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EFFECT OF TIMING SLASHING, BURNING AND SOIL AMENDMENT ON SOIL MICROBES

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ABSTRACT

Various challenges face the sustainability of soil ecosystem. This research was carried out to assess the impact of burning and application of cow dung on soil microbes. Soil samples were taken from three different locations: Afugiri, Lodu and Umudike. The study comprised of two experiments. The focus of the first experiment was to check the effect of slash and burn on soil pH, organic matter, microbial biomass phosphorus (MBP) and soil microbes. Result obtained showed that burning affected soil pH, organic matter and MBP and microbial population. Burning reduced the organic matter content of soil, and increased soil pH. The results of the microbial biomass showed that burning was disadvantageous to the sustainability of soil ecosystem. However, in the second experiment, cowdung and fortified cowdung amendment were applied to determine the effect of organic amendment on soil microbes. Cowdung significantly affected bacteria population and number of earthworm species. Bacterial species have more population than fungal species. The results from this study indicate that burning in agricultural land increases soil pH, but have the capacity to destroy beneficial microbes and reduce those activities carried out by them.

Keywords: Slash and burn, cow dung, bacteria, fungi and earthworm

INTRODUCTION

In Nigeria, most rural farmers practice slash and burn (Onijigin *et al*., 2016) as one of the ecological strategies for sustainable agriculture. Some farmers maintain different plots, resulting in a mosaic of plots under cropping and fallow, allowing natural processes of soil regeneration (Brady and Weil, 2012 (cite more recent version); Altieri, 2015). Slash and burn has long been considered to be the most adapted farming system in the Humid Forest zone (Brady and Weil, 2016), especially in areas of low population density. Slash and burn has been of benefit to soil fertility. The incorporation of ash from burned biomass is advantageous to the soil status (Nye and Greenland 2013).

During slash and burn, carbon and nitrogen are largely volatilized but phosphorus and cations are transferred from the biomass to ash and then into the soil. Cations may be leached, but generally, soils are enriched by ash after rainfall (Nye and Greenland, 2013, Giardima *et al*., 2014). The effect of burning on soil is temperature based. Plant debris and litters are burnt into ash, the soil temperature gradients increases sharply (Certini, 2005), which in turn affect the soil ecosystem. Fonseca *et al*. (2017) documented that the impact of fire on soil physical, chemical, biological and even the mineralogical properties of the soil (Hebel *et al*., 2009 and Aref *et al*., 2011).

When soil is left undisturbed for long period to fallow, it tends to recover ecologically. Fallows in this way help to re-establish the equilibrium that prevailed initially in the soil before the clearing of the land or forest. Unfortunately, some major external driving forces have led farmers to reduce the fallow period (Styger, 2004). . The external driving forces include; increasing population density in forest regions and the subsequent increasing demand for food, fibre and shelter (Oluwadare *et al*., 2013).

Soil microorganisms are major indicators of soil quality. Since, most microbes resides around the topsoil, and oftentimes close to the rhizospheres, depending on the intensity of fire, the practice of slash and burn, tends to decline microbial activities and sometimes kill microbes(Certini, 2005; Carballas *et al*., 2009 and Mataix-Solera *et al*., 2009).This practice destabilizes the ecosystem and their ecological interactions. Where slash and burn is practiced, soil C:N ratio declines, weeds and plant-soil pathogens are eliminated (Gliessman, 2014). Mariaca (2011) also reported that burning reduces plant nutrient and decreases soil organic matter in soil. However, during fallow, there is a recycling of minerals from the plant to the soil. The production of some plant nutrient such as potassium, Na oxides hydroxides and carbonate that results from burning cause increase in soil pH (Ulery, 1993) and this also causes increase in nutrient availability (Hue *et al*., 2014).

Earthworms have been described as being one of the main groups of soil engineers in tropical and temperate ecosystems because they change the structural properties of soil and thus influence soil microorganisms and plant growth (Kimmins, 2011; Jongman *et al*., 2013; Judas, 2015; Muratake, 2016).Slash and burn substantially affect the activities of earthworms that takes place below ground, like building and maintenance of structural porosity and aggregation in soils through burrowing, casting and nesting activities and control of microbial activities (Lavelle *et al*., 2016).

To help accelerate and enrich soils that have been affected by slash and burn practices, soil management practices such as application of organic amendments may revamp the soil bio-activities (Khan *et al*., 2022) within short periods. This eventually will result to more plant nutrient in the soil (Ojo *et al*., 2016).

Cow dung as a source of organic manure can stimulate a rapid multiplication soil microbes, which in turn increases microbial activities and mobilization of plant nutrients (Yasir *et al*.,2017). Cow dung converted into compost, fortified cow dung, ash or applied in its normal form has been found to increase the bacteria and fungi population in the soil (Onwuka *et al*., 2019).

The main focus of this study was to determine the effect of slash and burn on soil microbial population, microbial biomass phosphorus (P) and also evaluate the use of cow dung on microbial biomass phosphorus, earthworm and microbial population.

MATERIALS AND METHODS

Study Area

The research study was conducted at the Screen house of the Department of Soil Science and Meteorology, Michael Okpara University of Agriculture Umudike (Latitude 05°29' N and Longitude 07°33' E). The area falls within the Tropical Rainforest zone, having an altitude of 122meters above sea level. The mean annual rainfall is 2200mm, distributed over nine to ten months in bimodal rainfall pattern, these are the early rains (April to July) and late rains (August to October). There are five months of dry season and short dry period in August popularly called August break. The relative humidity varies from 84% to 87%, while maximum air temperature ranges from 20°C to 24°C. The monthly maximum air temperature ranges from 28°C to 35°C (NRCRI, 2014).

Soil Sampling and Treatment Preparation

The soil samples were collected from three smallholders farmers farms located at Afugiri (Latitude 5°35' 47" N and Longitude 7°28' 44" E), Lodu (Longitude 7°31' 27" N and Latitude 5° 30' 8''), Umudike (Longitude 7°32' 37" N and Latitude 5°29' 11"). Afugiri and Lodu are located in Umuahia North Local Government Area, while Umudike is located in Ikwuano Local Government Area, all in Abia State Nigeria. The study areas have vegetation of a tropical rainforest. The dominant plant species includes; shrubs and herbaceous plants. The areas were mainly used for cultivation of crops such as maize and cassava. Apart from the farm at Afugiri which had a short fallow period of one year, others had a fallow period of more than twenty years. In each location, samples were collected from ten spots using a soil auger in each of the farms. The samples were collected before the farmers burnt the slashed biomass and after burning.

Soil samples were collected at a depth of 0 – 15cm before the burning (unburnt) and after burning (Burnt) of the farmlands. The samples were bulked to get composite samples, which were bagged, properly labeled for the screenhouse experiment and pre-treatment soil analyses done. The burnt soil samples from the three locations were bulk together and used in planting of mungbean. This was done to cut done the experimental cost. The soils used for laboratory analyses were air-dried and passed through 2 mm sieve.

The treatments consisted of Cow dung (CD), Fortified Cow dung (FCD), NPK 15:15:15, Burnt soil which served as control (BSCTRL, with no amendment), and Unburnt soil which also served as control (UBSCTRL, with no amendment). The reason for having a burnt soil as a control was to see what happened in the soil when farmers subject their lands to burning. The reason for having unburnt soil as a second control is to see what happens in the soil if the farmers do not apply any amendments.

Cow dung was sourced from the Livestock unit of Michael Okpara University of Agriculture, Umudike and air dried. The Fortified Cow dung was prepared by mixing the poultry manure, Cow dung and Composted Fruit waste at a ratio of 1:2:1. While NPK 15:15:15 was sourced from the Ministry of Agriculture, Abia State, Nigeria. Some of the chemical compositions of the treatment used are shown on Table 1.

The test crop used was mung bean (*Vigna radiata)* and the seeds (NM 94) were sourced from the Department of Agronomy, Michael Okpara University of Agriculture Umudike. The seeds were planted in nursery containers made of wooden material, with length, width and depth of the containers was 90×60×30 cm respectively. The boxes will be filled with a mixture of loamy soil, manure, and river sand, at a ratio of 3:2:1. The seedlings were later transplanted to pots after two weeks of being raised in the nursery and two seedlings were planted per pot.

Application of Treatments

The organic amendments (CD, FCD) were applied at the rate of 10t/ha. The treatments were replicated four times in a Completely Randomized Design (CRD) to give a total pot of twenty pots.

A subsoil sample was collected from the composite soil samples taken from before burnt and after burnt sites from the three locations. The soil samples were air dried and passed through a 2mm sieve. They were properly labeled and taken to the laboratory for analysis.

Laboratory Analysis

Plate count of cultivable bacteria and fungi

The total number of cultivable bacteria and fungi were counted as colony forming units (CFUs) on agar plates using the dilution plate method. About 20ml of nutrient agar medium was added in 90 mm diameter sterile Petri dishes and then enumerated (Pace, 2012). After the serial dilution plates of the samples, they were incubated for 48 hours to grow the microbial colonies properly.

Microbial biomass Phosphorus

The soil microbial biomass P was estimated using the fumigation-extracted method described by Anderson and Ingram (2013) with slight modifications. Field fresh moist 2 mm sieved soil was used for the analysis. The soil samples were subjected to extraction or fumigation within 5 – 6 of field sampling. A 50 – 100g sub-sample was extracted immediately with 0.5 M K_2SO_4 to estimate the initial amount of phosphorus. A third 10g sub- sample was immediately fumigated in an incubator for 5 days using reagent-grade ethanol-free chloroform. Water-saturated filter paper was placed in the incubator to keep the sample moist. After 5 days the incubator was opened to allow chloroform to dissipate, the soil was extracted with 0.5m K_2SO_4 extractable P was also determined on the same extract. Microbial Biomass P was estimated by multiplying the difference in extractable P between fumigated and unfumigated samples by a conversion factor of 1.46. Total P in the extract was determined using Bray-2 method (Bray and Kurtz, 1945). All results for the microbial biomass P was express on an oven dry soil basis.

Procedures for Microbiological Analysis

The microbial analyses were conducted in an aseptic environment to avoid contamination. Petri dishes were sterilized. After sterilization, the plates were allowed to cool to about 45ºC before used for pour plate technique. Normal saline was prepared by dissolving 8 grams of Sodium Chloride (NaCl) in l000 ml of distilled water and autoclaved at I21ºC for 15 minutes in a clean container. Microbiological analysis of the samples were done by weighing one gram (1g) of each samples and homogenized into 9 ml of normal saline. Then ten-fold serially dilution of homogenate was made (Cheesbrough, 2006).

Samples inoculation and incubation

Aliquot of 0.1 ml volumes of 10^{-5} test tube each samples were inoculated by spread plate method on Nutrient agar plate, MacConkey agar plate, Potatoes Dextrose agar plate (PDA) and Manitose salt agar plate (MSA), for Total Heterotrophic Plate Count, Coliform Plate count, Total Staphylococcus Plate Count and Fungal Plate count respectively. All culture plates were incubated at 37°C for 24 to 48h except PDA for fungal isolation which was incubated at 28±2°C for 3 to 5 days (Harley *et al*., 2002)

Enumeration of microorganisms
Samples emerging colonies on the plates were counted and counts expressed as colony forming units per milliliter (CFU/ml).

Calculating Colony Forming Units (CFU)/ml

$$CFU/ml = \frac{\text{Colony count} \times \text{Tube dilution}}{\text{Volume plated}}$$

Isolation and identification of isolates
Different colonies were picked depending on their morphological differences and culture on fresh nutrient agar plate by streak plate methods. Growth was stored on slants at 4°C refrigeration temperature for microscopy and biochemical methods as described by APHA (2000). The following biochemical tests were carried to examine the characteristics of the isolates; catalase, coagulase, oxidase, citrate utilization, indole, voges-Proskauer and methyl red tests.

Statistical Analysis
Statistical analysis was performed using GENSTAT software package 19th Edition (GENSTAT Rothamsted Research Center, United Kingdom). Significant differences were obtained by the one-way analysis of variance (ANOVA) for Completely Randomized Design (CRD) with means separated using protected Fisher's Least Significant Difference at probability level of 5%.

RESULTS AND DISCUSSION

Table 1: Some chemical compositions of the treatment used in the experiment

Properties	CD	FCD
pH(H_2O)	6.40	6.80
AV. P Mg/kg	1.72	1.83
N%	1.88	1.98
OC%	14.42	15.26
OM%	24.86	26.3
Ca	0.83	0.89
K	2.36	2.49

CD = Cow dung, FCD = Fortified Cow Dung

Effect of burning on Soil pH, organic matter, microbial biomass phosphorus and microbial population
The result of soil pH (in water), organic matter, microbial biomass phosphorus, microbial population and identification of bacteria and fungi organisms in unburnt and burnt soil samples from the three locations is shown on Table 2.
From the result obtained on soil pH, it was observed that AUBSS and RBSS had a lower pH value of 5.60. ABSS recorded the highest pH value of 6.30 followed by LUBSS with pH of 6.00. Between the unburnt samples (for the 3 locations), the soil pH was highest in LUBSS (6.00) compare to that of AUBSS which had the least value of 5.60. For the burnt samples, soil pH was highest in ABSS (6.30), while the least value was recorded in RBSS (5.60). Ubuoh *et al*. (2017) a slight decrease in soil pH for unburnt farmland. It was also observed that in the burnt farmland, there was an upward slope in the pH value that tended toward neutral in the pH scale. This result is indicative that the burnt farmland introduces liming effect as it increase soil pH and produces more potassium and calcium ions (Adeyolanu *et al*., 2013; Ubuoh *et al*., 2017)
The organic matter content of the soil gotten from LUBSS recorded the highest the organic matter, 5.27%. While the least value of 2.41% was observed in AUBSS sample. This result agrees with the finding of Ubuoh *et al*. (2017) who reported significant increase soil organic matter as a result of bush burning. However, comparing the organic matter contents between locations for unburnt samples, LUBSS recorded the highest organic matter content of 5.27%, while AUBSS recorded the least, 2.41%. For the burnt samples, LBSS also recorded the highest value of 4.70%, while RBSS had the least value of 3.48%. In comparing the effect of the burning on organic matter content, there was an increase in organic matter after burning in Afugiri sample, while in the other two locations organic matter decreased through burning. The later result agreed with the findings of Ebel (2018) who reported a 25 % decrease due to burning practice. However, the increase observed in organic matter content of the burnt Afugiri sample (ABSS) may likely depend on soil moisture, soil type and nature of the burnt materials (González-Pérez *et al.*, 2004). Burning affects soil properties, and its impact on soil structure, reduced organic matter, porosity and increase in soil pH has been report (Certini 2005; Verma and Jayakumar 2012). The upward change in soil pH can be attributed to the deposition of ash that resulted from the burning of plant debris.
Microbial biomass is one soil indicator that reveals the microbial status of soil which in turn determines the biological properties (Manral *et al*., 2020). The result for microbial biomass phosphorus (MBP) showed that under unburnt samples, RUBSS had the highest value of5.18 $mgkg^{-1}$, while that of AUBSS (4.87 mg kg^{-1}) was least. For the burnt samples, ABSS was highest with a value of 6.01$mgkg^{-1}$.While LBSS recorded the lowest value of 5.21$mgkg^{-1}$. Generally, among all the treatments, ABSS showed the highest value while AUBSS recorded the least (see Table 2).
The list of microbial population isolated is shown in Table 2.A total of eight cultivable microbial species were isolated; five bacterial species and three fungal species. From the results, there were six (6) isolate from AUBSS, two (2) from ABSS, five (5) from LUBSS, LBSS and RUBSS. While four (4) was isolated from RBSS.
From the unburnt soil, four bacterial species (*Staphylococcus aureus*, *Klebsilla* species, *Bacillus* species and *Escherichia coli*) and two fungal species (*Aspergillus niger and Mucor alternaria*) were isolated from AUBSS, three bacterial species (*Bacillus* species, *Serratia* species and *Escherichia coli*) and two fungal species (*Aspergillus niger* and *Rhodotorula species*) were isolated from LUSS. While from RUBSS, three bacterial species (*Klebsilla* species, *Bacillus* species and *Escherichia coli*) and two fungal species (*Aspergillus niger* and *Rhodotorula species*) were isolated. Korb *et al*. (2004), in their study, observed that slash pile burning almost eliminated arbuscular mycorrhizal (AM) fungal propagules, which were still negatively affected after 15 months. Burning

raises the soil temperature and has been reported to impact microbes (Villar, 2004).
From the burnt soil samples, bacteria species namely, *Klebsilla* species and *Escherichia coli* were isolated from ABSS. No fungal species was isolated from ABSS. Four bacteria (*Klebsilla* species, *Bacillus* species, *Serratia* species and *Escherichia coli*) were isolated from LBSS, and three bacteria species (*Staphylococcus aureus*, *Serratia* species and *Escherichia coli*) were isolated from RBSS. While only one fungi species each namely: *Rhodotorula species and Mucor alternaria was isolated from LBSS and RBSS respectively.* Burning can be a major cause in population decline of soil microorganisms, probably, because of the destruction of vegetation and burning of plant residues (Saccá *et al*., 2017).

Table 2: Effect of burning on soil pH, organic matter, microbial biomass phosphorus and microbial population

Soil Properties	**Location**					
	AUBSS	**ABSS**	**LUBSS**	**LBSS**	**RUBSS**	**RBSS**
pH(water)	5.60	6.30	6.00	5.70	5.90	5.60
OM (%)	2.41	3.59	5.27	4.70	4.75	3.48
MBP (mg kg^{-1})	4.87	6.01	5.01	5.21	5.18	5.98
MP	6.00	2.00	5.00	5.00	5.00	4.00
Bacterial species	*Staph. aureus* *Klebsilla* species *Bacillus* species *Escherichia coli*	*Klebsilla* species *Escherichia coli*	*Bacillus* species *Serratia* species *Escherichia coli*	*Klebsilla* species *Bacillus* species *Serratia* species *Escherichia coli*	*Klebsilla* species *Bacillus* species *Escherichia coli*	*Staph. Aureus* *Serratia* species *Escherichia coli*
Fungi species	*Aspergillus niger* *Mucor alternaria*		*Aspergillus niger* *Rhodotorula species*	*Rhodotorula species*	*Aspergillus niger* *Rhodotorula species*	*Mucor alternaria*

AUBSS= Afugiiri unburnt sample, ABSS= Afugiri burnt sample, LUBSS= Lodu unburnt ample, LBSS= Lodu burnt sample, RUBSS= research unburnt sample and RBSS= burnt sample, MBP= microbial biomass phosphorus, MP = Microbial population.

Effects of treatments on soil pH and organic matter content

The results recorded on Table 3 shows the values of soil pH and organic matter between treatments. The soil pH ranged from 4.69 to 5.86. The BSCTRL sample had the lowest pH value of 4.69 which is acidic in the pH scale. While the pH for the FCD was raised to 5.86. The result also revealed that FCD recorded the highest organic matter (3.37%), while the BSCTRL (burnt sample with not treatment) had the lowest value of 2.42%. This findings support the study conducted by conducted by Ewulo (2007), who reported that organic matter and pH increased in the cowdung-treated soil. He ascertained that the cation added to the soil from the cowdung was responsible for the increase in soil pH. In his study, same trend was also observed in the use of organic wastes such as poultry manure.

Table 3: Effects of treatments on soil pH and organic matter content

Treatment	**pH**	**Organic matter (%)**
BSCTRL	4.69	2.77
UBSCTRL	5.23	2.42
FCD	5.86	3.37
CD	5.50	2.98
NPK 15:15:15	4.80	2.81
LSD $_{0.05}$	0.10	0.08

FCD =Fortified cow dung , CD= Cow dung, NPK= Nitrogen Phosphorus Potassium, UBSCTRL= unburnt control, BSCTRL= burnt control

Effect of treatments on soil microbial count

The result for soil microbial count on different treatments is shown in Table 4. Among treatments, soil treated with fortified cow dung had more total heterotrophic plate count (THPC) with a value of $6.6×10^4$, while total *Staphylococcus* plate count (TSPC) had the lowest value ($3.3×10^3$). For cow dung treated soil, total heterotrophic plate count also gave the highest count of $6.0×10^4$. Ge *et al*. (2008) and Tayyab *et al*. (2018) reported that organic manure enhances microbial diversity in soil. The trend was the same for soil treated with NPK, unburnt control (UBSCTRL) and burnt control (BSCTRL).
From Table 4, it was also observed that between treatments, fortified cow dung and unburnt samples gave the same and highest total heterotrophic plate count ($6.6×10^4$) which was significantly different ($p<0.05$) from other treatments. The BSCTRL treated soil recorded the lowest value ($4.3×10^4$). The trend was the same for total coliform plate count (TCPC) and total *Staphylococcus* plate count (TSPC). Qin and Liu (2021) explained that fire decreased that richness and diversity of bacterial and fungal species. However, within treatments there was no significant difference ($p>0.05$) for TSPC.
Between treatments for total fungal plate count, UBSCTRL gave the highest significant ($p<0.05$) value of $6.2×10^4$, while FCD, CD and NPK recorded the least significant ($p<0.05$) value of $3.1×10^4$. However, Onwuka *et al*. (2019), observed that cowdung forms increased the soil fungal species. They reported that the amount of fungi isolated from cowdung-amended soil were significantly higher than the control.

Table 4: Effect of treatments of on soil microbial count after plant harvest

Treatment	THPC	TCPC	TSPC	TFPC
FCD	6.6 x 10^4	6.4x 10^4	3.3 x 10^3	3.1 x 10^4
CD	6.0 x 10^4	5.1x 10^4	2.3 x 10^3	3.1 x 10^4
NPK	4.8 x 10^4	3.9x 10^4	1.6 x 10^3	3.1 x 10^4
UBSCTRL	6.6 x 10^4	5.9x 10^4	1.4 x 10^4	6.2 x 10^4
BSCTRL	4.3 x 10^4	2.0x 10^4	2.1 x 10^3	3.9 x 10^4
$LSD_{0.05}$	2.3 x 10^4	8.1x 10^3	ns	1.3 x 10^4

THPC= Total Heterotrophic plate count, TCPC = Total Coliform plate count, TSPC Total Staphylococcus plate count, TFPC Total Fungal plate count, FCD =Fortified cow dung , CD= Cow dung, NPK= Nitrogen Phosphorus Potassium, UBSCTRL= unburnt control, BSCTRL= burnt control, ns= non-significant difference

Effect of treatments on earthworm and microbial biomass phosphorus (MBP)

Figure 1 shows the effects of treatments on the population of earthworm. The result showed that the soil treated with cow dung (CD) recorded the highest earthworm population of 8, which was significantly different ($p<0.05$) from that of other treatments. No earthworm was recorded for BSCTRL and NPK treated soils. While in the UBSCTRL and FCD samples the earthworm populations were 2 and 6 respectively. In the findings of Munnoli and Bhosle (2009), they observed that weight of earthworm species treated with soil+cowdung increased significantly.

Microbial biomass phosphorus was determined and the result is shown in Figure 2. It was observed the different treatments did not significantly ($p>0.05$) affect the microbial biomass phosphorus. Although soil treated with NPK recorded the highest value of 9.35 mg kg^{-1} while the burnt soil had (BSCTRL) the lowest value of 6.02 mg kg^{-1}. This result contradicted the findings of Das *et al*. (2017). In their study, they observed that composted cowdung increased C, N and P which indirectly influenced microbial biomass positively.

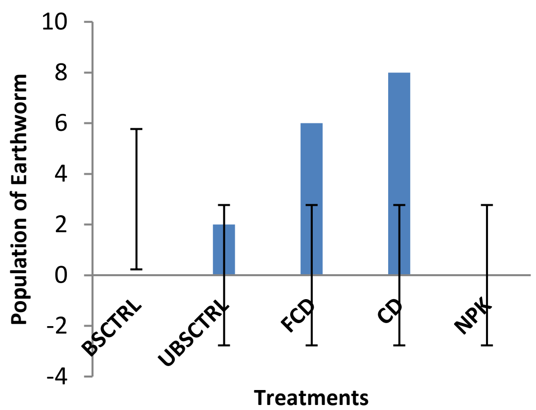

Figure 1: Barchart showing the effect of treatment on earthworm population

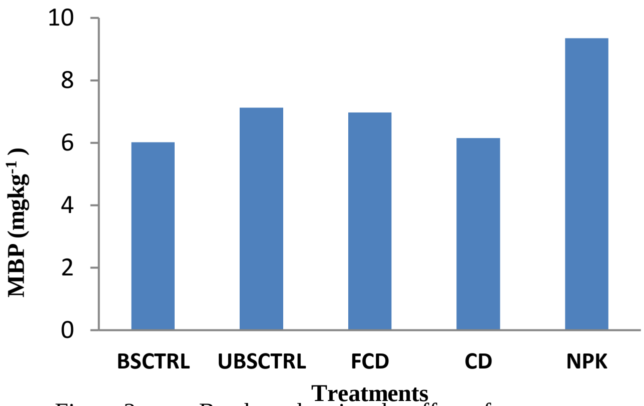

Figure 2: Barchart showing the effect of treatments on MBP

FCD =Fortified cow dung , CD= Cow dung, NPK= Nitrogen Phosphorus Potassium, UBSCTRL= unburnt control, BSCTRL= burnt control

Effects of treatments on bacterial and fungal species isolated from the soil samples

Of all the cultivable microbes, Table 5 shows the effect of treatments on bacterial and fungal species isolated from the soil samples. Bacterial isolates identified from fortified cow dung include: *Klebsilla* species, *Bacillus* species, *Escherichia coli* and *Serratia* species. Only *Bacillus species* and *Escherichia coli* were identified from cow dung treated soil. For the NPK fertilizer treated soil, *Staphylococcus aureus* and *Escherichia coli* were present. It was generally observed that *Escherichia coli* were present in all the different treatments, while *Bacillus* species was seen in FCD and CD treated soils. Some fungal isolates were also identified (see Table 5).*Aspergillus niger* was the only fungus observed to be present in the soil treated with fortified cow dung (FCD). It was also isolated from soil treated with NPK fertilizer together with *Mucor alternaria*, while *Mucor alternaria* and *Rhodotorula* species were present in cow dung treated soil.

Table 5: Effects of treatments on bacterial and fungal species isolated from the soil samples

Microbes	FCD	CD	NPK
Bacterial identification	*Klebsilla* species *Bacillus* species *Escherichia coli* *Serratia* species	*Bacillus* species *Escherichia coli*	*Staphylococcus aureus* *Escherichia coli*
Fungal identification	*Aspergillus niger*	*Mucor alternaria* *Rhodotorula species*	*Aspergillus niger* *Mucor alternaria*

FCD =Fortified cow dung , CD= Cow dung, NPK= Nitrogen Phosphorus Potassium

Percentage occurrence of bacterial and fungal isolates
The percentage occurrence of the isolates from the soil samples are presented in Table 6. The result showed that *Escherichia coli* had the highest percentage occurrence (22.50 %) followed by *Bacillus* species which recorded 15.00 %. *Staphylococcus aureus*, *Serratia* species and *Klebsilla* species had the least percent occurrence of 10.00 %.

The result for fungal species revealed that, *Aspergillus niger* had higher percentage occurrence (12.50 %) while *Mucor alternaria* and *Rhodotorula* species were lower (10.00 %). Generally, between the isolates, *Escherichia coli* recorded the highest percentage occurrence (22.50 %), followed by *Bacillus* species (15.00 %). The third in position was *Aspergillus niger* (12.50 %)

Table 6: Percentage occurrence of bacterial and fungal isolates from the soil samples

Microbes	Isolates	No. of positive gram	Percentage of occurrence
Bacterial species	*Bacillus* species	6.00	15.00
	Escherichia coli	9.00	22.50
	Staphylococcus aurues	4.00	10.00
	Serratia species	4.00	10.00
	Klebsilla species	4.00	10.00
Fungal species	*Mucor alternaria*	4.00	10.00
	Aspergillus niger	5.00	12.50
	Rhodotorula species	4.00	10.00

Characterization of the bacterial and fungal isolates from the soil samples
The characterization of the bacterial isolates is shown in Table 7. Bacterial species isolated include: *Staphylococcus aureus, Serratia* species, *Klebsilla* species, *Bacillus* species, and *Escherichia coli*.
Three (3) fungal isolates viz: *Mucor alternaria, Aspergillusniger* and *Rhodotorula* species were characterized and the result is shown in Table 8.

Table 7: Characterization of the bacterial isolates from the soil samples

Colonial features	Gram reaction	Cell arrangement	Suspected bacteria
White moisture	Gram +ve	Short rod	*Bacillus* species
Pink pigment	Gram –ve	Short rod	*Escherichia coli*
Yellow colonies	Gram +ve	Cocci group	*Staphylococcus aureus*
Red colonies	Gram –ve	Short rod	*Serratia* species
Pale pink	Gram –ve	Short rod	*Klebsilla* species

Table 8: Identification and characterization of fungal Isolates from the soil samples

Cultural characteristic	Morphological characteristic	Identification
White woolly growth resembling cotton candy, Turn to greyish-brown branched sporangiophores	Mucor has broad hyphae, Non-septate and long	*Mucor alternaria*
Dark- brown mycelium with Irregularly branched conidiophores	Conidiophores long and septate hyphae	*Aspergillus niger*
Red-pink colorsbiseriates	The vesicles were spherical to elongated	*Rhodotorula species*

CONCLUSION
Certain agricultural practices, such as burning of debris evidently affect the soil ecosystem. Although, such activity may return plant nutrient element to the soil, but will eventually cause significant harm to microbial community that keep the soil system active. Activities of microbes will retard. Also, application of synthetic fertilizers reduces the productivity of soil as a living system. Most of the beneficial microbe resides within the first 5 centimeters of the soil surface, and increased temperature as a result of burning destroys them.
The use of organic manure, either of animal or plant origin is a very important strategy that secures the sustainability of agricultural land and also provides a vibrant biological system. Other organic amendments when applied appropriately will support soil health and productivity.

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