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Effect of Vascular Wilts Pathogen (*Fusarium oxsporium*) on the Nutritional Contents of Oil Palm in the Savannah Ecological Zone of Nigeria

Madinatu Y.[2], Chimbekujwo I. B.[1], Zakari, B. G.[1]* and Etsanu U. J.[3]

[1]Department of Plant Science, Modibbo Adama University Yola, Adamawa State, Nigeria
[2]Department of Biological Science, Federal University Wukari, Taraba State, Nigeria
[3]Department of Chemistry, Taraba State University Jalingo, Taraba State, Nigeria

Corresponding Author: bgzakari@mau.edu.ng

ABSTRACT

Oil palms are versatile tree crops with economically valuable parts. The primary product obtained from oil palm is the palm fruit, which is processed to produce commercial products such as palm oil, palm kernel oil, and palm kernel cake. This study evaluates the effect of the vascular wilt pathogen (Fusarium oxysporum) on the nutritional value of oil palm in the Savannah Ecological Zone of Nigeria. A Complete Randomised Design (CRD) was employed in this research. Oil palm seedlings displaying fungal symptoms were collected, and the pathogen was isolated and identified using standard techniques. The effect of the pathogen on the nutritional values of the oil palm was determined using proximate analysis. Data were analyzed using analysis of variance (ANOVA) at a 0.005 level of significance. The results revealed the prevalence and severity of vascular wilt on oil palm seedlings and trees in the Kurmi plantation. The treatments were monitored at varying concentrations of the plant extracts. The effects of neem root were evident at concentrations as low as 40%, which coincided with the lowest mean of 24.33. The lowest mean for effective isolation of the organism was at a concentration of 80%, which were 39.17 for tobacco leaf. The nutritional composition of oil palm seedlings indicated that the levels of moisture, ash, crude protein, fat, fiber, and carbohydrates made the seedlings potentially susceptible to fungal diseases. The study recommended that the government and host communities implement integrated disease management practices combining cultural, biological, and chemical control methods to effectively manage fungal diseases in the Kurmi plantation.

Keywords: *Fusarium oxysporium*, Nutritional values, Oil palm, Vascular wilt

INTRODUCTION

The oil palm (*Elaeis guineensis* Jacq) is an Aracaceae and a perennial monoecious plant with trimerous flowers (Kinge *et al.,* 2019) that originated in West Africa (Khairudin and Chong, 2008). It is a Cocoideae, having 225 genera with over 2600 species and one of the most important because it produces the following: palm oil, palm kernel oil and palm wine liquor (Idris and Ariffin, 2004; Nkongho *et al.,* 2014). The palm oil is a cholesterol-free vegetable oil. The main producers in Africa are Nigeria, DRC, Ghana and Ivory Coast though Africa's contribution to global palm oil supplies dropped from 77% in 1961 to 4% in 2014 but still holding 4.5 million hectares of world's total oil palm cultivated area across climatically suitable regions of West and Central Africa (Elsa *et al.,* 2019).

In terms of agriculture, the oil palm is perhaps the world's most important palm species. Oil palm fruits are available year-round and have served as semi-wild food resources in traditional societies. In its regions of origin, the oil palm plant has great

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significance to local people and for wider biodiversity (Cosiaux *et al*. 2018; Reddy *et al*. 2019; Okolo *et al*., 2019). Cultivation of oil palm as a crop was originally an informal process mainly confined to the West/Central African coastal regions. Because the oil fruit has been found to be of high importance, not only in its production of oil and kernel oils, also in their ability to withstand temperature and wind barriers. Hence, during the nineteenth century, oil palm seeds were transported to the Dutch East Indies (modern Indonesia), and to the Malay States (modern Malaysia), as part of colonial ventures to grow newly introduced cash crops in the region (Murphy *et al*., 2021). Nigeria is considerably an agro-based economy since majority of her rural dwellers are farmers and depends heavily on agriculture for their sustenance. Her climate variation affects several cash crops and these constitute her exports before 1970s. But of recent, the growing human population necessitates high demand for staple crops from food companies across the globe. The increasing demand for food crops generates a ripple effect on the production value-chain for the farmers, food companies and the government at large (Ezenekwe and Uzonwanne, 2017). In view of the above problems and need to often data specific to savannah region of Nigeria where oil palm production is prominent, this research aimed to study the effect of vascular wilts pathogen on the nutritional contents of oil palm.

MATERIALS AND METHODS

Study Area

his experimental work title ‘the evaluation of fungal diseases of the oil palm (*Elaeis Guineensis* Jacq)’ was carried out in Kurmi Local Government Area of Taraba State. The Local Government lies roughly between Latitudes 5°31' and 7°18'N, longitudes 10°18' and 11°37'E at an elevation of 872 ft (265 m).Kurmi local government Area lies on the south border with Cameroon and these areas are richly blessed with fertile soil which grows a number of cash crops and food crops such as Bananas, Plantains, Rice, Groundnuts, Oranges, Palm trees, Cocoyam and Cocoa. Others include Maize, Guinea corn and Sesame. Kurmi is also a producer of high-quality Timber and the only Local Government with the state-owned abandoned Timber Company which was called Baissa Timber Development Corporation (Terkula, 2012).

Survey Areas

The experimental work titled "The Evaluation of Fungal Diseases of the Oil Palm (Elaeis guineensis Jacq)" was carried out in Kurmi Local Government Area of Taraba State. The local government lies roughly between latitudes 5°31' and 7°18'N and longitudes 10°18' and 11°37'E, at an elevation of 872 ft (265 m). Kurmi Local Government Area borders Cameroon to the south and is richly blessed with fertile soil that supports the growth of numerous cash and food crops such as bananas, plantains, rice, groundnuts, oranges, palm trees, cocoyam, and cocoa. Other crops include maize, guinea corn, and sesame. Kurmi is also a producer of high-quality timber and is the only local government area with the state-owned abandoned timber company, formerly known as Baissa Timber Development Corporation (Terkula, 2012).

Experimental Design

The Complete Randomised Design (CRD) was used. This design is one of the most widely used designs in this regard since it controls the variation in a particular experiment

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Collection of Palm Oil Samples

The infected oil palm seedlings collected from Kurmi Local Government plantations were used for this study. Three farms from each of the five oil palm plantations located in different villages were visited, and ten oil palm seedlings were collected to check for fungal disease infections. For each sample collected, the total disease incidences were recorded and the samples were placed in labeled polythene bags (based on the field location and collection date). The samples were then transported in accordance with quarantine regulations.

Isolation of the Pathogenic Fungi

Oil palm seedlings collected in Kurmi that displayed fungal symptoms were washed with clean tap water, surface-sterilized with 2% sodium hypochlorite for one minute, rinsed in distilled water, and air-dried. Small pieces of leaf from the margins of symptomatic regions were placed in Petri dishes containing potato dextrose agar (PDA) and incubated at room temperature (22°C–25°C) for five days. Pure cultures were obtained by transferring the mycelial tips onto 1.5% (wt/vol) water agar (WA) and allowing them to grow overnight. Hyphal tips of the mycelial growth in the WA were later transferred onto PDA. Slant universal bottles were used to preserve the pure cultures of the pathogen, which were then stored in the fridge at 4°C for later use.

Sterilization of Laboratory Materials

Detergent was used to wash the glassware for the experiment. Inoculation needles, corn borers, and scalpels were dipped into 70% ethanol for sterilization. Glassware such as beakers, pipettes, and agar plates were sterilized by heating at 120°C for an hour in a hot air oven, while the laminar flow hood was cleansed with cotton wool soaked in 70% ethanol. The UV light of the laminar flow hood was turned on for at least 2 hours and turned off before plating the various samples in semi-solidified agar.

Preparation of Growth Media

Potato Dextrose Agar (PDA) was used to isolate the fungi. The medium was prepared by suspending 39 g of the powder in 1000 ml of distilled water (as per the manufacturer's instructions). This was mixed while boiling to completely dissolve the suspension. It was then sterilized by autoclaving at a temperature of 121°C for 15 minutes. The medium was then poured into a sterile Petri dish under sterile conditions and allowed to solidify, according to Adebola *et al*. (2016).

Isolation of Fungal Pathogens

Diseased plant portions were used for fungal isolation. About 2 mm² of plant tissue was cut using a sterile scalpel from the leading edge of the symptomatic area, where fungal growth was most active. After washing with tap water, the tissue was surface-sterilized in a 1% sodium hypochlorite solution for 5 minutes and rinsed in distilled water 4 times, with each wash lasting 1 minute, in 9-cm diameter Petri dishes containing distilled water. Thereafter, 4 pieces of plant material were plated separately on solidified potato dextrose agar in Petri dishes. Constant observation was made for growth and isolation. To obtain a pure culture, sub-culturing was carried out until a pure culture was obtained

Identification of Fungal Pathogens

All microscopic examinations of fungal isolates for identification were done by teasing a small portion of the material with a sterilized needle on a slide using lactophenol and covering it with a cover slip before mounting it on a microscope. Sub-culturing

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was done by cutting a 2 mm² portion of growing mycelium with a sterile needle and placing it centrally on a fresh plate containing PDA. All magnifications were done at X100 and/or X400 based on the clarity of the micrographs. Colony morphology, growth rates, and the presence of pigments identified on PDA, alongside microconidia, were compared with structures in textbooks. Single spores were plated and incubated on water agar for a day, on complete medium for seven days, and on carnation leaf agar for two weeks. Pure fungal cultures raised were identified based on colony morphology and microscopic examination of their spores (Leslie and Summerell, 2001). Number of septa, shape of basal and apical cells, presence of chlamydospores, conidiogenous cells (monophialides and polyphialides), and spore type were all noted. Descriptions of microconidia were aided by the use of the mycological dictionary by Kirk et al. (2001). Terminologies were used to describe colony colors and the nature of their edges, zonation, and texture of aerial mycelium.

Proximate Analysis

Proximate analysis was conducted for both diseased and healthy oil palm (OP) to provide insights into how disease affects their nutritional content and overall quality. The components of the plants analyzed included protein, moisture content, ash, fiber, lipid, and carbohydrate. The results of these nutritional values were recorded and compared for both healthy and diseased OP.

Data Analysis

Data obtained from the experiment were collected and subjected to statistical analysis to obtain adequate interpretation of the findings using version 20 of the SPSS. All the analysis was done using the version 20 edition of the SPSS to obtained the mean, analysis of variance (ANOVA) tables at p value of 5% (0.05) level of significance. All significant mean differences were also separated using the LSD values each of the data at a 5% significant level.

RESULTS

Disease Incidence on Survey of Oil Palms in Kurmi Local Government Plantations

Results from the survey revealed varying levels of vascular wilts incidence across the study sites in Kurmi, Taraba State, Nigeria (Table 1). The incidence of the disease varied significantly ($p = 0.05$) across the five study sites. Kpowola had the highest incidence of vascular wilts in the study area with a mean incidence of 30.0%, followed by Gidam Mallam and Didan with incidences of 26.67% each. Baissa and Mailamba had the lowest incidence of vascular wilts among the villages surveyed, each with an incidence of 23.33%.

Isolation and Identification of Fungal Diseases of the Oil Palm in Kurmi LGA

The fungal pathogen of vascular wilts of oil palm was isolated from diseased plants collected from different oil palm fields in Kurmi, Taraba State, Nigeria. The fungal isolate was identified according to its characteristics appearance on culture media under a light microscope (Plates I).

Proximate Analysis of Diseased and Healthy Oil Palm Seedlings

Table 7 shows the results of the proximate composition of the fungal-infected and apparently healthy oil palm. The results indicate an decrease in moisture (6.68%), ash (3.77%), proteins (7.63%), carbohydrates (58.63%), Lipids (4.95%) and fiber (16.31%) contents in the fungal-infected oil palms compared to the apparently healthy oil palms, which had 9.83%, 5.22%, 11.32%, 66.67%, 7.07% and

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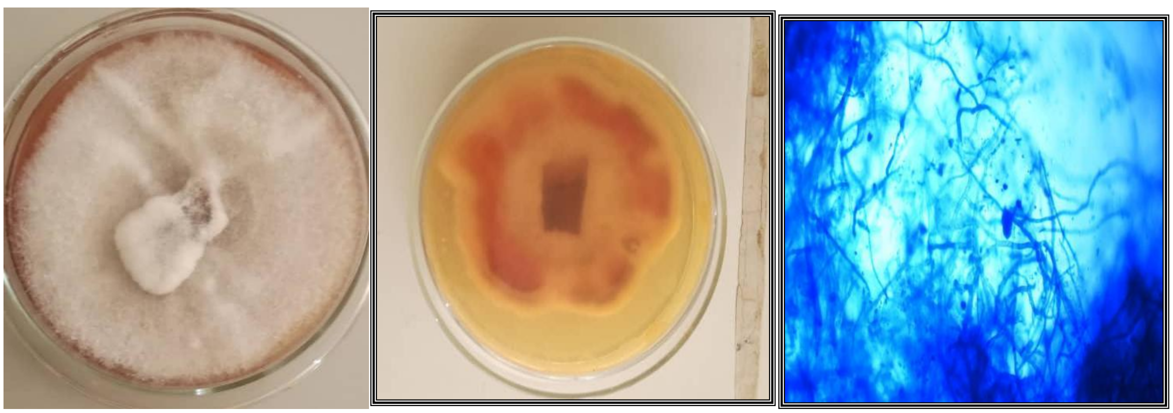
1.21% moisture, ash, proteins, carbohydrates, lipids and fiber contents, respectively.

Table 1: Mean disease Incidences from each village

Disease Incidences	No. of Plant examined	Infected	Healthy	Incidence
Baissa	10	2.33	7.67	23.33
Kpowola	10	3.00	7.00	30.00
Gidan Mallam	10	2.67	7.33	26.67
Didan	10	2.67	7.33	26.67
Mailamba	10	2.33	7.67	23.33
Mean	10	2.60	7.40	26.00
P value				0.9219
LSD				8.0365



A1 A2 A3

Plate I: *Fusarium oxysporium* isolate: (A2) Front plate, (A2) Reverse plate (A3) Micrograph at x10 objective.

Table 2: Mean Proximate Analysis of Diseased and Healthy Oil Palm Seedlings

Composition	Diseased OP Leave	Healthy OP Leaves
Proteins	7.63	11.32
Ash	3.77	5.22
Moisture	6.68	9.83
Fibre	0.69	1.21
Lipids	4.95	7.07
Carbohydrates	58.06	66.67
Mean	13.63	16.89
P value	0.000	0.000
LSD	10.25	6.04

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DISCUSSION

The assessment of disease incidence in Kurmi plantation revealed varying levels of fungal diseases affecting oil palm trees. The prevalence and severity of these diseases could be influenced by factors such as environmental conditions, plantation management practices, and genetic susceptibility of oil palm cultivars. Understanding disease incidence patterns is crucial for implementing targeted disease management strategies and mitigating the economic impact on oil palm production (Kalidas 2013; Ramle *et al*. 2005).

Fussarium oxysporium was the fungus isolated from diseased oil palm samples collected from fields across the oil palm cultivation sites in Kurmi Local Government Area of Taraba State. This fungus has also been reported to have been isolated from oil palm in different parts of the world (Kalidas 2013; Oben *et al*., 2021). Pathogenicity of the fungal isolate was conducted on oil palms seedlings under laboratory and screen house conditions. In all cases, the isolate was pathogenic on the oil palm samples examined. There seemed to be differences in the response to this fungal pathogen on the oil palm on seedlings in the pots.

Proximate analysis of oil palm seedlings provided valuable information on their nutritional status, including levels of moisture, ash, crude protein, fat, fiber, and carbohydrates. The nutritional composition of oil palm seedlings influences their susceptibility to fungal diseases and overall health. By optimizing cultivation practices to ensure adequate nutrition, growers can enhance the resilience of oil palm trees against fungal pathogens and improve overall plantation productivity.

The variation in the nutritional contents of the fungal-infected and apparently healthy oil palm was explained by several scientists across the world. Oben *et al*. (2021) reported that vascular wilt-infected oil palm often exhibits higher moisture content compared to healthy oil palm that can be attributed to the metabolic activity associated with the infection process and water uptake by the plant tissues. Ash content, representing the inorganic mineral content, may vary between healthy and infected oil palm. These alterations in ash content in diseased oil palm may be due to changes in nutrient uptake and metabolism (Ravichandra *et al*., 2015). The diversion of nutrients towards defense mechanisms against the pathogen may result in affect protein synthesis (Ghosh *et al*., 2017). Infected oil palm may exhibit alterations in crude fiber content due to structural modifications induced by wilts infection. Increased crude fiber levels can indicate cell wall thickening or lignification as a response to pathogen attack (Ravichandra *et al*., 2015). Carbohydrate metabolism is significantly affected by vascular wilts infection, leading to changes in carbohydrate composition and content. Reduced carbohydrate levels in infected oil palms may result from disrupted photosynthetic activity and nutrient translocation (Vidhyasekaran *et al*., 2014).

CONCLUSION

It may be concluded from this study that *Fusarium oxysporium* is a common pathogenic fungi which cause vascular wilts in the study area. The result from the pathogenicity test indicated that the isolated fungi is pathogenic and attributed to the cause of vascular wilts for the first time in Kurmi.

It is also clear from the result that fungi not only cause wilts on seedlings but also reduces the nutritional values of fruits as well. Fungal infection may leads to a reduction in carbohydrate and protein contents of the palm kannel which might have a remarkable effect on the value of the oil, especially in the food industry.

We therefore recommended timely spraying of the fruits with fungicides to reduce the damaging activities of the fungal pathogen and contamination with mycotoxins and other related fungal metabolites that might be harzadous to human health.

Since some of these pathogens gain access via wound screated by insect pests, there is also the need for further investigations of the pests causing injuries on karnels, with the aims of reducing their activities.

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