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Influence of Soil Types on the Performance of Cocoyams in the Humid Environment of Rivers and Bayelsa States of Nigeria

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Abstract: *Studies were done on the edaphic factors and their effects on the performance of cocoyam in the humid environment of Rivers and Bayelsa States of Nigeria. Fungal incidence in the three zones of Rivers and Bayelsa States namely, coastal plain sands (Igbo and Baen), Warri-SombreicDeltaic plain (Obrikoin and Ahoada) and Meander Belt (Agudama and Kaiama) were studied. The following micro-organisms (fungi) were isolated.From Igbo, Aspergillusniger, Mucorsp, Peniciliumsp, Rhizopusstolonifer, Aspergillusflavus, Sclerotiumrolfsii.Aspergillusniger, Mucorsp, Aspergillusflavus, Penicillumsp, Rhizopusstolonifer, Fusariumsp were isolated from Baen soil. Mucorsp, Aspergillusflavus, Rhizopusstolonifer, Sclerotiumrolfsii; Aspergillusflavusfrom Obrikon, while Fusariumsp, Penicilliumsp, Rhizopusstolonifer, Mucorsp, Aspergillusniger and Aspergillusflavuswere isolated from Ahoada soil. The following micro-organisms were isolated from Agudama: Aspergillusniger, Rhizopusstolonifer, Penicillumsp, Aspergillusflavusand Mucorsp while Rhizopusstolonifer, Aspergillusniger, Aspergillusflavusand Penicilliumspwere isolated from Kaiama soils.Soils rich in nutrients such as Potassium, nitrogen and phosphorus tended to have low fungal population and better agronomic traits and yield.*
Keywords: *Colocasiaesculenta; cormel; fungal; incidence; yield; Xanthosomamafaffa.*

I. Introduction

Xanthosomamafaffa and Colocasiaesculenta are tropical crops commonly referred to as Cocoyamswhich belong to the Araceae family. They are all native to tropical central and South America and the Caribbean (Montaldo, 1991).

The crops have multiple vernacular names. In Nigeria, taro refers to Colocasiaesculenta whereas Tannia refers to Xanthosomamafaffa. Two main cultivars each of taro and tannia exist in Nigeria. They are C. eculentac.v “cocoindia” C. esculentac.v “edewachukwu” Xanthosomamafaffa c.v. “Edeuhie” and X. mafaffac.v “Edeocha”. The cultivars differ in the relative ratio of corms and cormels they produce.

They are used as subsistence staples in many parts of the tropics and subtropics in Africa. They produce starch storage corms and cormels. Investigations have shown that cocoyams contain digestible starch protein of good quality, fats and vitamins, thiamin, riboflavin and niacin and have high scores of proteins and essential amino-acids. (Onayemi and Nwigwe, 1987. Tambonget al, 1997; Torres et al, 1994; Lebot and Aradhya, 1991; Onokpiseet al, 1999). The high carbohydrate content of new cocoyam and its wide availability makes it a very good source of starch for both domestic and industrial uses in Nigeria and tropical Africa. (Adebowale and Lawal, 2002b)

World production of the crop is estimated to be 5.5 million tonsannually and provides about a third of the food intake of more than 400 million people in the tropics (FAO 1991). More than three quarters of the world cocoyam production come from Africa, with Ghana and Nigeria being the world’s leading producers (Onwueme, 1982). Although it is important staple food crop in many tropical countries, cocoyam has received low research priority (Goenaga and Hepperly, 1990).

According to Goenaga and Chardon (1995), yield potential is seldom realized mainly because of lack of knowledge concerning disease, proper management practices and physiological determinants that may limit the growth and development.

Loss of corm and cormels has been attributed to the occurrence of these disease hence decline in the production of crop.An estimated loss of 40 – 45% of corms and cormels has been recorded (NRCRI, 1979 – 1980). Notable among such diseases is Cocoyam Decline Disease (CDD) a field disease which is well known in Nigeria, particularly southern Nigeria. The field symptoms include necrosis, shriveling of the affected parts, premature death of aerial portion of the plant, poor production of cormels and reduced corm sizes. Rotted roots are the most characteristic symptom.

This work therefore is aimed at investigating the impact of soil types on the performance of cocoyam in Rivers and Bayelsa States, Nigeria

II. Material And Methods

StudyArea

The study was conducted in two States; Rivers and Bayelsa in the Niger Delta region of Nigeria. The region has an annual rainfall range of 2000 to 2500 mm and a temperature range of 25 to 28^{o}C (FAO, 1984). Three soil types with two locations per soil type were selected for the study. The locations were Igbo-Etche and Baen; Ahoada and Obrikom; Agudama and Kaiama, for the coastal plain sand, Warri-SombreicDelta plain and Meander belt soil types, respectively. In each location, land was prepared and relatively healthy cocoyam, (Xanthosomaand Colocasiaspecies)corms were planted at a spacing of 0.6 x 0.6m per plot measuring 2.4 x 2.4m.

Four treatment (cultivars) replicated four times were used in a Randomized Complete Block Design. The cultivars were: Xanthosomamafaffa (c.v. 'Edeuhie' and 'Edeocha') and Colocasia (c.v. 'Cocoindia and 'Edenwachukwu'). Pathogenicity studies were carried out at the Soil Science laboratory of the Rivers State University of Science and Technology, Port Harcourt, Nigeria.

SoilAnalysis

All soil analysis were done according to procedures outlined by Tel and Rao (1982). Soil samples from five points at 0 – 15cm were collected per location for chemical analysis in the laboratory. Samples were air dried and analyzed in the laboratory for soil pH with Coleman pH meter using soil "saturation extract". (Soil – water, 1:1 ratio v/vol) and soil – PotassiumChloride ratio 1:2:5 w/vol. Total N was determined by the semi-micro kjeldahl digestion method as modified by Tel and Rao (1982), while available P was determined by the Bray and Kurtz No. 1 method (Tel and Rao, 1982). Exchangeable K was extracted with neutral normal ammonium acetate buffered at pH 7.0 Potassium (k). In the extract was measured by flame photo – meter (Tel and Rao, 1982). Ca and Mg in the extract were determined by EDTA complex metric titration (Tel and Rao 1982).

Isolation of Fungi from Soil Samples

Soil samples from five points at 0 – 15cm and 15 – 30cm depth were collected from each location, composited and placed into sterile polythene bags and immediately taken to the laboratory for isolation of micro-organism and chemical analysis. The samples were air-dried and Potato Dextrose Agar, PDA was used in the isolation of fungi. One gram of air-dried soil samples each at 0 – 15cm and 15 – 30cm depths were individually added to 25ml sterile distilled water. The soil suspension was thoroughly shaken and serially diluted three times. Each dilution was kept in sterile petri-dish. PotatoDextroseAgar, PDA was poured onto suspension and mixed thoroughly and allowed to set. They were left on the laboratory bench at 28 ± 1℃ for 4 days. Pure cultures of developing micro-organism were prepared and were identified using a light microscope. The fungi were identified on the basis of spore characteristics, colour, and the nature of hyphae. Viable counts were also made and recorded as colony forming unit (c.f.u) after 3 days of incubation.

GrowthParameters

Data on the following were collected:
Leaf area, height of plant, size of cormels, number of cormels, weight of cormels.

Leaf Area: The leaf area was obtained by multiplying length and breadth of the leaves by (5.00109 + 0.9984) (Igbokweet al, 1984)

Height of plant

This was taken to be the distance between the base of the sprout above the soil surface to the end of the plant. It was measured with the aid of a meter rule.

Size of cormel: The size of the cormel was determined by the use of a measuring tape to ascertain the circumference of the corm.

Number of cormels: The number of cormels per plant were counted after harvest.

Weight of cormel: The weight was measured with a scale balance – Sartorius 2250 series.
Data obtained from the study were subjected to Analysis of Variance (ANOVA), and means were separated using Least Significant Differences (LSD) method where significant differences occurred. Correlation and Regression analysis were also carried out to determine relationship among parameters

III. Results And Discussion

Soil Properties of Sampled Plots and Fungal Population.

Soil properties of sampled plots and fungal population are shown in Table 1

The fungal population of the various plots surveyed revealed that soil fungal population was highest at Igbo ((3.80×10^4) and (2.90×10^4) at 0 – 15cm and 15 – 30cm depth respectively), followed by Baen (3.50×10^4 and 2.30×10^4 at 0 – 15cm and 15 – 30cm depth respectively), Obrikom (2.7×10^4 and 2.00×10^4 at 0 – 15cm and 15 – 30cm depth respectively), and least in Kaiama (0.65×10^4 and 0.80×10^4 at 0 – 15cm and 15 – 30cm depth respectively). The soil chemical properties varied across the locations. Soil pH was highest at Baen followed by Ahoada and least at Obrikom. Nitrogen levels was observed to be highest at Agudama and least at Kaiama plot. Consequently, the fungal population were least at Kaiama plot. Calcium and Potassium were highest inKaiama (153.67 and 377.81 Cmolkg^{-1} at 0 – 15cm depth respectively).

Calcium was lowest at Ahoada (6.71 Cmolkg^{-1} at 0.15cm depth) while phosphorus was lowest at Igbo (0.45 CmolKg^{-1} at 0 – 15cm depth) Apparently soils with rich nutrients such as Potassium, nitrogen and phosphorus as shown in Table 2 tended to have low fungal population. This implies that high soil nutrient inhibited the growth of fungi in the soil. This agreed with the findings of Onuegbu (1995) Onuegbu and Chukwunda (2001) and NRCRI (1986) who reported the reduction of cocoyam decline disease with increased level of N, P and K in soils

TABLE 1: Soil Properties of Samples PlotsandFungalPopulation

Parameters	Igbo		Baen		Obrikom		Ahoada		Agudama		Kaiama	
	0 – 15cm	15 – 30cm	0 – 15cm	15 – 30cm	0 – 15cm	15 – 30cm	0 – 15cm	15 – 30cm	0 – 15cm	15 – 30cm	0 – 15cm	15 – 30cm
pH	4.27	4.00	5.65	5.71	3.98	4.01	5.47	5.57	4.18	4.48	4.14	5.59
Nitrogen (%)	0.098	0.131	0.111	0.098	0.105	0.088	0.118	0.094	0.162	0.152	0.094	0.071
Phosphorus (mgkg^{-1})	0.45	0.41	0.89	0.87	0.48	0.39	0.68	0.52	0.50	0.60	0.55	0.76
Potassium (cmolkg^{-1})	64.61	47.84	48.83	59.57	35.53	38.25	75.71	31.03	199.54	339.68	377.81	766.72
Calcium (cmolkg^{-1})	14.48	4.92	97.92	112.94	23.87	3.62	6.71	8.62	52.68	10.61	153.67	258.73
Fungal Population ($\mathrm{c.f.u/g\ soil} \times 10^4$)	3.80	2.90	3.50	2.30	2.70	2.00	2.10	1.90	1.80	1.60	0.65	0.80

The result on leaf area is shown in table 2.

Table 2:Leaf Area (cm^2) at various Locations.

Cultivar	Location					
	Igbo	Baen	Obrikom	Ahoada	Agudama	Kaiama
X. mafaffa c.v. Ede-uhie	4013.66	5187.34	5252.40	5590.26	3816.58	4999.08
X. mafaffa c.v.Edeocha	7731.69	7361.07	8120.67	9150.78	7413.87	6494.43
C. esculenta c.v. coco india	476.04	754.31	701.62	871.47	770.51	892.81
C. esculenta c.v. Edenwachukwu	1191.84	1246.55	1211.81	1380.15	1425.71	1517.04
$LSD_{(0.05)}$	221.45	270.81	351.23	261.72	268.91	506.25

In general, the leaf area of cocoyam cultivars zones and locations. For example in Warri Sombreic Deltaic Plain, WSD (Obrikom and Ahoada) of Rivers State, the Xanthosoma (Edeufie and Edeocha) cultivars recorded the largest leaf area, while the Colocasia (Edenwachukwu and Cocoindia) cultivars recorded the largest leaf area in Meander belt (Agudama and Kaiama).The coastal plain sands (Igbo and Baen) recorded the smallest leaf area in both Xanthosoma and Colocasia cultivars.

A similar observation was made in the plant height as shown in Table 3.

Table 3:Height of plant (cm) across locations

Cultivar	Location					
	Igbo	Baen	Obrikom	Ahoada	Agudama	Kaiama
X. mafaffa c.v. Ede-uhie	60.80	73.63	70.92	76.53	74.08	70.50
X. mafaffa c.vEdeocha	55.18	60.25	68.85	81.60	73.80	75.93
C. esculenta c.v. coco india	62.80	59.68	66.73	71.15	86.00	92.18
C. esculenta c.v. Edenwachukwu	86.88	81.88	77.95	90.66	94.30	99.35
$LSD_{(0.05)}$	3.25	3.14	2.45	4.82	5.07	2.28

The Colocasiavarieties: Edenwachukwu and cocoindia ranked highest in Meander belt (Kaiama plots).

Warri Deltaic Sombreic Plain (Ahoada plot) produced the tallest plant among Xanthosoma cultivars (Edocha and Edeuhie). While the least plant height was recorded by Igbo and Baen plots: (Coastal plain sands) among the Xanthosoma (Edeocha and Edeuhie) cultivars and Colocasia cultivars (cocoindia) respectively.It thus suggest that soil rich in nutrients such as Nitrogen, Calcium, Potassium and Phosphorus not only inhibit the growth of fungi in the soil but also enhances the growth and performance of cocoyam.

As stated earlier, calcium, Potassium, and copper were highest in Kaiama soil while Nitrogen was highest in Agudama soil. The cocoyam cultivars performed better on these soils compared to the soils of Igbo and Obrikom that were low in these nutrients.

Yield and Yield Components

The weight of cormels of the various cocoyam cultivars across the locations are presented in Table 4.

Table 4:Weight of Cormels (t ha^{-1})

Cultivar	**Location**					
	Igbo	Baen	Obrikom	Ahoada	Agudama	Kaiama
X. mafaffa c.v. Ede-uhie	5.376	4.799	6.194	7.320	5.166	5.994
X. mafaffa c.v.Edeocha	3.984	6.645	4.095	5.670	3.840	5.025
C. esculenta c.v. coco india	2.180	4.125	3.241	4.867	6.345	6.688
C. esculenta c.v. Edenwachukwu	3.125	4.497	2.847	4.391	5.110	8.366
LSD (0.05)	1.625	1.312	1.150	1.562	1.273	1.251

Results from yield parameters showed that Colocasia cultivars (Edenwachukwu and Cocoindia) performed best in Meander belt (Kaiama and Agudama).

The plots (Zone) produced yields comparatively higher than other locations. The highest yield among Xanthosoma cultivars was seen in Ahoada and Baen for Edeuhie and Edeocha respectively.

Igbo maintained the same trend of poor agronomic traits which was also reflected on yield. It therefore implies that agronomic traits of cocoyam cultivars impacts significantly on yield.

The result on the number of cormels are shown in Table 5.

Table 5:Number of Cormels

Cultivar	**Location**					
	Igbo	Baen	Obrikom	Ahoada	Agudama	Kaiama
X. mafaffa c.v. Ede-uhie	8	6	5	6	3	5
X. mafaffa c.vEdeocha	2	4	3	4	3	6
C. esculenta c.v. coco india	4	6	4	5	6	8
C. esculenta c.v. Edenwachukwu	2	3	2	3	7	13
LSD (0.05)	2.00	2.05	1.72	1.80	2.11	2.30

The number of cormels followed the same trend as weight of cormels for Colocasia (Edenwachukwu and cocoindia) cultivars in Kaiama plot (Meander belt) which had the highest number of cormels.However, this trend was not observed in the other cultivars and locations.Igbo plot (coastal plain sands) which had the highest number of cormels for Xanthosoma (edeuhie) cultivars did not record the highest weight of cormels. It therefore, implies that the number of cormels does not affect yield to any appreciable extent.

Table6: Size of Cormels

Cultivar	**Location**					
	Igbo	Baen	Obrikom	Ahoada	Agudama	Kaiama
X. mafaffa c.v. Ede-uhie	10.48	12.10	12.96	15.52	14.20	13.10
X. mafaffa c.vEdeocha	13.76	15.47	11.49	14.58	12.41	13.63
C. esculenta c.v. coco india	11.36	12.28	13.00	12.66	14.05	14.65
C. esculenta c.v. Edenwachukwu	8.87	11.38	9.30	13.85	13.14	12.07
LSD (0.05)	2.51	Ns	1.31	1.72	1.14	Ns

Results from size of cormels followed the same trend as weight of cormels.

The plots (zones) which recorded highest weight of cormels among cultivars also recorded largest size of cormels. For example; Kaiama and Agudama plots (Meander belt) which recorded high weight of cormels among Colocosia (edenwachukwu and cocoindia) cultivars also recorded the largest size of cormels among the same cultivars.

The same observation was among the Xanthosoma cultivars. Ahoada and Baen plots which had the highest cormel weight also recorded the highest cormel size for Edeuhie and Edeocha respectively, it therefore suggests that size of cormels affects weight of cormels to an appreciable extent.

IV. Conclusion

This study indicated that soil chemical properties such as Nitrogen, Potassiumand Calcium inhibited the growth of fungi in the soil. The fungal population declined as the soil nutrients increased. Cocoyam cultivars performed well in soils rich in these nutrients. Colocasia cultivars performed better in meander belts soils while Xanthosoma cultivars performed better in Warri Sombreic Deltaic Plain (WSD) soils.

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