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INCIDENCE OF *Phytophthora* LEAF-BLIGHT DISEASE OF COCOYAM IN NSUKKA AREA OF SOUTH-EASTERN NIGERIA

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Abstract- *Phytophthora* leaf-blight disease incidence was assessed on two local varieties in Nsukka area. The varieties, *Colocasia esculenta* var. *esculenta* (L.) Schott and *Colocasia esculenta* var. *antiquorum* (L.) Schott (Hubbard & Rehder) from three major cocoyam-growing localities- Ede-Oballa, Nsukka-Urban and Obukpa were used in the study. Data obtained were subjected to Analysis of Variance (ANOVA) and the means separated with Fischer's Least Significant Difference (F-LSD). The results showed a high percentage mean incidence of 91.3 and 67.0% in varieties *antiquorum* and *esculenta* respectively, which varied (LSD (P< 0.05) =5.85) significantly. Correspondingly high incidences of 74.2, 86.0 and 77.2% were recorded in the localities respectively LSD (P<0.05) =7.15. These high incidences reflect the scarcity and the exorbitant prizes of cocoyam in Nsukka area. Based on these results, it is apparent that both varieties are highly susceptible to *P.colocasiae* hence; there is the urgent need for the development of adequate control measures possibly via the breeding of resistant varieties.

Keywords- *Phytophthora*, Leaf-blight, Incidence, Nsukka area

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Introduction

Cocoyam (*Colocasia esculenta* (L.) Schott), a tropical aroid is an important traditional staple crop in most parts of the world, especially in the developing countries of the Tropics, Subtropics, Pacific Islands, West Indies and the Mediterraneans [1,2]. It is an ancient crop grown for its edible starchy corms, highly nutritive leaves and for its ornamental and traditional uses [3]. In Nigeria in particular, cocoyam provides an alternative source of carbohydrate to argument yam and cassava. It is cultivated extensively but subsistently for local consumption in the South-Eastern States, *C. esculenta* var. *esculenta* and *C. esculenta* var. *antiquorum* being the most widely grown species. Nigeria is currently the world's largest producer of cocoyam, accounting for up to 4 million tones out of a total of 9.2 million tones produced annually throughout the world [4].

In the past few decades, post harvest diseases caused by a number of pathogens [5,6] and pests were reported as the major constrains for cocoyam production in Nigeria. However, this trend took a drastic change within the past three years due to the outbreak of a devastating epidemic known as Taro Leaf Blight (TLB) or cocoyam leaf rot in the Southeastern States. Cocoyam production has now drastically declined by about 60%. Preliminary investigation has shown that the epidemic was caused by the fungus known as *Phytophthora colocasiae* [7]. Total crop loss due to this disease is now of common occurrence in this region.

TLB has been a major limiting factor to cocoyam production in all cocoyam-growing areas [4,8-15]. It is the most destructive disease of this crop causing yield losses of up to 50% in severe cases and more than 70% in extremely severe cases [16-21]. Symptoms include small, water soaked, round or irregular, dark brown necrotic lesions on the adaxial leaf lamina. Lesions enlarge rapidly by centrifugal growth and coalesce to form dark brown irregular necrotic areas having concentric colour patterns, which cover the entire leaf and damage it within a few days. Orange or reddish-brown exudates ooze from the spots and develop into dark brown hard pellets as they dry. Heavy losses due to TLB have been recorded in Asia and the Pacific [1,2,4-6,11-24].

The situation in Nsukka zone (Northern part of Enugu State of Nigeria) since the outbreak of this disease has reached alarming proportions due to the lack of cocoyam for local consumption, and the resultant exorbitant prizes in the local markets. Local farmers and consumers look up to the scientists to proffer solutions and salvage the ugly situation. Given the recent outbreak of the disease in Nsukka there is neither scientific data on the disease nor effective control measures. Consequently, a comprehensive knowledge of the incidence of this disease constraining cocoyam production in Nsukka and other parts of Nigeria is needed. Therefore, the objectives of this study were to determine the incidence of *Phytophthora*-blight on two local varieties in three major cocoyam-growing areas in Nsukka and to assess their susceptibility to the pathogen.

Materials and Methods

Assessment of Disease Incidence

Two varieties of cocoyam, *Colocasa esculenta* var. *esculenta* and *Colocasia esculenta* var.*antiquorum* were investigated for leaf-blight

incidence in three locations: Ede-Oballa, Nsukka-Urban and Obukpa all in Nsukka. Five sites per location and three farms per site were selected. In each farm, a square measuring 4m x 4m (mini plot) was marked out and pegged. Plants with characteristic disease symptoms as seen in Plates 1-5 were evaluated. Observations of disease incidence from each mini plot were recorded by counting the number of infected plants as well as overall total number of plants. The formula of Onyeke, et al. [25] was adopted for the calculation of the percentage leaf blight incidence on each variety.

Thus:

$$\text{Percentage Blight Incidence (PBI)} = \frac{\text{No. of infected plants (Nip)}}{\text{Total No. of plants (Tnp)}} \times 100$$

The experiment was laid out in a 2×3×5 factorial in completely randomized design.

Data Analysis

The data were subjected to Analysis of Variance (ANOVA) at 5% level of significance and means were separated with Fischer's Least Significant Difference (F-LSD). A multi-location Analysis of Variance was done for the three locations and their means were compared with LSD. The main effects of varieties, locations, sites, and their interactions on incidence were determined.

Results

The Main Effect of Variety on Disease Incidence

The results of the disease survey revealed high disease incidence in both varieties that differed significantly (LSD (P≤0.05) = 5.84). The variety *antiquorum* recorded higher percentage mean incidence (91.3%), which differed significantly forms 67.0% recorded by variety *esculenta* [Fig-1].

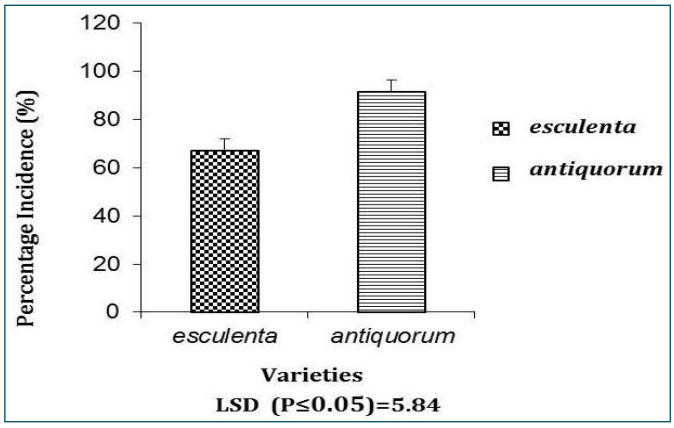

Fig. 1- The main effect of variety on the incidence of leaf blight disease

The Main Effect of Location on Disease Incidence

[Fig-2] shows the main effect of location on the incidence of leaf-blight disease. Leaf blight incidence was very high and differed significantly (LSD (P≤0.05) =7.15) between Nsukka-urban and Ede-Oballa; and Nsukka-urban and Obukpa. Nsukka had the highest percentage mean incidence of 86.0% and the least 74.2% was at Ede-Oballa. There was no significant difference between Ede-Oballa and Obukpa.

The Main Effect of Site on Disease Incidence

The main effect of sites on leaf-blight incidence varied across the sites (S1-S5) [Fig-3]. The highest percentage mean incidence of 86.0% was at S2 and the least 70.4% was for S4. Statistical analysis LSD (P≤0.05) =9.23 (site) showed no significant difference between these combinations; S1/S2, S1/S3, S1/S5, S2/S3, S3/S5 and S4/S5. But, S2/S4, S2/S5 and S3/S4 varied significantly.

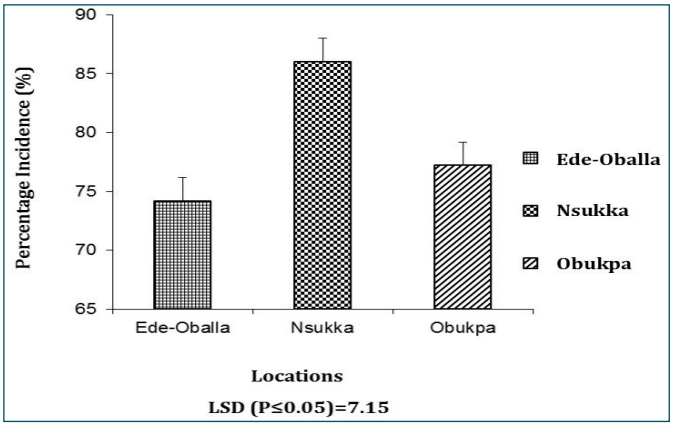

Fig. 2- The main effect of location on the incidence of leaf blight disease

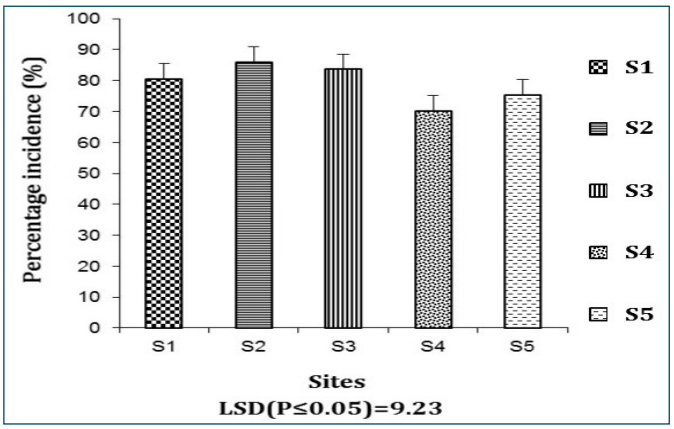

Fig. 3- The main effect of site on the incidence of leaf blight disease

The Interactive Effects of Variety and Location

The interactive effects of variety and location on leaf blight incidence are shown in [Table-1]. In the three locations disease incidence varied in both varieties. The var. *antiquorum* had higher mean percentage incidence than var. *esculenta* in all the three locations. Statistical analysis LSD(P≤0.05) = 10.11(interaction) showed that incidence in both varieties differed significantly at Obukpa and Ede-Oballa but not at Nsukka. In the var. *esculenta*, there were highly significant differences in disease incidence at Ede-Oballa and Nsukka and at Obukpa and Nsukka but not at Ede-Oballa and Obukpa. On the other hand, disease incidence in the var. *antiquorum* did not vary significantly across the three locations.

Table 1- The interactive effects of variety and location on the incidence of leaf blight disease of cocoyam

Cocoyam varieties	Locations		
	Ede-oballa	Nsukka	Obukpa
Antiquorum	86.8	90.8	96.1
Esculenta	61.7	81.2	58.2

$LSD_{0.05}$ *(interaction) = 10.11*

The Interactive Effects of Variety and Site

Leaf blight incidence also varied across sites in the two varieties. [Table-2] shows the interactive effects of variety and site on leaf blight incidence. The percentage mean incidence recorded across

the five sites (S1-S5) ranged from 50.7-81.5 for var. *esculenta* and 89.6-94.8 for var. *antiquorum*. The var. *antiquorum* had higher incidences than *esculenta* in all the sites. Statistical analysis LSD (P≤0.05) = 13.06 (interaction) showed that there was no significant difference between the sites in *antiquorum* whereas in *esculenta,* there were significant differences between some sites. S4 and S5 did not vary significantly in var *esculenta* but each varied significantly with S1, S2 and S3.

The Interactive Effects of Locations and Sites

The interactive effects of sites and locations on the percentage blight incidence are shown in [Table-3]. The highest incidence 98.4% occurred at Nsukka in S2 and the least 63.0% at Ede-Oballa, S1. Statistical analysis LSD (P≤0.05) =15.99 (interaction) showed that at Ede-Oballa incidence varied significantly between S2 and S1, and between S2 and S5 but not with the other sites, while at Nsukka all the sites varied significantly with S4 but not amongst themselves. At Obukpa S2 and S4 varied significantly with S1 and S3 but not with each other and S5.

Table 2- The interactive effects of variety and sites on the incidence of leaf blight disease of cocoyam

Cocoyam varieties	Sites				
	S1	S2	S3	S4	S5
Antiquorum	89.6	90.5	91.7	89.8	94.8
Esculenta	71.7	81.5	75.5	50.7	55.8

LSD (P≤ 0.05) = 13.06 (interaction)

Table 3- The interactive effects of sites and locations on the incidence of leaf blight disease of cocoyam

Locations	Sites				
	S1	S2	S3	S4	S5
Ede-Oballa	63	89.7	79.1	75.1	64.3
Nsukka	86.6	98.4	89.3	69	86.8
Obukpa	92.3	69.9	82.3	66.6	74.9

LSD (P≤0.05) =15.99 (Interaction)

Discussion

The results of the present study have shown high disease incidence (above 50%) in both varieties indicating that these varieties are highly susceptible to *Phytophthora* leaf blight. This is indicative of a great risk of crop loss by farmers in Nsukka area and not only would they contend with reduced levels of produce but also with the additional cost of control. The results also showed that the var. *esculenta* was more resistant to the pathogen than var. *antiquorum.* The higher resistance of var. *esculenta* could be due to varietal differences or to the presence of greater quantities of phenols and polygalacturonase inhibitors that are known as disease resistant compounds [23] but the levels were not high enough to confer immunity. The findings of the present study are at slight variancce with the results of Mehrotra and Aggarwal [17] who reported in India that both varieties (*esculenta* and *antiquorum*) were equally susceptible to *Phytophthora* leaf blight. This slight variation could be attributed to differences in environmental factors between India and Nsukka, in Nigeria.

The high percentage mean incidence of the disease at the three locations is indicative of the prevalence of the disease. Only the incidence at Nsukka-Urban was significantly higher than those at the other two locations. Misra [21] obtained similar results at an extensive survey of major *Colocasia* growing areas in Northern and Southern parts of India. He reported that out of 128 *Colocasia* fields sampled in1988, 94% of the fields were infected by leaf blight. The following year 164 fields were sampled and 92% showed blight infection. Mehrotra and Aggarwal [17] attributed variations in disease incidence from one location to another to differences in inoculum potentials across these locations and this is subject to the time of commencement of the epidemic in each site. They observed that the place where the disease started first under favorable conditions produced higher inoculum and higher disease and vice versa. Significant differences exhibited between two locations also suggest that each distinct location influenced the disease in a unique manner probably due to other micro-climatic factors like vegetation, soil type and fertility peculiar to each environment.

Our results have shown that the effect of site on disease incidence varies from one location to another but was not very remarkable. While a few sites within a location showed significant differences, most of the sites were not significantly different. This could be attributed to differences in agronomic practices observed by each individual farmer before, during and after planting. While some farmers may apply adequate fertilizer to their farms before planting, others may not. Preliminary findings have indicated that intercropping and adequate fertilizer treatment may help the plant to cope with leaf blight [22,26]. Jackson [14] observed that wide spacing of plants and avoiding planting near an infected plot reduced disease incidence and severity. In addition, Misra [20] reported that time of planting affects incidence and severity of *Phytophthora* leaf blight. Some farmers planted their crops long before the outbreak of the infection while others planted just before the infection or after the infection. It has been suggested that in some plant-pathogen interactions such as *Pythium* damping off, downy mildews, *Phytophthora* diseases and viral infections, the hosts which have attained reasonable maturity and vigor before the outbreak of an infection, would show more resistance to the infection than those in their juvenile stages [9,17]. This phenomenon is known as ontogenic resistance. In this regard, farmers who planted their crops long before the incidence of this disease are likely to have less disease on their crops than those who planted at the time of the disease.

Environment has been recognized as one of the major factors that can influence the process of an epidemic, having the capacity to induce or retard it [9]. The interactive effect of the different environments and varieties on the blight disease showed that the disease is more variety dependent in the Nsukka area since the three locations surveyed all fall within the same climatic zone [24] and had similar weather parameters. Results have shown that across these three locations, var. *antiquorum* had similar disease incidence. On the other hand, var. *esculenta* had varied results. This probably suggests that there were higher levels of genetic uniformity in *antiquorum* than in *esculenta*. The implication of this is that *esculenta* may have greater chances of resisting a new race of the pathogen that can attack the genome of these varieties if there was an epidemic [9]. In view of this, there is the need to screen cultivars from various locations within Nigeria for resistance to this disease in order to produce resistant varieties suitable for our Nigerian weather. This has been done in many Pacific countries where the disease started and good results have been recorded [10-12].

The impact of cocoyam leaf blight on Nsukka indigenes, the subsequent loss of cocoyam genetic resources, and the continuing vulnerability of other parts of the country to the disease should be the driving force towards the development of sustainable strategies for the management of this disease. From the above results, it is ap-

parent that the two most common *Colocasia* varieties in Nsukka were susceptible to *Phytophthora* leaf blight hence the development of genetically resistant cultivars along side with good phytosanitary measures are paramount to solving this problem.

Conflict of Interest : None declared.

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