



(RESEARCH ARTICLE)



EFFECT OF OIL PALM BUNCH ASH ON SOIL MICROBIAL DENSITY

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ABSTRACT

Defruited oil palm bunch ash was used for treatment of garden soil with the aim of determining its effect on the soil microbial load. One thousand grams (1000g) of garden soil was weighed into sterile cellophane bags and treated with 10g, 20g, 30g, 40g, 50g, 60g, 70, 80g, 90g, and 100g of bunch ash representing 1.0% w/w, to 10.0% w/w concentrations of the treatment material in the soil samples respectively. The untreated soil with 0.0% w/w concentration of bunch ash served as the control. The experiment was carried out in three replicates and the set up was moistened daily for 21 days. The results of the microbiological analysis of the soil samples showed that the untreated soil samples had mean bacterial load of 1.0×10^6 CFU/g, while the bacterial load of the treated soil samples ranged from 4.5×10^6 CFU/g to 2.2×10^6 CFU/g. The highest bacterial load of the soil was recorded with 9.0% w/w concentration of bunch ash. The fungal load of the treated soil ranged from 3.3×10^5 CFU/g to 2.0×10^5 CFU/g while the untreated sample had 1.6×10^5 CFU/g. The highest fungal load was recorded with 3.0% w/w concentration of the bunch ash. The results of this work show that oil palm bunch ash could serve as a useful amendment tool for increasing the microbial density of the soil and possibly enhance their activities.

Keywords: Bunch Ash: Garden Soil: Microbial Load: Bacteria: Fungi.

1 INTRODUCTION

Oil palm bunch ash is the ash obtained by burning defruited and dried oil palm bunches in the presence of air. This is a common means of managing a significant amount of solid wastes generated as empty fruit bunches during oil palm

production. In eastern part of Nigeria, the conversion of these agricultural wastes into ash provides useful material for domestic and agricultural purposes. Local farmers are usually in the practice of disposing bunch ash and other ash samples obtained from agricultural wastes to garden soils as amendment material for improving the quality of the soil for productive agricultural practice. Studies have been reported on the impact of oil palm bunch ash (OPBA) and other organic amendments on soil [1, 2,3]. These researches indicate that the application of oil palm bunch ash increases the pH of acidic soil and also enhances the essential nutrients required for plant growth.

Apart from the physicochemical components of the soil, microorganisms also contribute significantly to soil health and plant growth. Beneficial microorganisms add to soil fertility and decompose organic residues, toxic substances and other pollutants [4,5]. Facilitation of nitrogen fixation, nutrient cycling and phosphate solubilization are other important roles played by soil microorganisms [6,7,8,9]. Mycorrhizal fungi produce glomalin, a glycoprotein that enhances the stability of soil aggregates and improves aeration [10]. Healthy soil microbial communities control pathogenic bacteria and fungi through competition, parasitism and predation [11].

In view of the important roles microorganisms play in the soil environment and the resultant effect on plant growth, this research work aims at investigating the effect of oil palm bunch ash on soil microbial density.

2 MATERIALS AND METHODS

2.1 Collection of samples

Defruited and dried oil palm bunch used for the preparation of bunch ash were collected from local processors of palm oil in Owerri West local government area of Imo state, Nigeria.

2.2 Preparation of the ash sample

The ash sample was obtained by burning 30 kg of the defruited and dried oil palm bunches into ash in the presence of air. This was followed by the collection and storage of the ash sample in a sterile and chemically clean storage container.

2.3 Physicochemical characterization of the bunch ash sample.

The physicochemical characterization of the ash sample involved the analysis of the following parameters; sulphate, salinity, carbonate, bicarbonate, nitrate, pH, and metals (Sodium, copper, zinc, calcium, magnesium, iron, lead, cadmium, nickel and barium). The analyses were carried out using standard analytical methods adopted from international standards and guidelines.

2.4 Treatment of soil with bunch ash.

One thousand grams (1000g) of garden soil was weighed into sterile cellophane bags and treated with 10g, 20g, 30g, 40g, 50g, 60g, 70, 80g, 90g, and 100g of bunch ash. These quantities represented 1.0% w/w, to 10.0% w/w concentrations of the treatment material (bunch ash) in the soil samples respectively. The untreated soil was referred to as the control. The experiment was carried out in three replicates. The set up was transferred to green house and was moistened daily for 21 days.

2.5 Determination of the physicochemical characteristics of treated and untreated soil.

The physicochemical properties of the soil were analyzed before and after treatment to assess the impact of bunch ash application on the soil quality. The parameters measured were pH, electrical conductivity, total organic carbon, phosphate, exchangeable calcium, magnesium and potassium. Each of these parameters were determined using specific analytical methods adopted from international standards.

2.6 Microbiological analysis of the soil samples.

The microbiological analysis of the soil samples was limited to the determination of the total heterotrophic bacterial and fungal load of the soil samples. Standard microbiological methods were adopted. The media used were nutrient agar and sabouraud dextrose agar for determination of bacterial and fungal load respectively. The plate counts were performed using the spread plate method after serial dilution of the samples. The microbial counts were expressed as colony forming units per gram (CFU/g) of samples.

3 RESULTS AND DISCUSSION

The physicochemical properties of the oil palm bunch ash are shown in table 1. The bunch ash had a pH of 10.01 and a high salinity of 7000 g/Kg. The sulphate and nitrate contents of the ash sample were recorded as 12.50g/Kg and

4.30g/Kg respectively. The concentrations of some metals such as magnesium, potassium, sodium and zinc were 86.6g/Kg, 128.64g/Kg, 13.24g/Kg and 6.25g/Kg respectively. Similar composition of oil palm bunch ash has also been reported [12]. The pH value of 10.01 of the bunch ash is similar to that recorded by previous researchers [13,14] who reported a pH of about 10.8. The high pH and alkalinity as well as available macronutrients of oil palm bunch ash used in this and other studies [15] justify its usefulness as soil neutralizer and effective amendment substance for agricultural soils.

Table 1: Physicochemical properties of oil palm bunch ash.

Parameter	Concentration (g/Kg)
pH (10.01)	
Salinity	7000
Iron	10.45
Magnesium	86.67
Potassium	128.64
Sodium	13.24
Copper	2.48
Nitrate	4.30
Sulphate	12.50
Calcium	62.65
Zinc	6.25
Lead	q.42
Carbonate	23.43
Bicarbonate	17.67
Cadmium	<0,001
Nickel	0.48
Barium	1.15

Oil palm bunch ash influenced the soil physicochemical characteristics (table 2). The pH of the soil increased from 6.7 to 8.6 after treatment. Other parameters such as electrical conductivity, available phosphorus, organic carbon and nitrogen also increased to 3.2 $\mu\text{S}/\text{cm}$, 28.3 ppm, 4.10 % and 0.20 % respectively. Enhanced values of soil exchangeable cations were also recorded after treatment with bunch ash. The high pH level of the oil palm bunch ash and the liming effect of high values of Mg and Ca on the soil obviously resulted in increased pH of the soil after treatment with oil palm bunch ash [16]. The increased available phosphorus content of the soil after application of bunch ash also has been reported by previous researchers [15] and could be attributed to the release of phosphorus from complexes of Fe and Al under increasing soil pH [17]. Low exchangeable acidity resulting from precipitation of Al as Hydroxyl-Al [18, 19, 20] increases exchangeable cations in the soil. This explains the increased concentration of exchangeable magnesium, potassium and calcium in the soil amended with bunch ash as recorded in this study.

Table 2: Effect of oil palm bunch ash on soil physicochemical characteristics

Parameter	Untreated soil	Soil treated with bunch ash
pH	6.7	8.6
Electrical conductivity ($\mu\text{S}/\text{cm}$)	3.2	4.3
Available phosphorus (ppm)	14.2	28.3
Organic carbon (%)	0.08	4.10
Exchangeable Ca (me 100g ⁻¹)	6.14	8.31
Exchangeable K (me 100g ⁻¹)	0.19	0.84

Exchangeable Mg (me 100g ⁻¹)	2.06	4.11
Percentage Nitrogen (% N)	0.01	0.20

Results of the microbiological analysis of the soil are shown in table 3. Application of the oil palm bunch ash increased both the bacterial and fungal counts of the soil at various concentrations. The untreated soil samples (with 0.0 % w/w concentration of bunch ash) had mean bacterial and fungal loads of 1.0×10^6 CFU/g and 1.6×10^5 CFU/g respectively. The bacterial load of the treated soil samples ranged from 4.5×10^6 CFU/g to 2.2×10^6 CFU/g. The highest bacterial load of the soil was recorded with 9.0% w/w concentration of bunch ash. The fungal load of the treated soil ranged from 3.3×10^5 CFU/g to 2.0×10^5 CFU/g. The highest fungal load was recorded with 3.0% w/w concentration of the bunch ash.

Table 3: Heterotrophic microbial counts of the soil at various concentrations of bunch ash

Concentration of Bunch ash used (%w/w)	Heterotrophic bacterial Count (CFU/g)	Heterotrophic fungal Count (CFU/g)
0.0	1.0×10^6	1.6×10^5
1.0	2.2×10^6	3.0×10^5
2.0	2.3×10^6	2.0×10^5
3.0	3.2×10^6	3.3×10^5
4.0	4.0×10^6	3.0×10^5
5.0	2.4×10^6	2.3×10^5
6.0	2.6×10^6	2.1×10^5
7.0	3.3×10^6	2.3×10^5
8.0	3.6×10^6	2.0×10^5
9.0	4.5×10^6	2.4×10^5
10.0	3.9×10^6	2.2×10^5

The observed effect of oil palm bunch ash on soil microbial load as recorded in this study does not differ from the results obtained by previous researchers. It has been reported that organic amendments can have positive impact on soil microorganisms by providing essential nutrients and improving soil structure [21]. Oil palm bunch ash enhances the soil with essential nutrients such as magnesium, calcium and potassium creating a more favorable environment for microbial growth [22] and improved microbial activity, which are essential for organic matter decomposition and nitrogen fixation. Significant increases in heterotrophic microbial population and enzymatic activity essential for nutrient recycling also have been reported following the application of oil palm bunch ash in the soil [13, 23].

Natural ameliorants such as quail manure, bunch ash and green plantain peels ash have been recommended to farmers as soil amendment tools for improved productivity [24]. Previous researchers also have demonstrated the usefulness of these ameliorants for soil fertility and crop yield [14, 25]. It is, therefore, not unlikely that the treatment of the garden soil with oil palm bunch ash accounted for the increased microbial load recorded in this study.

4 CONCLUSION

The results of this study indicate that oil palm bunch ash could serve as a suitable amendment substance for enhancing the microbial load of the soil. The optimal concentrations for enhancing the bacterial and fungal loads of the garden soil were found to be 9.0 %w/w and 3.0%w/w respectively, indicating the need for precise application to maximize benefits while minimizing potential risks to soil microorganisms. The ability of the bunch ash to eliminate the acidic pH of the garden soil further indicates its usefulness as a suitable neutralizer for acidic soils. The positive effects observed in this study underscore the potential benefits of utilizing oil palm bunch ash for soil improvement.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that no competing interest exists

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