is more harmful than the damage caused by direct feeding (Phillips et al., 1999; Okoroafor, 2009). Other insects are weevils, scarius flies, and grasshoppers (Wood and Ambridge, 1996). They chew leaves, bore holes in tuber and suck sap from plants. The insects associated with yam in Abuja have not been fully identified and this has initiated this study. Therefore, the aim of this study was to determine the insect pests that are associated with yam on the research yam field of the University of Abuja during a three-year period.

MATERIALS AND METHODS

The trials were laid in a Randomized Complete Block Design (RCBD) with six treatments and three replications during growing season of 2012 to 2014 in the Research and Teaching farm of the University of Abuja. Treatments consisted of six varieties comprising four local yam varieties (Makakusa, Army, Dan-anachia and Gbakunmo) and two accessions (TDr 89/022665 and TDa 05/000129) from International Institute of Tropical Agriculture (IITA), Ibadan. The fields were prepared by ploughing soil in heaps of ten per row (totalling 150 heaps at each location) with spacing of 1 m x 1 m. Propagation was done by cutting of tuber into several pieces or planting setts (top, middle and bottom setts) of approximately 500 g weight, with each piece having at least a dominant eye or bud (Degras, 1993). After emergence, shoots that were approximately 1 m long were staked with sticks to allow better sunlight interception by the leaves. Mulch was placed over the soil in the field to prevent setts from excessive moisture loss particularly in the months of February and March when the rains are yet to be fully established. Weed control was done using herbicide (a.i:paraquat) once, two weeks after planting in order to kill weeds that were on the field before seed germination. Further weed control was carried out manually and hand pulling methods as often as necessary. The surveyed fields were assessed and scored for virus disease incidence (DI) by visual observation of plants showing typical yam virus symptoms expressed on the leaves. The incidence of plants that showed virus-like symptoms was calculated as number of symptomatic plants over total number of plants sampled expressed in percentage (Odedara et al., 2008).

Traps made of purple plastic containers were set at 40 cm above ground level on cement blocks and some were placed on plant heaps. Each tray (coloured green) was one-quarter filled with a solution of 70% ethanol, 1.5% teepol detergent and water. The trapped aphids were collected once every week for ten weeks and the liquid in trap containers were changed after every collection. The aphids trapped were collected and identified in the Insect Museum Laboratory, Department of Crop Protection, Institute of Agricultural Research (I.A.R), Zaria. The weather data (Temperature, Hours of Sunshine, Relative Humidity and Rainfall) for the three (2012-2014) years of trial were collected from the Meteorological Department of the Nnamdi Azikwe International Airport, Abuja.

RESULTS

Insect pests trapped per order and year

The results show that 5 insect pest orders with a total number of 94 insects were encountered in this study in 2012 yam growing season. The orders comprised of Coloeptera, Othoptera, Hymenoptera, Heteroptera and Hemiptera (Table 1). Order Hymenoptera had the highest number of insects trapped and the family *Formicidae* (*Camponotus vestitus* Smith) recorded the highest number of trapped insects. This was followed by the order Coloeptera while the family *Carabidae* had the highest number of insects trapped. In the order Othoptera, Pyrgomorphodae had the highest number of trapped insects. The order Heteroptera recorded insects from three different families with Cynidae recording the highest. The order Hemiptera recorded the lowest number of trapped insect, all from the family Aphididae (Table 1, Figure 1). In 2013, a total of 117 insects from 4 orders were encountered (Table 2). These orders were Coloeptera, Othoptera, Hymenoptera and Hemiptera. The order Hymenoptera had the highest number of insect collected, followed by order Coloeptera. The order Othoptera had 16 insects trapped, with the majority of them belonging to the family Gryllidae while the order Hemiptera recorded the lowest all from the family *Aphididae* (Table 2). The result for 2014 showed that 4 insect orders were encountered with a total of 169 insects collected. The order Hymenoptera still recorded the highest number of insects, followed by the order Othoptera and Heteroptera. No insects in the order Hemiptera were found for that year.

Insect pests trapped per month

For each year under study, the highest number of insects were collected in July followed by August. The

Table 1. The Order, family and number of insect pest trapped and identified during the 2012 yam growing season in the Guinea Savanna Zone of Nigeria.

Order/ Scientific name	Family	Common Names	Total No of insects trapped
Order: Coloeptera			
Scarabaeus spp.	*Scarabaeidae*	Scarab beetle	6
Tetragonoderus spp.	*Carabidae*	Ground beetle	8
Monolepta nigeriaebryant.	*Chrysomelidae*	Leaf beetle	2
		Total	16
Order: Othoptera			
Zonocerus varvegate Fab.	*Pyrgomorphodae*	Verigated grasshopper	6
Catantops melanostictus	*Acrididae*	Shorthorned grasshopper	4
Gryllu bimaculatus Deg.	*Gryllidae*	Field cricket	4
		Total	14
Order: Hymenoptera			
Camponotus vestitus Smith.	*Formicidae*	Big Headed Ants	42
Ammophila tenuis. P.-B	*Sphecidae*	Black and yellow bug	4
Apis mellifera L.	*Apidae*	Honey bee	1
		Total	47
Order: Heteroptera			
Plautra sp.nr brunnipennis M.	*Petatomidae*	Sting bug	3
Gracnethust spp.	*Cynidae*	Black sting bug	5
Dieuches albostriatus. Fab.	*Lygaeidae*	Seed bug	2
		Total	10
Order: Hemiptera			
Aphis spp.	*Aphididae*	Aphid	7
		Grande Total	94

Table 2. The Order, family and number of insect pest trapped and identified during the 2013 yam growing season in the Guinea Savanna Zone of Nigeria.

Order/ Scientific name	Family	Common Names	Total No of insects trapped
Order: Coloeptera			
Scarabaeus spp.	*Scarabaeidae*	Scarab beetle	
Tetragonoderus spp.	*Carabidae*	Ground beetle	10
Monolepta nigeriaebryant.	*Chrysomelidae*	Leaf beetle	9
Lema cephalites	*Chrysomilidae*	Leaf beetle	4
Cheilomenes sulphurea. Oliv.	*Coccinellidae*	Lady beetle	2
Cydnidae	*Aethus indicus. westw*	Black sting bug	8
		Total	33
Order: Othoptera			
Zonocerus varvegate Fab.	*Pyrgomorphodae*	Verigated grasshopper	1
Acorypha modesta Uvar.	*Acrididae*	Short horned grasshopper	1
Gryllu bimaculatus Deg.	*Gryllidae*	Field cricket	8
Teleogryllus xanthoneurus Ger.	*Gryllidae*	Field cricket	6
		Total	16
Order: Hymenoptera			
Camponotus vestitus Smith.	*Formicidae*	Big Headed Ants	31
Tiphia spp.	*Tiphiidae*	White grubs	1
Apis mellifera L.	*Apidae*	Honey bee	2
Myrmicaria striata. Stilz	*Formicidae*	Ant	22
Pheidole sp.	*Formicidae*	Big headed Ant	10
		Total	66
Order: Hemiptera			
Aphis spp.	Aphididae	Aphid	2
		Grande Total	117

least number of insects was seen in October (Figure 2). The number of insects trapped was significantly higher in July and August than in September and October. On the whole, more insects were trapped in 2014 than in other years (Figure 2).

Associated weather conditions

Rainfall: Rainfall was significantly higher (*P<0.5*) in 2012 than in 2013 and 2014 (Figure 3). The difference in rainfall between 2013 and 2014 was not significantly

Table 3. The Order, family and number of insect pest trapped and identified during the 2014 yam growing season in the Guinea Savanna Zone of Nigeria.

Order/ Scientific name	Family	Common Names	Total No of insects trapped
Order: Coloeptera			
Scarabaeus spp.	*Scarabaeidae*	Scarab beetle	16
Tetragonoderus spp.	*Carabidae*	Ground beetle	6
Monolepta nigeriaebryant.	*Chrysomelidae*	Leaf beetle	8
		Total	**32**
Order: Othoptera			
Zonocerus varvegate Fab.	*Pyrgomorphodae*	Verigated grasshopper	3
Catantops melanostictus	*Acrididae*	Short horned grasshopper	6
Gryllu bimaculatus Deg.	*Gryllidae*	Field cricket	48
		Total	**57**
Order: Hymenoptera			
Camponotus vestitus Smith.	*Formicidae*	Big Headed Ants	70
Ammophila tenuis. P.-B	*Sphecidae*	Black and yellow bug	1
Apis mellifera L.	*Apidae*	Honey bee	1
		Total	**72**
Order: Heteroptera			
Plautra sp.nr brunnipennis M.	*Petatomidae*	Sting bug	2
Gracnethust spp.	*Cynidae*	Black sting bug	3
Dieuches albostriatus. Fab.	*Lygaeidae*	Seed bug	2
		Total	**7**
Order: Hemiptera			
Aphis spp.	*Aphididae*	Aphid	0
		Grande Total	169

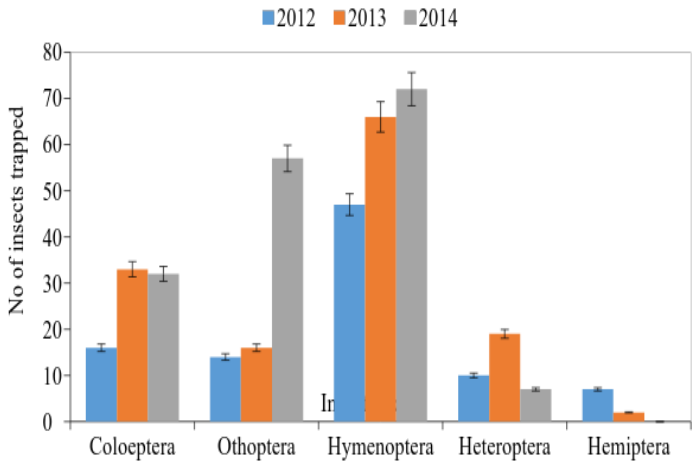

Figure 1. Number of insects trapped per order for the three years.

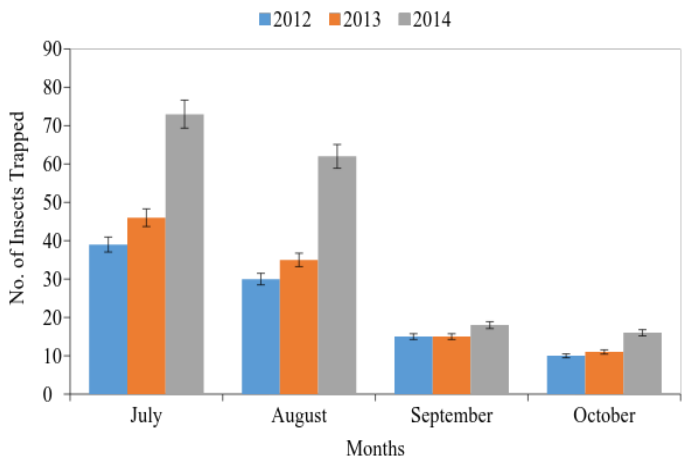

Figure 2. Number of insects trapped per month from July to October for three years.

different (*P>0.05*). The apparent differences in rainfall across the months were, however, not significantly different (*P>0.05*) for each of the three years. The overall rainfall was significantly higher (P<0.05) in 2012 than 2013. Although rainfall was lowest in July 2014 but increased to a maximum level, which was similar to the least rainfall in October 2012, 2014 experiences a more consistent rainfall than other years in terms of its frequency.

Temperature: The yam growing season experienced significantly higher (*P<0.5*) temperatures in 2013 than in the other two years (Figure 4). However, the differences in temperature across the months were not statistically significant (*P>0.05*) for the three years under study.

Incidence of virus symptoms

The incidence of virus symptoms detected on yam leaves increased from July to October for each of the three years under study (Figure 5). The virus incidence was highest in the year 2013 and lowest in 2014 (Figure 3c). However, the differences in the incidence between the months and years were not statistically significant (*P>0.05*).

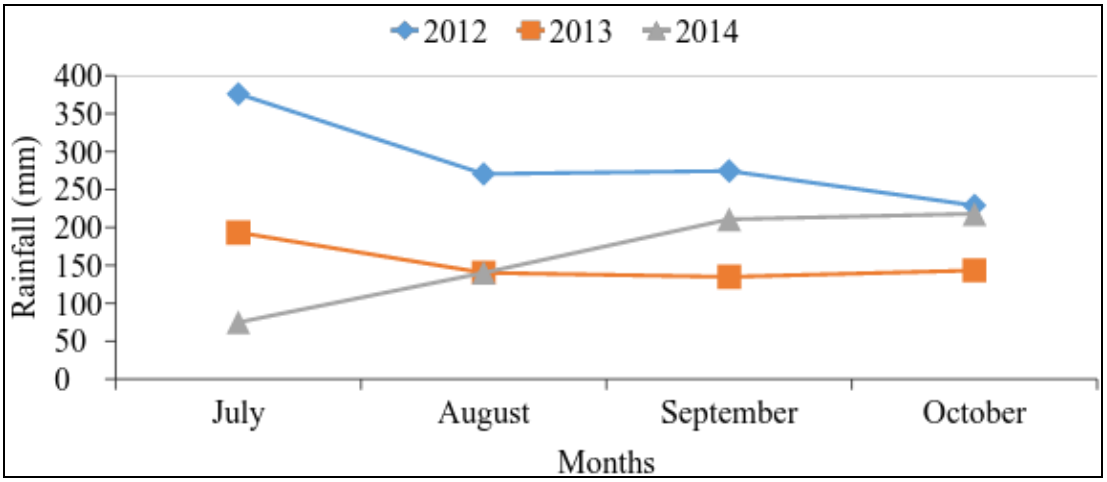

Figure 3. Rainfall data during the yam growing periods of 2012 to 2014.

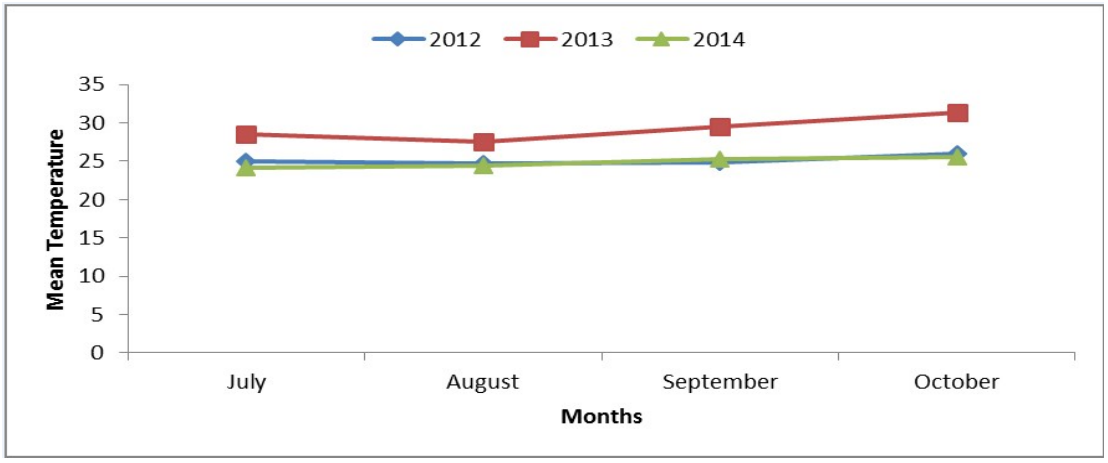

Figure 4. Mean Temperature during the yam growing periods of 2012 to 2014.

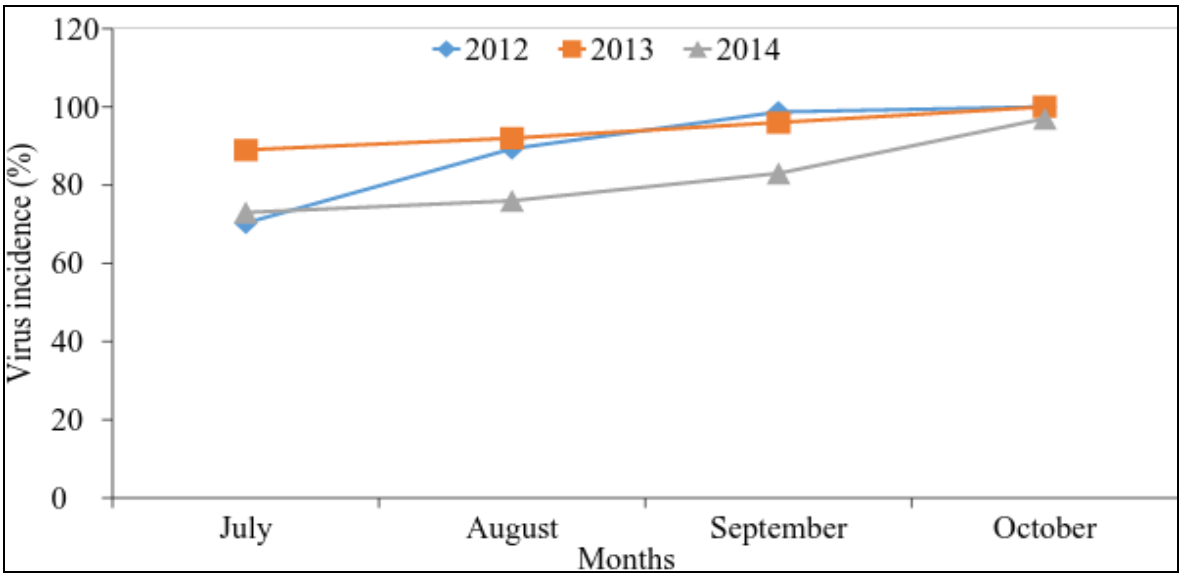

Figure 5. Mean incidence (%) of virus symptoms during the yam growing period of 2012 to 2014.

DISCUSSION

The insect pests that were encounter and identified in this study were ants, bees and yellow bug from the order Hymenoptera which constituted the highest number of insect trapped for the three years. Insects such as weevils, scarius flies, ants and grasshoppers chew leaves, bore holes in tubers and suck sap from plants (Wood and Ambridge, 1996). The next order of insect collected were the Coloeptera made up of scarab beetles, ground beetles and leave beetles. They are also leave defoliators which have the capacity to impact negatively on yam production and consequent marketing. For example, leaf beetles (*Crioceris livida* Dalm), mealy-bug (*Planococcus* spp.), termites (*Amitermes*), scale insect (*Aspidiella hortii* Cockerell) and tuber beetle (*Heteroligus* spp.) contribute to yield reduction and the deterioration of tuber quality in storage (Wood et al., 1980; Akinlosotu, 1985; Okoroafor, 2009). Tubers are attacked by borers, coleoptera larvae, especially in the soil and are damaged by these insects whose activities are intensified between harvesting and next planting season. Although the bugs from the order Heteroptera and aphids from the order Hemiptera were encountered in low population for the three years, they are very important vectors of most of the viruses of yam. This is supported by work of Atiri et al. (2003) which showed that several yam potyviruses are transmitted by aphids, after initial infection through use of infected seed pieces, following which the aphids may spread the viruses to other plants. Dioscorea alata bacilliform has been shown to be transmitted by mealy-bugs (Phillips et al., 1999; Atiri et al., 2003).

Diseased plants showed mild to very severe symptoms which did not develop at the same time on all the plants. Chlorotic mosaic and mottling were the most common symptoms observed, followed by shoe-string, vein-clearing, necrosis, green-vein banding and stunting. The pattern was similar for the three years in Abuja. In each of the three years, there was progressive increase in the incidence of virus infection until all the plants in the trial showed symptoms of viruses YMV, YMMV and Badnavirus (DaBV). A study on the epidemiology of YMV, YMMV and Badnavirus (DaBV) in the Guinea Savanna of Nigeria by Asala (2014) revealed a strong relationship between weather factors and the progression of the incidence and severity of viral diseases of yam in the field. The mean incidence of virus was high for the three years, with almost all the plants in each treatment showing symptoms-like viral infection. This result also shows that increase in rainfall and reduced temperature is associated with reduced insect population on the yam leaves. This will in turn lead to reduced incidence of virus infection. Studies by Alegbejo (2001) observed a very fast spread of groundnut rosette virus (GRV) under conditions optimal for aphids multiplication and activity. Similar work again by Alegbejo (1996) showed that the optimum temperature for reproduction of *Aphis craccivora*, *A. gossypii* and *Myzus persicae* in Pepper venial mottle virus (PVMV) disease was 25°C and above. The relatively high temperatures with little rains that were recorded prior to the establishment of rain during the study period might have provided suitable environments for vectors in the month of July in Abuja. The lower rainfall with intermittent dry spells could have favoured insects, especially aphid development, multiplication and migration; hence the spread of the viruses with higher incidence. The early rains can encourage rapid growth of weeds which increased vector population (Alegbejo, 2001). The consistent rainfall that was experienced in July to September of 2014 might have interfered with the trapping of aphids.

CONCLUSION AND RECOMMENDATION

Generally, inconsistent rainfall with intermittent dry spells and high temperature, encourage the growth and development of insects which carry viruses that may infect yam and subsequently reduce its yield. Whereas weather factors are not subject to the farmer's control, weeds which also provide suitable environment for vector development can and should be controlled to reduce virus infection in the yam field.

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