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Distribution of fungi and bacteria in the soils of the University of Ilorin Teaching and Research Farm

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ABSTRACT

The occurrence of fungi and bacteria in Afon, Tanke, Badi, Bolorunduro and Ilemona soils of the University of Ilorin Teaching and Research Farm and the impact of some physicochemical properties of the soils on distribution of microorganisms were studied. The soil dilution technique was used to isolate bacteria and fungi on Nutrient Agar and Potato Dextrose Agar Plates respectively. Cultural and microscopic characteristics were employed in the identification of isolates. The population density of fungi in the soils was in the order Afon > Ilemona > Tanke > Bolorunduro > Badi series while that of bacteria was in the order of Afon > Tanke > Bolorunduro > Badi > Ilemona series. The high microbial load of Afon series was attributed to a combination of factors such as its relatively high organic matter content (0.20%) and Effective Cation Exchange Capacity (9.93), the sandy loam texture and the pH (5.7). A variety of fungal and bacterial species associated with nitrogen fixation and organic matter decomposition were isolated from all the soils. The mycoflora of Ilemona soil was dominated by saprophytic *Aspergillus* spp while plant pathogenic moulds such as *Colletotrichum* and *Fusarium* species occurred frequently in the other soils. The frequency of occurrence of *Colletotrichum* sp in Afon was 52%, while *Fusarium* spp was 87% in Badi, 36% in Tanke and 5% in Bolorunduro. The occurrence of enteric bacteria in high numbers in Bolorunduro and Ilemona soils was attributed to the presence of grazing cattle in the farmlands. It was concluded that for optimum crop yield, Afon, Badi, Tanke and Bolorunduro soils need to be treated with appropriate fungicides before the cultivation of crops.

INTRODUCTION

Soil microorganisms play a very significant role in soil formation, organic matter decomposition and in the transformations of toxic metabolites in soil. They produce enzymes that allow them to use such toxic compounds as food. The action of soil microorganisms make essential elements such as nitrogen, sulphur, phosphorus, iron and manganese available to plants (Lambert *et al*; 1979). Also, some soil microorganisms act to protect plant roots from invasion by soil parasites and pathogens by producing antibiotics and intracellular enzymes (Gilbert *et al*, 1994).

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The Teaching and Research Farm of the Faculty of Agriculture University of Ilorin was set up in 1984/85 academic session as field laboratory for students of Agriculture and staff researchers in the field of Agriculture. It was to serve as a place for practical farming and application of research findings to foods and raw materials production (Fasakin. 1985).

A pedological study of the soils of the University of Ilorin Teaching and Research farm was carried out by Ogunwale *et al.* (2000). Five soil series namely Afon. Bolorunduro. Badi. Ilemona and Tanke were reported based on physicochemical characteristics. There is however no information on the microbial ecology of the soil series in the Teaching and Research Farm.

This research work was thus carried out to study the occurrence of fungal and bacterial species and the impact of physicochemical characteristics of the soil series in the Teaching and Research Farm on the distribution of the microorganisms. Such information on the microbial ecology of the soil series of the University of Ilorin Teaching and Research Farm would be useful in manipulating the soil environment for improved crop yield and achievement of the objectives for setting up the farm.

MATERIALS AND METHODS

Sources of soil samples

Soil samples were collected from profile pits of five soil series in the Unilorin Teaching and Research Farm using the random sampling method. Auger samples were collected from each of the sampling unit at 15-30cm. The soil samples were transported to the laboratory in well-labelled polyethylene bags. The core samples were then air-dried and passed through a 2mm sieve. The physicochemical and microbial analyses of samples were then carried out.

Physicochemical analyses

Particle size analysis of the soil samples was by the hydrometer method of Bouyoucos (1951). The cation exchange capacity (CEC) and exchangeable bases (K. Ca. Na. Mg.) were determined by ammonium acetate method of Chapman (1965). The effective CEC was then calculated by the sum of exchangeable bases and total acidity (Al. H). The total soil nitrogen was determined by the Macrokjedahl analysis (Bremner.

1965). Soil pH was measured in suspension of soil in water using a Pye Unicam model 292-mk2 pH meter. The wet oxidation method of Walkley and Black (1934) was used in the determination of soil organic carbon. The organic matter content was then calculated by multiplication with a correcting factor (1.74). The Bray 1 method was used in the determination of available phosphorus (Murphy and Riley, 1962).

Microbial analyses

Culture media used for the isolation of fungi and bacteria were Potato Dextrose Agar (PDA) and Nutrient Agar (NA) respectively. In estimating the fungi and bacteria population, ten fold serial dilutions of soil suspensions were made in sterile water. The pour plate technique was used to culture fungi and bacteria from 10^{-3} and 10^{-5} soil dilutions respectively. The PDA plates were incubated at 28° ± 2°C for 3-5 days while the NA plates were incubated for 24 hours. After the incubation period, colony-forming units were counted. The frequencies of occurrence of isolates were then calculated. The standard errors of data collected from triplicate determinations were also calculated. Bacteria isolates were identified with the aid of cultural characteristics, cell morphology and a number of physiological and biochemical tests such as motility test, catalase test, anaerobic growth, and sugar fermentation tests with reference to Baird-Parker (1974). Cultural and microscopic morphological characteristics were also employed in the identification of fungal isolates with reference to Gilman (1978). The identification of the *Fusarium* species was based on the pigmentation of colonies, presence of chlamydospores, and the structure of micro & macroconidia (Marasus *et al.*, 1983).

RESULTS

Physicochemical characteristics of the soils of University of Ilorin Teaching and Research Farm

Table 1 shows the physicochemical characteristics of the University of Ilorin Teaching and Research Farm. Bolorunduro, Tanke and Ilemona series had loamy sand texture while Afon and Badi series are sandy loams. The pH range recorded for the five soil series was 5.7 to 6.8. Ilemona series had a higher organic matter level (0.28%) and higher total nitrogen (3.4%) than other soil series. The lowest level of organic matter

(0.15%) and lowest level of Effective Cation Exchange Capacity [ECEC] (5.63 cmol/kg) were observed in Bolorunduro series. Tanke series had the highest available phosphorus but the lowest total nitrogen content. The ECEC and total acidity were highest in Afon series. Least total acidity was recorded in Badi series.

Table 1: Some physicochemical characteristics of the soils of the University of Ilorin Teaching and Research Farm

Characteristics	Soil Series				
	Bolorunduro	Afon	Badi	Ilemona	Tanke
pH	6.4	5.7	6.3	6.4	6.8
OM (%)	0.15	0.2	0.12	0.26	0.18
Ca (cmol kg)	2.7	7.9	6.7	1.5	6.4
Mg "	2.2	1.3	0.7	4.4	1.2
K "	0.2	0.14	0.22	0.14	0.15
Na "	0.11	0.12	0.10	0.18	0.13
Total acidity	0.42	0.47	0.30	0.4	0.31
EFEC	5.63	9.93	8.02	6.52	8.19
Available P (ppm)	12.02	8.6	9.75	13.36	12.14
Total N (%)	1.7	2.8	1.0	3.4	0.6
Texture	LS	SL	SL	LS	LS

OM Organic Matter
ECEC Effective Cation Exchange Capacity.
LS Loamy sand
SL Sandy loam

Occurrence of Fungi and Bacteria in the soils of University of Ilorin Teaching and Research Farm

The total fungal and bacterial count of the soils of University of Ilorin Teaching and Research Farm are shown in Figure 1. Population of fungi followed the order: Afon > Ilemona > Tanke > Bolorunduro > Badi series while the total population bacterial count was in the order of Afon > Tanke > Bolorunduro > Badi > Ilemona series.

Table 2: Frequency of occurrence of the predominant bacteria species in the soils of University of Ilorin Teaching and Research Farm

Soil Series	Predominant Bacteria species	% Frequency of occurence
Afon	*Nitrosococcus sp*	34
Badi	*Listeria sp*	83
Bolorunduro	*Escherichia coli*	40
Ilemona	*Proteus sp*	34
Tanke	*Escherichia coli*	58

DISCUSSION

The highest fungal and bacterial counts in Afon series (Fig. 1) could be due to a combination of factors. It could be partly attributed to its organic matter and ECEC content which were relatively higher than those of other soils (Table 1). According to Adams *et al.* (1999), the highest bacteria numbers and the numbers of filamentous fungi in soil vary directly with the content of utilizable organic matter. The bacteria population of Ilemona soil was rather low despite its high organic matter content. It is possible that protozoans and other microbial groups that prey on bacteria cells are abundant in this soil. Microbial activities were supported by pH levels of the five soils (5.7-6.8). Highest number of fungi recorded in Afon series could be as a result of its having the lowest pH. Bacteria thrive in a range of pH 5.5-7.5 while fungi tend to dominate the more acid soils (Alexander, 1977). The sandy loam texture of Afon series may also be a contributing factor to its high microbial content. Sandy loams tend to be better aerated than finer textured soils and this results in higher microbial activities (Adams *et al.*, 1999)

The high frequency of occurrence of *Colletotrichum* sp (Fig. 1) in Afon series is of particular significance. Members of the genus *Colletotrichum* are pathogens of a number of crops. Onwelemu and Sinha (1991) reported that *Colletotrichum indemuthianum* causes anthracnose in cowpea. They also stated that other *Colletotrichum* species especially *C. dermatum*, *C. truncatum* and *C. capsi* attack legumes causing blotch diseases. Legumes and other crops could thus be in danger of infection by *Colletotrichum* species when cropped in Afon series.

Bolorunduro series had the highest variety of fungal species as shown in Figure 2. These isolates, which belong to five fungal genera: *Penicillium, Aspergillus, Trichoderma, Fusarium* and *Rhizopus* were probably able to thrive well in this series because of the warm humid condition of the soil and favourable hydrogen ion concentration. Marasus *et al.* (1983) stated that Fusaria are prevalent in the tropical countries. *Fusarium* is one of the most ubiquitous genera of plant pathogenic fungi. Several species of Fusaria produce mycotoxins such as trichotheecenes, butenolide, moniliformin and zearalenone on a variety of substrates (Marasus *et al.*, 1983). Hill and Waller (1988) also reported that *Fusarium* spp cause wilt in okro and stem rot in groundnut.

Many species of *Fusarium* were found to occur in Badi series. This could be a response to cultivation of cowpea in this series. In a study carried out by Odunfa (1978), *Fusarium* species were found to be the most abundant rhizoplane fungi of cowpea. He reported that exudation from the root of cowpea and sorghum enhanced the germination of conidia of four *Fusarium* species: *Fusarium solani, F. oxysporum, F. semitectum, F. sulphareum.* These four species of *Fusarium* were encountered in Badi series which had a history of cowpea cultivation. This could also explain the abundance of Fusaria in three out of five soils studied. A number of the predominant fungal isolates of Tanke series (*Aspergillus, Fusarium* and *Geotrichum* species) (Fig. 2) have also been associated with diseases of many crops. *Fusarium solani* for example was said to be frequently responsible for seedling blight of cowpea and reddish stem cancer of *Phaseolus* (Allen, 1984). The predominance of *Aspergillus* spp in Ilemona series (Fig. 2) could be attributed to the high organic matter content of the soil; *Aspergillus* spp are cellulose decomposing fungi and it is known that improving the nutrient status of soil by crop residue incorporation, green manuring and animal manuring, increases the population of *Aspergillus* in soil (Abdel-Kader *et al.*, 1983).

The presence of *Nitrosococcus*, a genus of nitrifying bacteria in high numbers in Afon series points to a higher available nitrogen content and could therefore explain higher fungal and bacterial population in this series. *Escherichia coli* and *Proteus sp* that dominated the other four soil series most probably found their ways into the soil through animal manure

Alexander (1977) stated that the presence of Enterobacteria such as *E. coli* in arable land may result from fecal droppings of animals and birds. The villages surrounding the Teaching and Research Farm have been reported to be occupied by nomadic herdsmen who rear their animals indiscriminately (Ogunwale *et al.*, 2000).

CONCLUSION

This study has shown that apart from the occurrence of heterotrophic bacteria and fungi associated with decomposition of organic matter and nitrogen fixation, pathogenic microorganisms also exist in high numbers in Afon, Badi, Bolorunduro and Tanke series. Proper care should therefore be taken in cultivation of susceptible varieties of crops in these series. Planting of disease resistant seeds, treatment of soils and seeds with appropriate fungicides and healthy cultivation practices could be of help. However, Ilemona series could be cropped with a number of crops without fear of pathogens since it is predominated by saprophytic organisms.

More information on the functional groups of microorganisms in the soils of University of Ilorin Teaching and Research farm will give room for manipulation of the soil for improved soil fertility.

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