

Screening Potentials Weed Species as Alternate Hosts of Insect Vectors of the Lethal Yellowing Disease (LYD) of Coconut Palms (*Cocos nucifera* L.) in Nigeria

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Abstract

Weed species screened as alternate hosts implicated *Panicum maximum* Jacq as the most abundant host of vector insects known to transmit phytoplasma. Ten weed species out of the 19 screened hosted leafhoppers of *Cicadellidae* and planthoppers of *Flugorida*. They were found in inner leafsheets and leaflets. The weed species in coconut LYD areas recorded high level of vector insects with *Panicum maximum* 32.7%, *Andropogon gayanus* 23.6%, *Sorghum arundinaceum* 13.4%, *Cyperus difformis* 12.4% and *Oryza barthii* 11.2%. Weed species in coconut non-LYD areas recorded relatively low level of vector insects with *P. maximum* 9.1%, *A. gayanus* 8.4%, *Leptochloa filiformis* 6.8%, and *S. arundinaceun* 2.8%. Excised of eggs, nymphs and adult planthoppers from these weeds, mainly grasses were not only for nesting and resting but also for their mass breeding. The canopies of coconut palms with LYD made the vegetation cool, conducive and environmentally friendly for mass breeding of vector insects such as leafhoppers and planthoppers. The insects were found on the canopies of LYD coconut palms up to late in the evening (7:00 p.m.) and early in the morning (6:30 a.m.). The inner leafsheets of the coconut leaf spear had streaks, an indication of

feeding and nesting. Abundance of weeds, decayed palm logs and pruned fronds were reservoir for mass breeding. This development could predispose coconuts to series of infections and possible transmission of the disease to healthy coconut palms.

Key words: LYD, Weed, Coconut, Alternate host, Vector insect

Introduction

Lethal yellowing is the most damaging coconut disease in West Africa (Dery et al., 1997). In Nigeria the disease is called Awka wilt and was first reported in 1917 in the Awka district in the former Eastern region (Johnson, 1918). In Nigeria, the coconut grove populations are estimated at 13,615 hectare with over 2 million coconut trees of mainly the West African Tall cultivars, providing livelihood for over 30,000 rural families for whom coconut is the source of food, wood-fuel, building material, drink etc (Osagie et al., 2008).

The LYD was first detected in a ten hectare coconut plantation in 1995 when a general disease survey was conducted. By the eleventh year (2006), 98.8% of the West African tall (WAT) palms in the same field had died, while averages of 72% of the dwarfs were lost (Odewale et al., 2010). Wei et al. (2004) located the Nigerian coconut lethal decline group (LND) to a distinct 16Sr group, 16SrXXII-A. This has been confirmed by the work of Hodgetts et al. (2008), who showed a high degree of divergence between the different coconut phytoplasmas based on the *secA* gene which supported their separation into at

least three distinct *Ca* phytoplasma species that reflect the geographical origin of the strains (Wei et al., 2004)

Coconut palm is vulnerable to LYD attack such as phytoplasma. These phloem-limited, insect vectors transmitted phytoplasma are responsible for hundreds of diseases worldwide (Wayne et al., 2008). The phytoplasma, wall-less cell bacteria inhibit the phloem sieve elements. This location inside the plant and the obligate nature of the phytoplasma implies they can be transmitted and spread mainly by phloem sucking insect vectors such as leafhoppers and planthoppers. In fact, all the known insect vectors of phytoplasma are *Auchenorrhyncha* family members (Fabian et al., 2008). Phytoplasma diseases are invariably transmitted by insects of the order *Homoptera*, suborder *Auchenorrhyncha*, particularly the families, *Cicadellidae* (leafhoppers) and *Flugoroidea* (Planthoppers) (Nelson, 1979). The leafhoppers and planthoppers are among the most abundant groups of insects (Wilson, 2007). Approximately 20,000 leafhopper species have been described (Dietrich 2005). Aisagbonhi (2008), Aisagbonhi and Kolade (1994) also presented the list and numbers of insects encountered per 100 coconut palms surveyed, insect vectors *Meenoplus proximus* (M.R. Wilson) and *Proutista fritillaries* were reported. There are 200 vectors of phytoplasma that are already known. There are many more characterized phytoplasma diseases than there are known vectors of the disease (Wilson, 2005). Some plant species such as *Emelia forbergii* and *Synedrella nodiflora* have been reported as hosts of the coconut lethal yellowing disease. (Brown et al., 2007). In related studies, pepper, tomato, potato, cassava, sugar cane,

Solanum spp. and *Euphorbia* spp. have been reported to host phytoplasmas (Nasir et al., 2007).

Control of the spread of LYD insect vectors has been difficult due to paucity of information in the literature on weed species as alternate hosts. In Nigeria, there are areas where the disease outbreak occurred in coconut fields and twelve years after the disease was still spreading to adjoining replanted coconut fields. This was a clear indication of continued slow spread of the disease. It was therefore, necessary to search for alternate hosts of the insect vectors known to transmit phytoplasma of the LYD since the pathogen is an obligate parasite.

Materials and Methods

Sampling Locations

Sampling of weed species was carried out in four locations of LYD and non-LYD (field not planted with coconuts) areas in Edo State (NIFOR sub station Ubiaja Edo State), South East (Igboriom Anambra State), South West (NIFOR sub station, Badagry Lagos State) and central (Aloma-Ofu, Kogi State) of Nigeria. The insects collected were preserved in sample bottles containing 80% alcohol and buffer solutions for future use.

Sampling Period

Sampling was done during the dry and rainy seasons between the periods of October 2010 till September 2011. This was necessary in order to observe the various taxonomic group and population dynamics of different weed species. During the field

study the mean maximum temperature was 33 °C and the mean minimum temperature was 28 °C.

Sampling methodology of weed species

The sampled weed species were mainly grasses and a few aquatic species. A total of 19 weed species were sampled during the period. The weeds were sampled within coconut LYD endemic tracts and non-LYD (not planted with coconuts) areas. Rectangular quadrat of 1m x 1m x 1m was used for the sampling. Random quadrat was laid in different locations. For each field, five were included for the weed study. The number of weed species within each quadrat was observed identified and the mean percentage occurrence of the insect vectors in each weed host was recorded. Weeds that could not be identified directly in the field using a field handbook of West African weeds by Akobundu and Agyakwa (1987), were taken to the Herbarium Unit of Botany Department, University of Lagos, Nigeria for identification.

Screening weed species and other alternate hosts for vector insects

Weed leaflets/leafsheets with streaks or damages, decaying palm logs, fronds and canopy of LYD infected coconut palms were collected for screening. Samples were excised, viewed with the aid of magnifying lens and kept in cages for observation. Eggs, nymphs and adult insects were recovered. They were viewed with the aid of Motic 230 digital camera lens connected to Motic microscope and computer. The vector insects were identified while the eggs were transferred to millet seedling inside insect cage (Plate 2A) for rearing at the screen house. The millets were planted in small black

plastic pots. The nymphs were reared in an artificial diet (composition of artificial diet in 1 litre: H₂O 1000ml, KOH 4ml, Soy flour 15gm, Wheat flour 15gm, Fresh grass leaf 2gm, Sucrose 30gm, Methyl paraben 1.0gm, Yeast 15gm, Agar 15gm, Leaf powder 1.2gm, Acetic acid 4ml, Formaldehyde 2ml and Vitamins capsule 1) at $27 \pm 2^{\circ}\text{C}$ for 6 weeks, for the emergence of adult insects. For screening of weed species as alternate hosts of vector insects, priority was given to common species with insect streaks and damages. The uncommon species without streaks and damages were excluded. The LYD areas were fields with mixture of dwarfs, hybrids, West African tall coconut palms including decapitated coconut stems (Plate 1D) while the non-LYD areas were fields not planted with coconuts. The unidentified vector insects were taken to Entomology Division of the Nigerian Institute for Oil Palm Research (NIFOR) for identification or sent to Natural History Museum in United Kingdom.

Statistical analysis

The experiments were repeated twice. The sampling procedure was random. Data were analyzed as means using t-test.

Results and Discussion

Out of a total of 19 weed species sampled, only 10 were found hosting leafhoppers of *Cicadellidae* and planthoppers of *Flugoridea* families. They were found in the inner leafsheets/leafsurface of *Panicum maximum* with 32.7%, *Andropogon gayanus* 23.6%, *Sorghum arundinaceum* 13.4%, *Cyperus difformis* 12.4% and *Oryza barthii* 11.2%. The weed species in non-LYD areas recorded relatively low level of vector insects with *P.*

maximum 9.1%, *A. gayanus* 8.4%, *Leptochloa filiformis* 6.8%, and *S. arundinaceun* 2.8% respectively (Table 1). They were nesting inside these weeds. It was obvious that they were feeding from the inner leafsheets of the weeds mainly grasses (Plate 1B and C) as there were visible insect streaks and damages.

The excission of the eggs, nymphs and adult planthoppers from these grasses (Plates 2B, C and D) were not only for their nesting and resting but also for mass breeding. Decaying coconut palm logs and fronds were also found to host the vector insects in large numbers. The canopies of the LYD coconut palms made the vegetation cool, conducive and environmentally friendly for mass breeding of vector insects whereas the condition in non-LYD areas were hot and hash due to the absence of cooling canopies. On close observation, planthoppers were found on the canopies of LYD coconut palms up to late in the evening when observation was stopped (7:00 p.m.) and early in the morning (6:30 a.m.) when observation commenced (Plate 1C).

Evidence in this study indicates that *Panicum maximum* Jacq Guinea grass (Plate 1A) was by far the most abundant potential host of insect vectors and populations of these leafhoppers and planthoppers were as much as three to eight times higher in areas of high LYD incidence than non-LYD areas. The implication of ten weed species as alternate hosts of LYD in this study confirmed that the weed species could be the major source of mass breeding of vector insects of the LY disease known to transmit phytoplasma. This agreed with Wilson (2005), who reported that planthopper species

were of major importance because of their high fecundity thereby damaging crops and are also known vectors of bacterial or viral pathogens.

The resting and nesting of the insect vectors on LYD coconut canopies till late in the evening (7:00 p.m.) and early in the morning (6:30 a.m.) proved that the coconut vegetation was a cool and conducive environment for mass breeding. This agreed with the report of Brown (2008), on the study of understory vegetation on coconut farms in which eight species among the 50 plant species examined were found to contain LY-group (16SrIV) phytoplasma.

The abundance of weeds, decaying palm logs and pruned fronds encouraged mass breeding of the planthoppers. These alternate hosts facilitated the complete life cycle of vector insects, reservoir of pathogens and this could predispose the coconuts to more attacks. This was supported by Oropeza et al., (2008) who reported that the rate of infection was found to increase with time and was associated with greater availability of inoculum. He emphasized that phytoplasmas have been found in non-palm species that might be acting as alternate hosts and permanent sources of inoculum. Harrison et al (2008), also reported that *Bacillus megaterium* was isolated from trunk of date palms (*Phoenix canariensis*, Chaband) affected by the lethal decline phytoplasma. Aisagbonhi (2008), Aisagbonhi and Kolade (1994) also presented the list and numbers of insects encountered per 100 coconut palms surveyed, of these insect vectors *Meenoplus proximus* (M.R. Wilson) and *Proutista fritillaries* were reported.

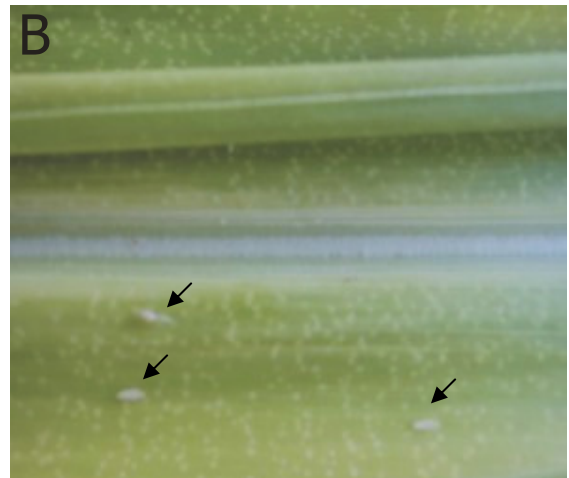
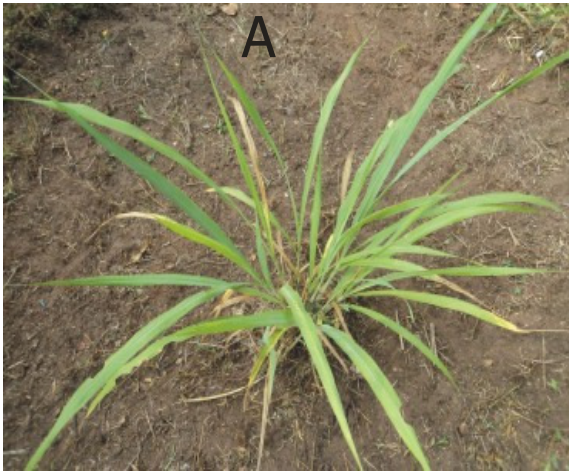
This study disagreed with Nkasah-Poku et al., (2009), who reported that to reduce the rate of spread of the disease, infected palms must be felled with a chain saw machine, fronds pruned off and trunk cut into pieces of meters to facilitate quick drying. The duration of leaving the felled diseased palms, pruned fronds and trunk cut into pieces for quick drying is enough to promote mass breeding of vector insects since these substrata are alternate hosts for the vector insects. Rather they should be eliminated by burning soon after felling. Adequate weed management technique should also be practiced.

Conclusion

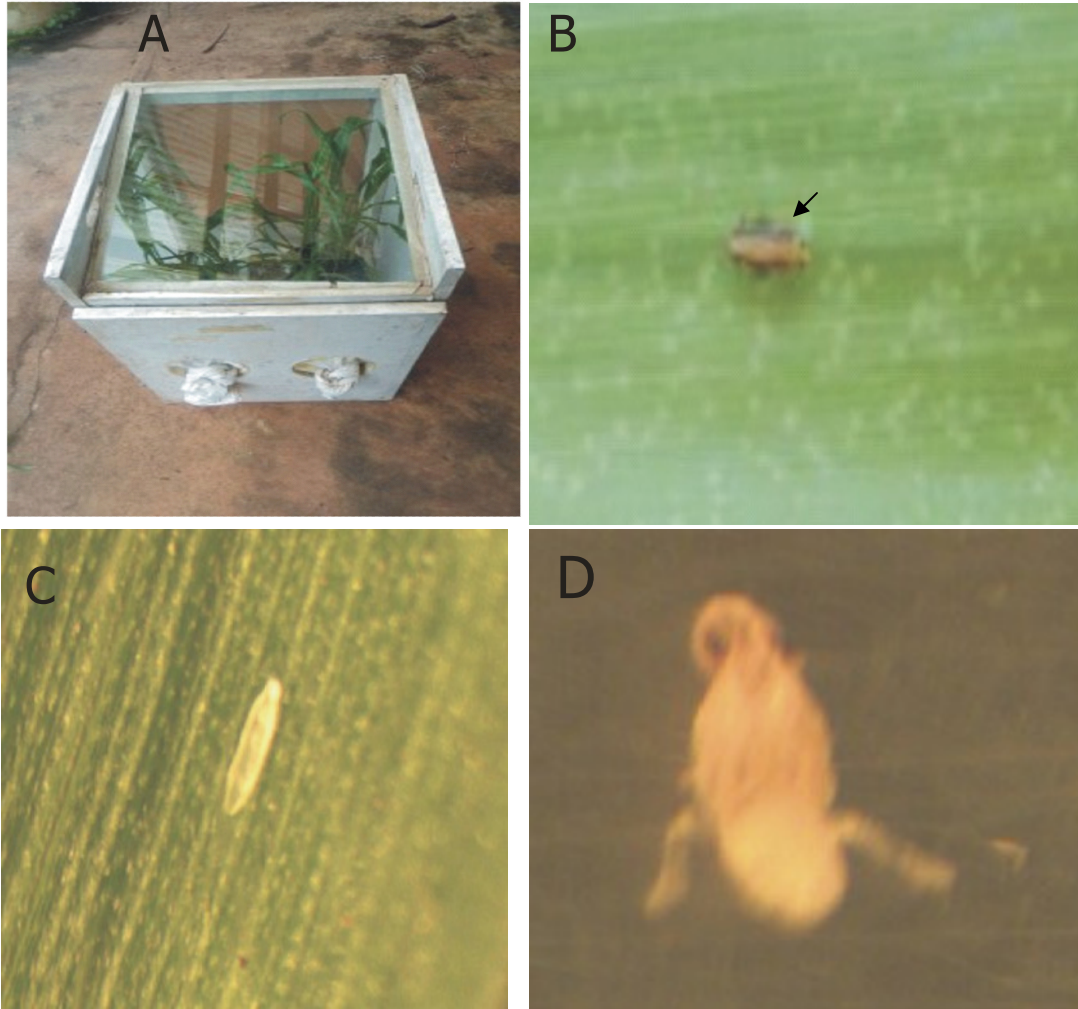
To reduce the spread of the insect vectors, coconut plantation must be weed free and debris free. There must be burning of eradicated weeds, coconut palm logs, diseased coconut palms and pruned coconut fronds in plantations. This management approach will reduce avenues for mass breeding of alternate hosts of vector insects known to transmit phytoplasma of the LY disease

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- Plates 1A. Shows Guinea grass *Panicum maximum* as alternate host of Planthoppers (vector insects).
- B. Arrows show planthoppers emerging from the inner leaf sheet of Guinea grass
- C. Planthopper (*Flugoridea*) found feeding on the canopy of LYD coconut palm
- D. LYD crownless coconut palms caused by insect vectors known to transmit phytoplasma disease.



- Plates 2A. Shows insect cage with millet seedlings for rearing planthoppers
- B. Arrow shows planthopper emerging from the inner leaf sheet of Guinea grass
- C. Egg of a Planthopper *Flugoridea* found in the inner leaf sheet of Guinea grass
- D. Nymph of a Planthopper *Flugoridea* found in the inner leaf sheet of Guinea grass

Table 1. Abundance of vector insects in weed species in LYD and non LYD areas

Weed species	Mean % of leafhoppers & planthoppers	
	LYD areas	non-LYD areas
<i>Acanthus montanus</i>	0.0 ± 0.00	0.0 ± 0.0
<i>Acroceras zizanioides</i> Dandy	0.0 ± 0.00	0.0±0.0
<i>Andropogon gayanus</i> Kunth Var.	23.6 ± 1.30 a	8.4 ± 0.06 a
<i>Cyperus rotundus</i> Linn	0.0 ± 0.00	0.0 ± 0.0
<i>Cyperus difformis</i> Zinn	12.4 ± 0.04 b	5.2 ± 0.21 b
<i>Conyza sumatrensis</i> Retz Walker	0.0 ± 0.07	0.0 ± 0.0
<i>Diplazium sammatti</i> Kuhn	0.0 ± 0.00	0.0 ± 0.0
<i>Heteranthera callifolia</i> Rchb. ex Kunth	3.5 ± 0.02 d	0.0 ± 0.00
<i>Heterotis rotundifolia</i> (SM) Triana	0.0 ± 0.00	0.0 ± 0.0
<i>Hyphis suaveolous</i> Poit	0.0 ± 0.00	0.0 ± 0.0
<i>Kyllinga squamulaoa</i> Thorn	0.0 ± 0.00	0.0 ± 0.0
<i>Leptochloa filiformis</i> (Lam.) P. Beauv Featherfrass	0.0 ± 0.00	6.8 ± 0.14 b
<i>Oryza barthii</i> A. Chev	11.2 ± 0.31 b	2.7 ± 0.20 d
<i>Panicum maximum</i> Jacq Guinea grass	32.7 ± 0.41a	9.1 ± 0.03 a
<i>Paspalum scrobiculatum</i> linn (Ricegrass paspalum)	6.5 ± 0.02 c	1.3 ± 0.04 e
<i>Rottboellia cochinchinensis</i> (Lour) Clayton (Itchgrass)	0.0 ± 0.00	2.4 ± 0.13 d
<i>Setaria barbarata</i> (Linn)	2.7 ± 0.08 e	0.0 ± 0.0
<i>Sorghum arundinaceum</i> (Desv.) Stapf	13.4 ± 0.11 b	2.8 ± 0.08 c
<i>Sporobolus pyramidalis</i> P. Beauv.	0.0 ± 0.00	0.0 ± 0.0

Values are mean $\pm$ SEM of five replicate results. Weed (*P. maximum*) with the highest number of vector insects was compared to others using t – test. Values of the same alphabets in the same column are significant.

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