

SOIL ALGAE: A CASE STUDY OF TWO VEGETABLE FARMLANDS IN LAGOS AND OGUN STATES, SOUTHWEST NIGERIA.

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ABSTRACT

Microalgae occur in nearly all terrestrial environments and are invariably encountered both on soil surface and beneath. Also, the importance of algae in soil formation and soil fertility improvement cannot be over emphasized as the world is working towards food security. Based on this, top soil samples (0-15cm) were collected fortnightly for seven months (October 2012- April 2013) from two different vegetable farms and analyzed for abiotic parameters and algae composition. These vegetable farms were characterized by the same soil types and fertilizers used but differ in their land use history. Four classes of algae were identified, Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae. Higher total organic matter value (6.60%) and more euglenoids were recorded at James farm as compared to Iyana-Iba farm probably due to the pig sty around it. The presence of nitrogen fixing microalgae (*Nostoc azollae*) in the top soil of both vegetable farms further establishes the role of blue green algae in soil nutrients for plant growth.

Key words- Soil Fertility, Soil algae, Farmland, Nitrogen fixation, Vegetables

INTRODUCTION

Soil is natural body consisting of layers that are primarily composed of minerals, mixed with some organic matters which differ from their parent materials in their texture, structure, consistency, color, chemical, biological and other characteristics. The soil is a mineral medium that house the living organisms. Aside from their role in soil forming, these organisms are vital for plant growth due to their effect on soil fertility levels. Adequate moisture and Phosphorus, together with sunlight will promote the growth of soil algae and their contribution to agricultural productivity. Soil consists of various types of micro and macro organisms which play one role or the other in soil formation and fertility. The most common organisms found in the soil are algae which belong to the micro group (Hoffman, 1998). Algae are ubiquitous in habitat and vary widely in many characteristics. Unlike most other microorganisms, algae contain chlorophylls and are present in most of the soils where moisture and sunlight is available (Hoffman 1998). Soil algae are known to associate with plant roots, producing hormones that stimulate root growth and enhance the activities of other beneficial root-associated microorganisms. The interaction of soil biota like micro-organisms, roots, animals and plants is affected, sometimes significantly, by agricultural practices and human activities. Soil

habours pesticide residues, chemical fertilizers and agronomic practices affect plants, animal life and soil community structure (Paoletti 1988). Despite numerous studies on soil algae elsewhere in the world, it is still difficult to draw general conclusions on the diversity of the flora and their influence on ecosystem function (Metting, 1981; Thomas *et al.*, 1991; Johansen, 1993; Lukes'ova', 1993; Lukes'ova' and Hoffmann, 1996; Lukes'ova', 2001; Neustupa, 2001).

Soil algae like higher plants are capable of photosynthesizing their own food. They are found in nearly all environments, and can be divided into four groups; blue-green, green, yellow-green and diatoms. Significant amounts are present at the soil surface and within sub-surface layers of moist soils. Cyanobacteria have significant potential as biofertilisers. Studies concerning the use of bioindicators have suggested biodiversity as a basic indicator of landscape quality and a fundamental tool for assessing the impact and success of remediation processes. A similar study that has been done in Nigeria is the study of algal compost effect on soil nutrient status (Eneje and Donatus, 2009). The result of their studies shows that the composted amendment influenced the soil nutrient status and structural stability. The alga compost was more effective in improving soil structural stability and nutrient. More research

works in Nigeria have focused on water bodies (Adesalu and Nwankwo 2005; Adesalu *et al.*, 2008). The objective of this work is aimed at establishing the importance of the soil algae in vegetable farmlands through identification and also to use the identified species to explain the status of the two farmlands.

MATERIALS AND METHODS

Description of study sites

Iyana-Iba farm: Iyana-Iba farm with Latitude $6^{\circ} 49'35''\text{N}$, Longitude $003^{\circ} 28'29''\text{E}$ (Plate 1a) is located along Lagos State University Ojo express way, Lagos. Some of the vegetables growing in this farm include: *Celosia argentea* L., *Solanum tuberosum*

L., *Occimum gratissimum* L., *Lactuca sativa* L., *Talinum triangulare* (Jacq.), *Corchorus olitorius* L. and *Telfaira occidentalis* Hook. F. These vegetables are mainly for export and sometimes bulk sales to market women in Lagos and its environments. NPK fertilizers are used in this farm to improve the crop yield.

James farms: James farm with Latitude $6^{\circ} 34'25''\text{N}$, Longitude $003^{\circ} 21'15''\text{E}$ (Plate 1b) is situated in Mowe-Ibafo, Ogun state. Some of the vegetables grown in this farm include: *Celosia argentea*, *Talinum triangulare*, *Corchorus olitorius* and *Telfaira occidentalis*. Farmers here also cultivate these crops using NPK fertilizers.



Plate 1: Iyana-Iba Farm, Lagos State (A), James Farm, Mowe-Ibafo, Ogun State (B)

Collection of Sample

Top soil samples (0-15cm) were collected fortnightly for six months (October 2012- April 2013) from the two farms studied. Two replicated soil samples were collected in two Petri dishes from each location making a total of four replicates from each farm. On each Petri dish, six cover slips were placed, slightly watered using distilled water, placed in a dark box and then transported to the laboratory. In the laboratory, the dark box was transferred in to the cupboard for 24 hours counting from when the sample was first collected. Biological analysis was done using Olympus XSZ-N107 and monographs for proper identification soil samples collected were also analyzed for pH, salinity, acidity, alkalinity and Total organic matter.

Analysis of Physico-Chemical Parameters

The salinity of the soil samples was determined using a portable salinity meter while total acidity and alkalinity were analyzed using titration method. Total Organic Matter (%) was determined by putting 5 g of soil into a weighed porcelain crucible and ignited over a Bunsen burner flame until the smoke stopped. The crucible was transferred into a muffle furnace, heated for 2 h at 550°C and allowed to cool, then weighed. Identification of biological samples were aided by the work of Patrick and Reimer (1975); Prescott (1962), Whitford and Schumacher (1973).

Statistical Analysis

To obtain the estimate of species diversity, three community structure indices were used; Margalef's diversity index (d) (1970), Shannon-Weaver Index (H') (Shannon & Weaver 1963) and Species Equitability (j) or Evenness (Pielou, 1975).

RESULTS

The top soil physico-chemical analysis result showed a high value of total organic matter and alkalinity at James Farm as compared to Iyana-Iba (Figure 1). Total number of 24 taxa belonging to four classes, Chlorophyceae (Eight taxa), Cyanophyceae (Eight taxa), Bacillariophyceae (Four taxa) and Euglenophyceae (4 taxa) were recorded. Tables 1 and 2 show the composition of algal communities at Iyana-Iba and James Farms respectively. The highest species richness (Figures 2 and 3) was recorded at Iyana-Iba Farm with Cyanophyceae (*Oscillatoria limosa*) and

Bacillariophyceae (*Navicula cryptonella*) recorded as frequently occurring species while the lowest number of species was recorded at James Farm with Chlorophyceae (*Reptosira terrestris*) and Euglenophyceae (*Euglena acus*) in abundance. Cyanophyceae was found in abundance in both vegetable farms followed by Chlorophyceae, Bacillariophyceae and Euglenophyceae. The vegetables farm located in Ogun State (James Farm) had a higher abundance of Euglenophyceae (Table 2). The highest number of diatoms was recorded at Iyana-Iba (Figure 4).

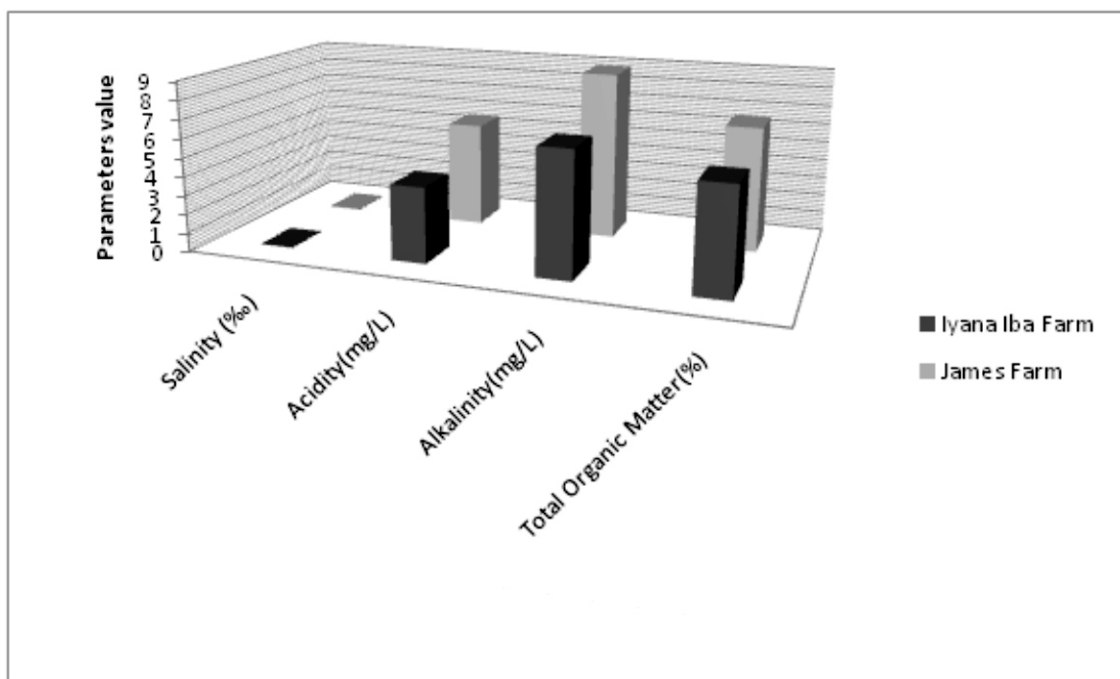


Figure 1: Comparison of soil sample analysis results at Iyana -Iba and James Farm

Table 1: Microalgae composition at Iyana-Iba Farms

	Oct. 7 and Oct. 21		Nov.4 and Nov.18		Dec. 2 and Dec. 16		Jan.6 and Jan. 20		Feb.3 and Feb.17		Mar.3 and Mar. 17		Mar.31 and Apr. 7	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Division: Chlorophyta Class: Chlorophyceae														
<i>Haematococcus lacustris</i> (Girod) Roststafinski	5	1	4	2	2	1	2	1	3	3	1	4	5	6
<i>Mesotaerium mirificum</i> (Wittr.) Lagern	9	4	3	1	2	-	1	2	1	-	-	-	2	-
<i>Closterium monilliferum</i> Ehrenberg	-	-	-	-	-	-	1	1	-	-	-	-	-	-
<i>Chlamydomonas reinhardtii</i> P.A. Dang	1	2	1	1	-	-	-	-	1	-	-	-	1	1
<i>Microspora</i> sp	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chlorella vulgaris</i> Beyerinck	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Division: Cyanophyta Class: Cyanophyceae														
<i>Oscillatoria limosa</i> C.Agardh	5	7	4	5	9	2	6	7	9	3	10	11	10	4
<i>Phormidium rubescens</i> Gomont	2	3	-	-	-	-	-	-	-	-	-	-	1	-
<i>Nostoc azollae</i> Strain	1	-	1	-	2	-	-	-	-	-	-	-	-	-
<i>Symploca borealis</i> Rabenhorst	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Aphanocapsa parietina</i> Nageli	4	1	-	-	-	-	-	-	-	-	-	-	-	-
<i>Spirulina agilisissima</i> (Lagerheim) Kirchner	4	4	3	8	2	4	7	4	4	1	2	3	2	4
<i>Calothrix confervicola</i> C. Agardh	1	1	-	-	-	-	-	-	-	-	-	-	-	-
<i>Schizothrix fuscescens</i> Kutzinger	-	1	-	-	1	1	1	-	-	-	-	-	-	-
Division: Bacillariophyta Class: Bacillariophyceae														
<i>Navicula cryptonella</i> Lange-Bertalot	10	8	4	2	8	7	11	4	2	9	8	7	3	8
<i>Pinnularia viridis</i> (Nitzsch) Ehrenberg	3	-	8	8	4	3	1	-	2	1	-	1	2	2
<i>Suriella acuminata</i> F. Hustedt	2	3	1	1	1	-	-	-	-	-	1	1	-	-
<i>Frustulia rhomboidea</i> (Ehrenberg)	2	2	1	1	-	4	3	1	2	-	2	2	1	5
Division: Euglenophyta Class: Euglenophyceae														
<i>Phacus acuminatus</i> Stokes	2	1	-	-	-	1	-	1	-	-	-	-	-	-
<i>Lepocinclis globules</i> Perty	1	1	-	1	-	-	-	-	1	1	-	-	-	-
<i>Ochromonas danica</i> Pringshein		1			1									
Total number of individuals	54	40	30	30	32	23	34	22	24	19	24	29	27	30
Total number of species	17	15	10	10	10	8	10	9	8	7	6	7	9	7

Table 2: Microalgae composition at James Farms

	Oct. 7 and Oct. 21		Nov. 4 and Nov. 18		Dec. 2 and Dec. 16		Jan. 6 and Jan. 20		Feb. 3 and Feb. 17		Mar. 3 and Mar. 17		Mar. 31 and Apr. 7	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Class: Chlorophyceae														
<i>Haematococcus lacustris</i> (Girod) Rostafinski	3	2	3	4	1	1	1	1	2	2	2	3	3	2
<i>Mesotaerium mirificum</i> (Wittr.) Lagern	4	1	-	2	-	2	-	1	-	5	1	-	2	1
<i>Closterium monilliferum</i> Ehrenberg	1	1	1	1	-	-	-	-	-	-	-	-	-	-
<i>Penium spinospermum</i> W. Joshua	-	-	1	-	-	-	1	-	-	-	-	-	-	-
<i>Chlamydomonas reinhardtii</i> P.A. Dang	2	2	1	3	-	-	1	1	-	-	2	2	1	1
<i>Chlorella vulgaris</i> Beyerinck	3	2	1	1	1	1	1	1	2	-	-	-	-	-
<i>Leptosira terrestris</i> (F.E. Fritsch) Printz	1	1	-	-	-	1	1	1	-	-	-	-	-	-
Class: Cyanophyceae														
<i>Oscillatoria limosa</i> C. Agardh	5	4	-	2	6	3	-	-	2	4	8	7	3	4
<i>Phormidium rubescens</i> Gomont	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nostoc azollae</i> Strain	-	-	5	-	-	-	8	10	-	-	-	-	-	-
<i>Symploca borealis</i> Rabenhorst	-	-	1	-	1	1	-	-	-	-	-	-	-	-
<i>Spirulina agilisissima</i> (Lagerheim) Kirchner	1	3	3	4	5	1	3	1	3	3	2	1	1	1
<i>Schizothrix fuscescens</i> Kutzing	-	-	-	1	1	-	-	1	1	-	-	-	-	-
Class: Bacillariophyceae														
<i>Navicula cryptotenella</i> Lange-Bertalot	2	1	3	1	1	-	1	2	2	2	4	3	1	-
<i>Pinnularia viridis</i> (Nitzsch) Ehrenberg	-	1	4	6	7	2	1	1	1	1	1	3	1	1
<i>Surirella acuminata</i> F. Hustedt	-	-	-	-	-	-	-	-	1	1	1	1	-	1
<i>Frustulia rhomboidea</i> (Ehrenberg)	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Class: Euglenophyceae														
<i>Phacus acuminatus</i> Stokes	4	3	2	2	2	2	2	2	2	3	2	1	4	2
<i>Leptocindis globules</i> Perty	2	1	1	1	2	3	1	4	1	1	1	1	-	1
<i>Ochromonas danica</i> Pringsheim	1	1	1	-	-	-	-	-	-	-	1	1	-	1
<i>Euglena acus</i> (O.F. Muller) Ehrenberg	1	1	1	1	1	-	1	1	1	1	1	1	1	1
Total number of individuals	30	25	28	29	28	17	24	27	18	23	26	24	17	16
Total number of species	13	15	14	13	11	10	12	13	11	10	12	11	9	11

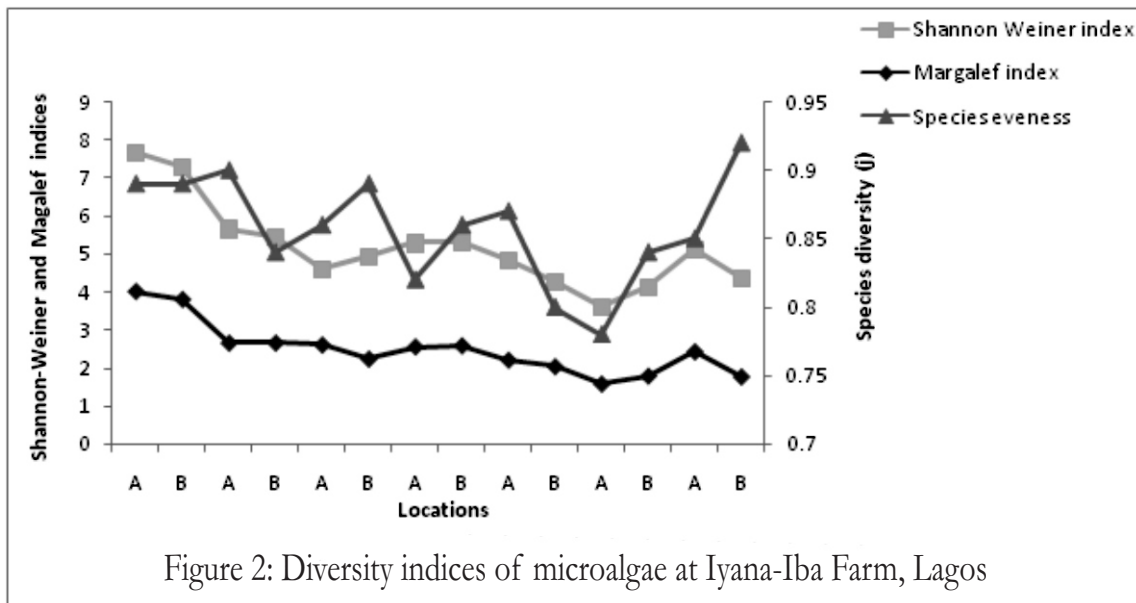


Figure 2: Diversity indices of microalgae at Iyana-Iba Farm, Lagos

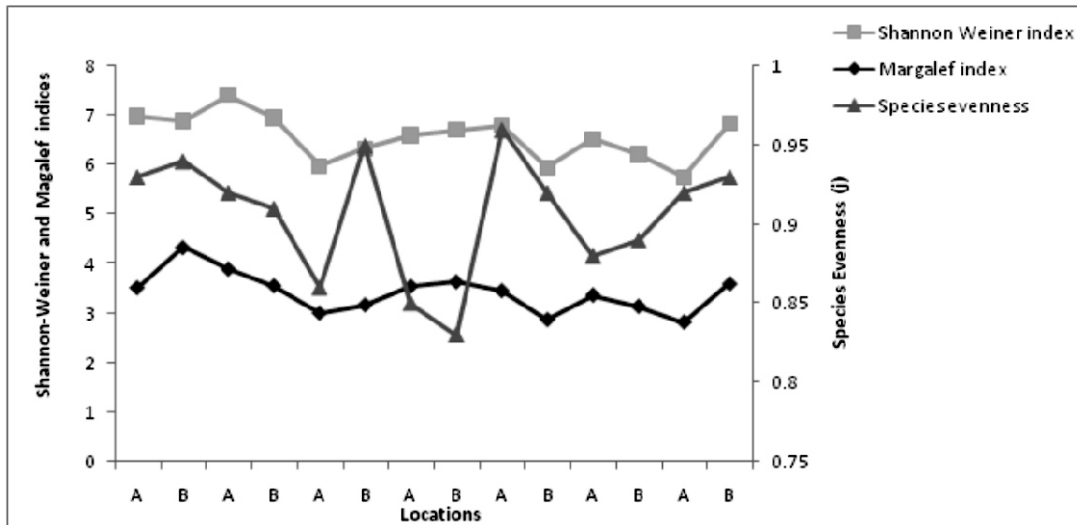


Figure 3: Diversity indices of microalgae at James Farm.

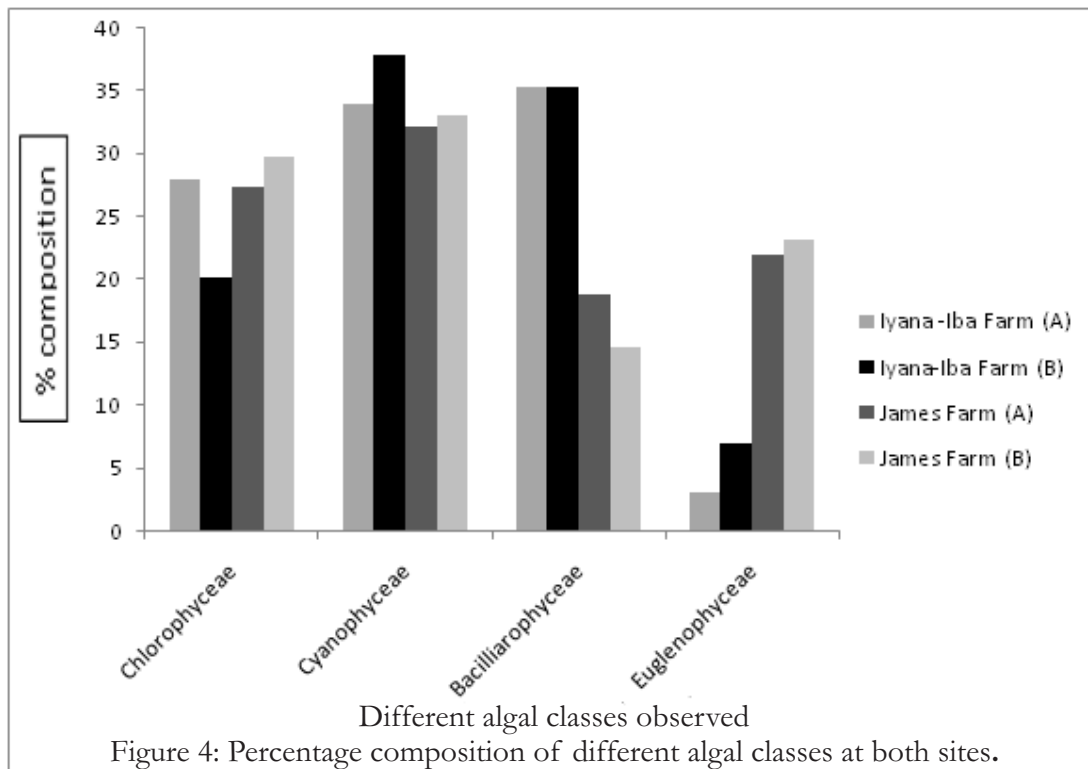


Figure 4: Percentage composition of different algal classes at both sites.

DISCUSSION

Farmlands are places of intensive anthropogenic activity, including tillage and the application of fertilizers, pesticides and herbicides which activities affect the physico-chemical environment of soils and thus lower the diversity of soil algae. In this study, the identification of twenty-four taxa belonging to four classes is in conformity with the work done in Taiwan by Chin-Su *et al.*, (2013). In their report, 64 taxa belonging to four classes were recorded for five different farmlands including

vegetable farms.

Lin and Wu (2013) indicated that water content (humidity) plays a very important role in the distribution and diversity of soil algae and the nature of soil algal communities is the result of the complex influence of vegetation type, soil properties and climatic conditions (Quesada *et al.*, 1998). The presence of *Nostoc*, *Oscillatoria* and *Phormidium* in this study is in accordance with Khaybullina *et al.* (2010), who stated that some of

the cyanobacterial species frequently occurring in the farmlands studied are of *Anabaena*, *Calothrix*, *Lyngbya*, *Microcoleus*, *Nostoc*, *Oscillatoria* and *Phormidium*. Khaybulli *et al.*, (2010) further stated that these species are cosmopolitan and widespread in various types of soil. Lengthy periods of intense fertilization lead to a reduction in species diversity and a suppression of blue-green algae development (Kuzyakhmetov, 1998). The low diversity of the algal communities and the low number of Cyanobacteria at James Farm compared to Iyana-Iba farm supported the claims of Kuzyakhmetov (1998). Less disturbed sites support more diverse and abundant algal communities than sites submitted to the intensive ploughing, planting, herbicide and fungicide applications, fertilization and harvesting associated with farming.

Soil algae community structures are affected more by soil usage than by physico-chemical parameters. Cyanobacteria show the most evident response in the different agro-ecosystems, and consequently seem to be the most suitable group to adopt as a soil bioindicator of land use. As suggested by Paoletti (1999), however, there is a general need to improve our knowledge of microorganisms, including algae, to better appreciate the many benefits that humans derive from their existence. Increase in populations of soil microflora such as algae and bacteria will help improve soil fertility and plant growth cyanobacteria's (blue green algae) ability to protect nitrogen enzymes in an oxygenated environment enables fixed nitrogen to be made available to crops through the slow leaching of nitrogen from living filaments as well as the mineralisation of dead biomass.

CONCLUSION

Cyanobacterial biofertilizers are eco-friendly and cost effective for farmlands. In this regard, the N-fixing species of cyanobacteria identified in this study are good candidates for biofertilizers in Nigeria. The continued deposition of animal dung, fish food and dirty water from fish ponds on the farm which probably enhanced the proliferation of euglenoids is in conformity with Adesalu and Nwankwo (2005) report.

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