Environmental Research Journal 2 (2): 88-98, 2008
ISSN: 1994-5396

Application of Poultry Droppings and Cowpea Straw to Mined-Out Soil for Nutrients Improvement

Z.O. Opafunso, I.I. Ozigi and G.O. Oniyide
Department of Mining Engineering, Federal University of Technology, Akure, Nigeria

Abstract: Over a period of 6 months (April-September, 2005) the mined-out soil of Itakpe Iron Ore Mine, Kogi State, Nigeria was amended with poultry dropping at the rate of 0 100, 150 and 200 g/3Kg soils. It was then potted and mulched using cowpea straw. The stockpile mine topsoil was added to the amended soil after 21, 42 and 63 days of amendment. Tomato, melon and groundnut were then planted on the amended substrate. The results indicated an improvement in the quality of the soil planted with groundnut (leguminous plant) whereas tomato and melon caused depletion of nutrients in the soil. However, none of the plant could survive on the mined-out soil without application of poultry droppings. The results showed that poultry droppings amendment is capable of improving soil conditions thus reclaiming the soil for agricultural purpose in addition to other soil management practices.

Key words: Manure, cowpea straw, remediation, mined-out, reclamation, cropping, environment

INTRODUCTION

The Itakpe Iron ore deposit is exploited by open pit mining method with a bench height of 10 m. The gradient of the 3.4 km access road is 7%. A bench slope of 45°, which is suitable for slope stability is used. The mineral is a metallic ore overlain and inter banded with host rocks, hence excavation of waste material are carried out to expose the ore body for a meaningful exploitation. The wastes are disposed in waste dump. Two production pit of the east and west segment of the mine were developed for exploitation after the mining method was first tried at the pilot mine. The east pit has been mined from the original depth of 405 m to a depth of 370 m above sea level, resulting in the exploitation of 3 conventional 10 m mine benches, with the additions hill crest of 5 m. The west pit has equally been exploited from its initial 360 m depth to 320 m above sea level. The blasting method of rock fragmentation is used by charging the blast hole with explosives. The blasted rock of ≤1000 mm is always used to feed the primary crusher. Since enormous quantity of 5.5 MT of Run-Off Mine (ROM) and 22 MT of waste are required to be excavated annually to provide 2.15 MT of concentrate needed for the production of 1.3 MT of steel per year, at a stripping ratio of Waste to Ore of 4:1, a huge mining equipment such as rotary drill, high capacity shovels, front end loaders dump truck, dozers, motor grader and excavator will be required. With this production rate of 5.5 MT year^{-1}, Itakpe Iron mine is expected to have a life span of 25 years.

Impact of Mining Operation on the Environment (Ecosystem): Mining, quarrying, construction and other related activities change the natural environment by degrading and contaminating the land (McCormack, 2001). Abrahams (1991) defined environment as the sum total of all external conditions influencing the growth and development of an organism. These factors could be Physical, biological, social and cultural (Keller, 1996). To extract minerals for industry, the earth's crust must be disturbed. On the earth's crust are living things-man, animals and plants, with their natural habitats. The life pattern of the living things are therefore disturbed when mining is undertaken (Adepoju and Flemming, 1987). All processes associated with mining and processing of minerals has impact on the environment either positively and negatively. The natural process of soil development can take several years hence the rationale for carrying out reclamation so as to reduce the impact on the landscape of these undesirable features. It may be sometimes difficult or slow for mine degraded land to regenerate naturally. As soon as mining operations are complete, the overburden material is re-applied and leveled and the topsoil is re-applied and spread over the overburden material to provide a planting medium (USDA, 1998). The removal and replacement of the soil involves the use of

Corresponding Author: Z.O. Opafunso, Department of Mining Engineering, Federal University of Technology, Akure, Nigeria

heavy equipment. Wrong mixing of subsoil and topsoil layers can create plant establishment problems. Usually the subsoil layers lack the organic and microbial organism necessary to sustain plants; hence the subsoil needs to be treated. There are many Physical, chemical and biological technologies for treating mined out area, however the treatment selected, depends on severity of degradation, the site characteristic, regulatory requirement, cost and time constraints (Ramsay, 1998). In view of the apparent infertility of the soil, deliberate efforts are required to promote utilization of organic manure for crop production. This method is based on the provision of optimal condition for the proliferation and growth of micro organism (Prado-jata *et al.*, 2003). The rate of biodegradation determines the extent of fertility or reclamation. Microbial activity in stockpile top soil will bounce back relatively quickly once the soil is re-spread (Abdukareem *et al.*, 2002). Although, relatively slow and complex in nature, ecosystem, biodegration of organic manure has been widely accepted as environmental friendly as well as an economical approach to the remediation of degraded soil (McCormack, 2001; Kasthori *et al.*, 2003).

Soil and ecosystem development: With the growing awareness of the environment, more interest and attention is being given to soils, including the use of soil as medium for plant growth (Fitzpatrick, 1996). Soil or the pedoshere are formed as a result of the interaction of mineral substrate, climate, organism, topography and time (Deeangelis, 2002). Most soil systems are derived initially from exposed bedrock. Weathering results in the mobilization of mineral materials from the rock (Odum, 2003). At this point, several processes can occur; loose material may be washed or blown away depending upon the topography, exposure and climatology in which case the loose materials will eventually settle some where to produce soils (Deeangelis, 2002). Soils are composite of air, water mineral material, organic material and organism and can be regarded as an amalgam of the lithosphere, the biosphere, the hydrosphere and the atmosphere.

Soil quality indicators for plant growth: Soil quality indicator such as pH, organic matter, total Nitrogen, available Phosphorous, Magnesium, Potassium, sodium, Calcium, heavy metal such Iron, Copper, Zinc, Manganese are essential for plant growth and development (Brady and Weir, 1999). Brady and Weir (1999) also asserted that the pH of the soil should be considered when choosing plant species. Within the pH range of 5-8, the primary effect of soil pH on plant growth is minimal. Nitrogen is often referred to as primary limiting nutrients in plant growth. It provides protein that is major constituents of plant cell cytoplasm and form Ribonucleic Acid (RNA) and Deoxy ribonucleic (DNA) which play a vital role in the metabolic activities of living organism. Nitrogen is present in Chlorophyll Phosphate, Alkaloids, Enzyme and many other organism that form the plant cells (Bornke and Lavkulish, 1999). Although, lack of Nitrogen is often view as problem, nature has an immense reserve of Nitrogen everywhere that could be harnessed by plants. Air consists of an approximately 80% Nitrogen gas (N_2), representing about 6400 kg of N over every hectare of land. However, N_2 is a stable gas, normally available to plants through Nitrogen fixation process. Phosphorous is a constituent of every living cell and occur in the protoplasm with its greatest concentration in seeds. Phosphorous deficiency causes a purplish colouration of the seedling, with later yellowing, stunted growth and delayed maturity (Fitzpatrick, 1996). It is also a component of Adenosine Diphosphate (ADP) and Adenosine Troposphere (ATP), the two most significant energy transformations in plants. Phosphorous is essential component of Deoxyribonucleic Acid (DNA) the seat of genetic inheritance in plants (Brady, 1990). Potassium is essential in all cell metabolic processes. It influences the uptake of other elements and affects both respiration and transpiration. It also encourages the synthesis and translocation of carbohydrate thereby encouraging thickening of cell wall and increase stem strength. It is important in all cell metabolic process (Fitzpatrick, 1996). Phosphorous deficiency can cause yellowing of the leaf tips and margin. It causes reduction of growth, marked shortening of internodes, premature death of leaves and inhibition of flowering. Calcium in the form of Calcium Pectate, is an important component of plant cell walls. It occurs in membrane and is essential to the maintenance of their structure and properties. Calcium deficiency Leads to malformation of growing part (Fitzpatrick, 1996). It also results in early death of meristematic region of stem and root malformation of the young leaves, causing the tips to be hooked back. The leaves may also show marginal chlorosis and these areas eventually become neurotic (Bornke and Lavkulish, 1999). Magnesium is an essential constituent of chlorophyll and is also associated with many plant proteins (Brady and Weir, 1999). Magnesium ions are the natural activators of a number of enzymes inducing nearly all of these acting on phosphorylated substrates. Deficiency of Mg causes extensive intervene chlorosis followed by accumulation of anthcyanin pigment. Iron is fund in heamoglobin and in cytochrome, it is necessary for synthesis of chlorophyll and play significant role in enzyme system. It is essential in the transfer of oxygen and the element most closely associated with anaemia. Iron deficiency becomes evident in younger leaves and is seen as a yellowing particularly in the intervene area known as iron-chlorosis. Copper is important in photosynthesis, protein and carbohydrate metabolism. Plants cell walls lignifications are stimulated, but deficiency can lead to growth abnormalities with no grain formation (Fitzpatrick, 1996). Zinc promotes growth hormones and starch formation. This eventually enhances seed maturation and production. Deficiency of Zinc Leads to mottled leaf, most especially in citrus plant (Brady and Weir, 1999).

The objectives of this study are to determine the effect of open-pit mining of Iron Ore at Itakpe on the soil nutrients contents and determine the adequacy of bio remediation measures with poultry manure.

MATERIALS AND METHODS

Description of the study area: Itakpe is an area near Okene in the North Central part of Nigeria. It lies within longitudes 6°16^{1}E and latitudes 7°36^{1}N and 7°39^{1}N. The uneven topography of high-rises and indicating plains which characterize the area is a selection of the underlying geology. The high topography features mark zones of weathering-resistant rocks like quartzite, granite and Iron. The climate of the area is tropical and consists of 6 months (May-October) of wet season and 6 months (November to April) of dry season. The wet season is characterized by south westerly winds (monsoon) from the Atlantic Ocean and dry season by northeasterly winds (harmatan) from the Sahara deserts. The annual rainfall is 1200 mm, with an average monthly maximum of between 200 and 250 mm (July-September) and an average monthly minimum of 10 mm (December-January).

Soil sample from the study area: Soil samples were collected from the waste dump of each segment of the mine i.e. East mine, West mine and the Pilot mine. The pit soil which ranges from 370-320 m was excavated and dumped at the waste dump. Soil samples were collected from ten different locations at the waste dump in a zigzag order. The soil samples were thoroughly mixed to have a representative sample. The soil samples were analyzed in triplicates and label EM1, EM2, EM3 for East mine; WM1, WM2 and WM3 for the West mine and PM1, PM2 and PM3 for the Pilot mine. The samples from the stockpiled top soil were label TS1, TS2 and TS3. Soil sample were also collected from ten different spot in a zigzag order from three farms, two of which were located within the mines environment named farm A and B. Farm A is 100 m away from the mine site and Farm B is located 200 m away from the mine site. The third farm C is 300 m from the mines. At Farm C there was no mining activity. Soil samples were taken at different slope and spots such as fertile area, eroded area and bare spot using shovel and plastic container. Core samples collected to a depth of 10 cm from surface made a component sample. Collected samples were gently crushed and mixed thoroughly discarding any roots or stones to form a representative sample. They were placed in a label container as FA1, FA2 and FA3 for farm A, while farm B sample were label FB1, FB2 and FB3 and farm C (control) samples were label FC1, FC2 and FC3. They were all analyzed in triplicate while the remaining soil were stored and used for repeat trials.

Soil remediation with poultry manure and cowpea straw: The poultry manure treatments were based on: Control (no application), 100, 150 and 200 g/3kg in addition to use of cowpea straw for mulching. The poultry droplets were obtained from Macks Farm Limited, Osara, Kogi State, Nigeria. After the poultry manure were added and thoroughly mixed they were transferred into ceramic pot with drainage holes at the base plugged with cotton wool to retain the soil and allow free exchange of air. The 4 treatments were replicated in pots 4 times in a completely randomized design at Agricultural Development Project, Lokoja from 2nd April to 3rd June 2005, for a green house experiment. They were watered to saturation once in a week. On the whole, four pots had no plant and the rest twelve pots had plants. Soil samples were taken from the pots at 21, 42, 63 days after treatment application.

Composition of the poultry manure: Estimates of manures production of poultry varies due to climate, type of feed, production method and measured techniques (Bradshaw, 1997). The poultry manure was air dried and ground to pass through 2×10^9 μm sieves and analyzed for its chemical composition. Table 1 shows the chemical composition of the poultry manure used.

Soil remediation with cropping: After 21 days of poultry treatment, the stockpile top soils were added to the pot to

Table 1: The chemical compositions of the poultry manure

Chemical composition	Amount	Unit
Total nitrogen	1.85	%
Organic matter	25.25	%
Phosphorous	26	mg kg^{-1}
Potassium	1129	mg kg^{-1}
Calcium	96	mg kg^{-1}
Magnesium	750	mg kg^{-1}

enable establishment of cropping. The seeds of tomato, melon and groundnut were planted. There were two plants per pot and weeds were constantly removed. They were watered to saturation once in a week except when it rained. The planting started on April 22nd and the soil was analyzed on 3rd June (i.e. 42 days after planting) to know the effect of cropping on the soil nutrient status.

Soil analyses: Soil Science Laboratory of Department of Crop, Soil and Pest Management (CSP) and Chemistry laboratory of the Department of Industrial Chemistry of Federal University of Technology, Akure, Nigeria were used for soil analyses of this study. The major extracting and analytical tests were carried out at the Soil Science Laboratory of CSP except the flame emission and atomic absorption spectrometry tests which were done at the Chemistry laboratory. Macronutrients such as Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and soil micronutrients were determined from soil samples.

Determination of soil pH: Twenty gram of air dried spoil was put into a 50 mL barker and 20 mL of distilled water was added. It was allowed to stand for 30 min and occasionally stirred with a glass rod. The pH meter was inserted and the pH was measured. Table 2 shows the pH value of the mine-out soil and the farms in the study, while Table 3 and 4 show the pH value of the soil after various days of poultry manure application and cropping, respectively. Similar Tables were prepared for all other parameters that were determined such as organic matter, Nitrogen in soil, soil Phosphorous, extractable Calcium, Magnesium, Potassium, Manganese, Iron, Copper and Zinc. The average (mean) values of these parameters were

Table 2: pH value of the soil in the study area

	1^{ST}	2^{ND}	3^{RD}	MEAN	S.D	MIN	MAX
TS	7.66	7.70	7.68	7.68	0.02	7.66	7.70
EP	7.54	7.54	7.57	7.55	0.016	7.54	7.57
WP	7.44	7.46	7.45	7.45	0.01	7.44	7.46
PM	7.63	7.66	7.63	7.64	0.016	7.63	7.66
FA	6.87	6.90	6.90	6.89	0.016	6.87	6.90
FB	7.00	7.02	7.04	7.02	0.02	7.00	7.04
FC	7.44	7.48	7.40	7.44	0.04	7.40	7.48

Table 3: pH value of the soil after various days of poultry manure application

	CONTROL 0g/3Kg	100g/3Kg	150g/3Kg	200g/3Kg	MEAN	S.D
21 days	7.55	7.58	7.62	7.68	7.63	0.05
42 days	7.55	7.62	7.70	7.76	7.70	0.06
63 days	7.55	7.68	7.77	7.87	7.77	0.06

Table 4: pH value of the treated mined-out soil after cropping (42 days after planting)

	100 g/3Kg	150 g/3Kg	200 g/3Kg	MEAN	S.D
No plant (control)	7.68	7.76	7.87	7.77	0.08
Tomato	7.50	7.17	7.38	7.735	0.14
Melon	7.42	7.10	7.08	7.20	0.16
Groundnut	7.60	7.72	7.78	7.70	0.07

Table 5: Mean value of the chemical analysis of the itakpe iron ore mined-out soil

	Locations				
	Top soil		Sub soil		Mean
Soil property	Mines Top Soil (TS)	East Pit (EP)	West Pit (WP)	Pilot Mines (PM)	EP + WP + PM/3
pH	7.68	7.55	7.45	7.64	7.55
Organic matter (%)	5.09	0.03	0.03	0.04	0.04
Total Nitrogen (%)	0.14	0.002	0.002	0.003	0.003
Available Phosphorous (Mg kg^{-1})	6.05	1.84	2.10	2.11	2.05
Calcium (Cmol kg^{-1})	8.45	3.0	3.31	3.90	3.37
Magnesium(Cmol kg^{-1})	4.83	1.04	1.10	1.03	1.02
Potassium(C mol/kg)	0.54	0.16	0.17	0.19	0.17
Manganese (mg kg^{-1})	2.26	4.19	4.10	3.82	4.03
Iron (mg kg^{-1})	4.28	7.41	7.38	7.45	7.41
Copper (mg kg^{-1})	4.21	3.24	3.17	3.10	3.17
Zinc (mg kg^{-1})	3.45	3.07	3.10	3.15	3.12
Lead (mg kg^{-1})	Nd	Nd	Nd	Nd	Nd

Nd = Not detected

Table 6: Mean value of the chemical analysis of the soil on the farms in the study area

	Location		
Soil property	Farm (FA)	Farm B (FB)	Farm (FC) control
pH	7.44	7.02	6.89
Organic matter (%)	2.08	2.17	3.18
Total Nitrogen%	0.12	0.14	0.20
Available Phosphorous (mg kg^{-1})	2.21	2.39	3.38
Calcium (Cmol kg^{-1})	2.43	2.33	2.30
Magnesium (Cmol kg^{-1})	1.49	1.60	1.72
Potassium (Cmol kg^{-1})	0.25	0.26	0.34
Manganese (mg kg^{-1})	2.18	2.15	2.13
Iron (mg kg^{-1})	4.00	3.55	2.35
Copper (mg kg^{-1})	2.11	2.08	2.05
Zinc (mg kg^{-1})	2.06	2.05	2.03
Lead (mg kg^{-1})	Nd	Nd	Nd

Nd = Not detected

Table 7: Mean value of chemical properties of treated itakpe iron ore mined-out soil after cropping (42 days after planting)

	Nutrient/crop			
Soil property	No. Plant (Control)	Tomato	Melon	Groundnut
PH	7.77	7.35	7.2	7.7
Organic matter%	2.42	2.31	2.38	2.28
Total Nitrogen%	0.54	0.46	0.44	0.63
Available Phosphorus (mg kg^{-1})	14.77	12.75	11.20	14.10
Calcium (C mol/kg	3.79	3.65	3.60	3.71
Magnesium (C mol/kg)	1.33	1.21	1.12	1.25
Potassium (C mol/kg)	0.32	0.20	0.18	0.21
Mangenese (mg kg^{-1})	3.71	3.66	3.53	3.38
Iron (mg kg^{-1})	6.98	6.90	6.88	6.85
Copper (mg kg^{-1})	2.95	2.84	2.80	2.81
Zinc (mg kg^{-1})	3.11	2.98	3.00	2.75
Lead (mg kg^{-1})	Nd	Nd	Nd	Nd

Nd = Not detected

determined for the 3 mine sites and the 3 farms as shown in Table 5 and 6, respectively. The mean value of chemical properties of the treated Iron ore mined-out soil after cropping, 42 days after planting, are shown in Table 7. The laboratory procedures used to determine other parameters are described:

Determination of organic matter: Organic matter contents of the soil were measured using ASTM D 2974-87 procedures.

Determination of nitrogen in soil: Nitrogen contents of the soil were measured using ASTM D6187-97 procedures.

Determination of available soil phosphorous: For the determination of soil Phosphorous, 5 g of air dried 2×10^{9} µm sieved soil was weighed into a beaker and 35 mL of Phosphorous extracting solution of Ammonium chloride (NH_4Cl) was added. The mixture was stirred for 15 min before filtration to obtain the filtrate 10 mL of the filtrate was pipetted into 50 mL volumetric flask and 8 mL of ascorbic acid in Murphy and Railliy reagent was added and made up to 50 mL with distilled water. The mixture was allowed to settle for about 30 min for development to blue colour. Standards were prepared for 0, 0.2, 0.4, 0.8, 1.0 and 1.8 ppm. To prepared 0.2 ppm, 0.2 mL of 50 ppm, Phosphorous standard solution was pipetted into a volumetric flask. Eight mL of ascorbic acid in M and R reagent solution was added and made up to 50 mL with distilled water. The processes were repeated for 0.4, 0.8, 1.0 and 1.8 ppm. Soil Phosphorous absorbance was read at a wavelength of 660 microns using the spectrophotometer. The graph of standards was plotted against absorbance and the soil Phosphorous in mg kg^{-1} was determined.

Determination of extractable calcium, magnesium and potassium: Exchangeable K, Ca and Mg were extracted using ammonium acetate (Jackson, 1992) and K determined on a flame photometer. About 10 g of soil sample was weighted-into a beaker and 10 mL of 1 m neutral ammonium acetate solution was added. The mixture was stirred and allowed to stay for 1 h. The mixture was then filtered and the filtrate was collected. Ten mL of the solution was pipetted into 100 mL Volumetric flask and made up to mark with distilled water and poured into a test tube. Standard solutions within the range of 0, 2, 4, 6, 8 and 10 ppm were prepared.

The appropriate filter was selected and the flame photometer was set up and calibrated using the standard solutions. Emission intensities for the standard and the unknown samples were then measured. Ca^{++} and Mg^{++} were determined by Ethylene Di-amine Tetra Acetic Acid (EDTA) titration method 10 mL of the solution extracted for Potassium was pipetted into 250 mL conical flask, 5 drops of erichroma black T indicator, 5 drops of 2% Potassium Cyanide (KCN) and 5 drops of 5% OH. HN_2HCl were added. A wine colour developed. Titration with 0.01M EDTA was done and the colour of the mixture changed to deep blue. These procedures gave a combination of Ca^{++} and Mg^{++} content alone. For Ca^{++} alone, 10 mL of sample extracted by ammonium acetate was pipetted into 250 mL conical flask. 5 drops of 2% Potassium cyanide (KCN), 5 drops of 5% of concentrated ammonia OH. NH_2HCl and small quantity of aleserine power indicator were added. A wine red colour was obtained which later changed to a deep blue and point after titration with 0.01M EDTA solution. To get the titre value for Mg^{++} subtracted the titre value of Ca^{++} from that of Ca^{++} and Mg^{++} i.e. $(Ca^{++}+Mg^{++})- Ca^{++} = Mg^{++}$.

Determination of Mn, Fe, Cu, Zn, extracts: Atomic Absorption Spectrometry (AAS) method was used to determine Mn, Fe, Cu and Zn extracts of the soil samples.

RESULTS AND DISCUSSION

Physical analysis of the soil in the study area: The colour and texture of the soils in the study area varied from one location to another. The overburden in the mines was reddish brown and sometimes ash colour. They were sandy clay and coarse to medium grain in size. The stockpile mine top soil was loamy and was impregnated with organic matter giving it dark colour. The topsoil in the farms around the mines was grayish brown and it becomes darker in farm which is in an unmined area .i.e. control. This could be attributed to the presence of decomposed organic matter in the soil. The soil textures were sandy clay loam which ranges from coarse to medium grain in size.

Chemical analysis of the soil in the study area: The following indicators of soil quality were determined: pH, soil organic matter, total Nitrogen and available Phosphorous. Exchangeable bases such as Calcium, Magnesium, Potassium and also extractable micronutrients such as Iron, Manganese, Zinc, Copper and Lead were also determined. The soil quality was done using the critical values of the selected indicator in line with FAO (2000) standard. Table 5 shows the chemical analysis of the mine out soil while Table 6 shows the chemical analysis of the soil sample of 3 different farms studied.

pH values in soil: The soil analysis data in Table 5 indicated that the pH values of stockpile mine topsoil was 7.68 while the mined out soil had an average value of 7.55. Table 3 shows that farms A and B in the mines environment had pH values of 7.44 and 7.02, respectively, while the farm C (control) had pH value of 6.89. As evident from Table 5, the pH was neutral for mined-opsoil, mine-out subsoil, Farm A and the Farm B, which characterizes the nature of the soil in the study area and it could be due to their parent material. However, the pH in farm C was slightly neutral. This may be due to continuous cropping. The pH was within the optimum condition for crop production.

Organic matter and nitrogen in soil: Generally the mined out soil had very low organic matter content as shown in Table 5. The Nitrogen content was 0.04% which is below sufficient range of 1.5-3% (Bornke *et al.*, 1999). This may be due to removal of topsoil and vegetation during mining. The stockpile mine topsoil had high organic matter content of 5.09%. Table 6 shows that the organic matter content on the farms A, B and C increased with increase in distance from the mines. The total Nitrogen content of the mined-out soil were critically low, less than 0.002% and it is below sufficient range of 0.08-3% indicating serious deficiency problems as shown in Table 5. The probable reasons for lower values of Nitrogen in the soil may be due to lack of organic matter, high rate of leaching and to some extent, soil erosion. Farms A, B and C have Nitrogen content of 0.12, 0.14 and 0.20% which was within the sufficient range of 0.08-0.15% (Bornke *et al.*, 1999). Addition of inorganic NPK fertilizer might have made the farms Nitrogen to be within the sufficient range. The stockpile mine topsoil Nitrogen content was 0.14%.

Phosphorous and extractable micronutrients in soil: Table 5 and 6 show the chemical analysis of Phosphorous and the extractable micronutrient contents of soil in the three mine-out soil and the three experimental farms, respectively. Table 5 shows that the Phosphorous concentration in stockpile mine topsoil was 6.05 mg kg^{-1}, while the average for the mined-out soil was 2.05 mg kg^{-1}. The Phosphorous content were 2.21, 2.39 and 3.38 mg kg^{-1} for farm A, farm B and farm C, respectively. The values increased on the farms with increase in distance from the mines. The Phosphorous concentration was lower than 7.20 mg kg^{-1}, which was within the sufficient range (Maraere *et al*., 2001). Iron recorded the highest concentration of 7.41 mg kg^{-1} in the mined out soil. The stockpile mined topsoil recorded 4.28 mg kg^{-1} Iron content. This value decreased on the farms with increase in distance from the mines. It is lower than the critical values of 8.4 mg kg^{-1} (Bornke *et al*., 1999). The average value of Manganese was 4.03 mg kg^{-1} in the mined out soil and 2.26 mg kg^{-1} in the stockpile mine topsoil. The value decreased on the farms with increase in the distance from the mines. The values are lower than the critical values of 4-50 mg kg^{-1} and these figures obtained sufficiently support the finding of Bradshaw *et al*. (1980) that Manganese and Iron deficiencies are likely in alkaline soil. The average value of Copper in the mined-out soil was 2.26 mg kg^{-1} while it was 4.21 mg kg^{-1} in the stockpile mine topsoil. This may be due to the presence of Copper in the soil parent materials and high clay content of the soil. This is because high clay content of soils favours accumulation of Copper. Table 6 shows that the concentration of Copper on the farms decreases with increase in distance from the mines. The soil Zinc content averages 3.12 mg kg^{-1} in the mined-out soil and 3.45 mg kg^{-1} in the stockpile topsoil. There was slight decrease in Zinc concentration on the farms with increasing distance from the mines. The concentrations of Zinc in all the samples were within the critical range of 2.0-4.8 mg kg^{-1}.

Exchangeable bases (Cations) in soil: The cation exchange site was dominated by Calcium as shown in Table 5 and 6. The cation occur in order ca>mg>k. Calcium content in the mined-out soil averages 3.37 Cmol kg^{-1} and 8.45 Cmol kg^{-1} in the stockpile soil. The value of Calcium in the experimental farms decreased with increasing distance from the mine. Potassium had a lower value of 0.17 Cmol kg^{-1} in the mined-out soil than 0.54 Cmol kg^{-1} in the stockpiled top soil. Table 6 shows that the value of Potassium in the experimental farms increased slightly with increasing distance from the mines. 1.02 and 4.83 Cmol kg^{-1} were the values of Magnesium in the mined-out soil and the stockpiled soil, respectively. The values of Magnesium varied from 1.49 Cmol kg^{-1} for farm A, 1.60 Cmol kg^{-1} for farm B and 1.72 Cmol kg^{-1} for farm C. Magnesium had low value in the mined out soil, but have high value on the farms, this may so due to the release of Magnesium by plant into the soil. The sufficient ranges are 2.8-8.8, 0.29 -1.73 Cmol kg^{-1} and 0.15-0.41 Cmol kg^{-1}, for Calcium, Magnesium and Potassium, respectively (Bradshaw *et al*., 1980).

Effect of cropping of tomatoes, melon and groundnut on the soil nutrient: Table 7 shows the changes in soil nutrient status after cropping with tomatoes, melon and groundnut. It was observed that the pH of the soil reduced after cropping. Cropping with melon gave the highest reduction while groundnut gave the lowest. The organic matter reduced also with groundnut having the highest reduction and melon the lowest. There was a decline in the total Nitrogen in the soil after cropping with tomato and melon but an increase with the groundnut. The available Phosphorus also decreased. Melon gave the highest decrease and groundnut, the lowest. The decrease in total Nitrogen and available Phosphorus could be attributed to their removal by crops. This is because Nitrogen is required in large quantity for good vegetative structure and phosphorous for the development of root system. Groundnut can fix atmospheric Nitrogen and this explains why Nitrogen level was higher in pot containing groundnut. After cropping, exchangeable bases such as Calcium, Magnesium and Potassium decreased. Cropping with melon gave the highest reduction and groundnut the lowest as indicated in Table 7. The reduction in Potassium level could be ascribed to the Potassium removed by the plant for bulking. The result implies that melon could cause a steady decrease in the level of exchangeable bases. The heavy metal such as Iron, Manganese, Copper and Zinc slightly reduced, hence cropping helped in bioremediation of the mined out soil as shown in Table 7. Groundnut had the highest reduction while tomatoes had the lowest.

Effect of poultry manure on the chemical properties of the mined-out soil

Effect of the addition of poultry manure on pH of Soil: Figure 1 shows the effect of poultry manure on the pH of the mine out soil after various numbers of days of application. The pH of the soils was found to increase as the numbers of days of application increase. Hence poultry manure was found to be capable of increasing the soil pH. This is probably due to the presence of exchangeable cation in the poultry manure.

Effect of the addition of poultry manure on organic matter of soil: Figure 2 shows the effect of the addition of poultry manure on the organic matter content after various days of application. There were increases in organic matter under poultry manure application with the highest application having the greatest effect. There was also increase in soil fertility status which emphasis the important contribution of organic matter to the maintenance of soil fertility. However, due to microbial

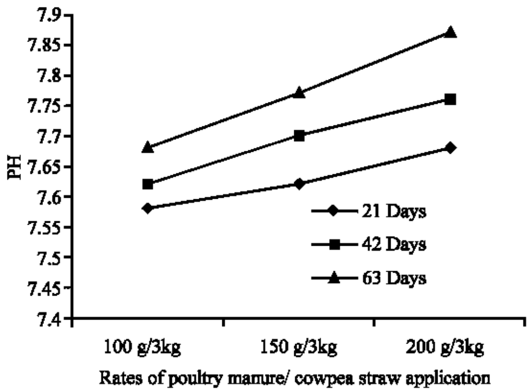

Fig. 1: The pH value for different rates of poultry/cowpea straw application

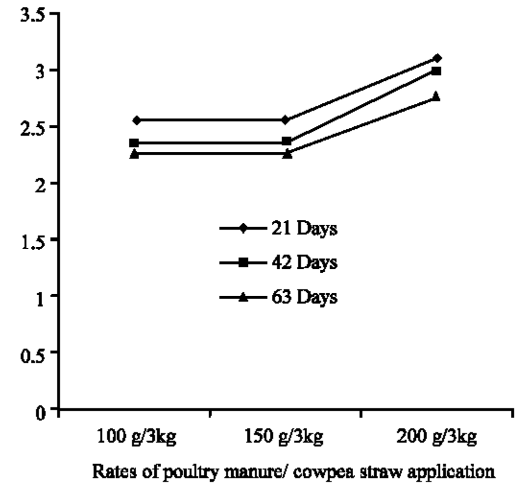

Fig. 2: The value of organic matter for different rates of poultry/cowpea straw application

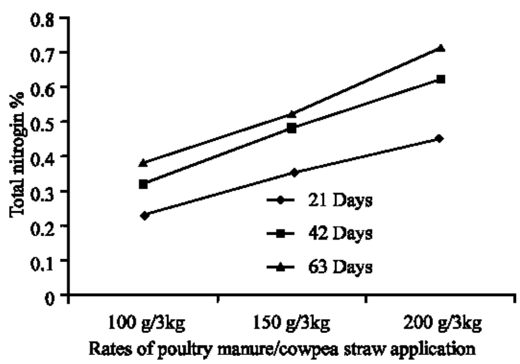

Fig. 3: The value of nitrogen for different rates of poultry/cowpea straw application

activities which enhance decomposition of organic matter, there was decrease in the organic matter with time.

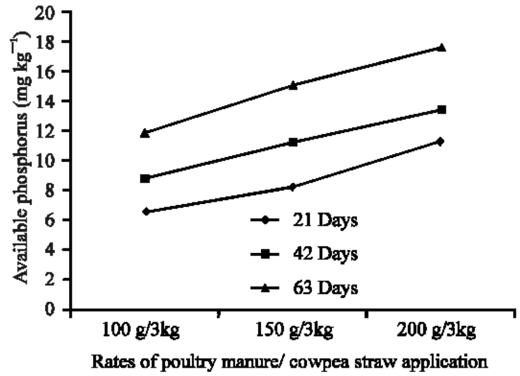

Fig. 4: The value of phosphorous for different rates of poultry/cowpea straw application

Effect of the addition of poultry manure on nitrogen and phosphorous of soil: Figure 3 and 4 show the effect of poultry manure on Nitrogen and Phosphorus contents of the mined out soil after various days of application. The soil available Nitrogen and Phosphorus significantly increased with increasing rate of manure application and there was also an increase of nutrient with time within the two months of the experiment. Hence the additions of the mine topsoil to mined-out soil which were treated with poultry manure for the first twenty one days also increase the nutrient content of the soil. This support the finding of Maraere *et al.* (2001) that the organic manure application I ncreases the soil nutrient within the first two months. The highest rate of application (200 g/3kg) resulted in the highest effect on the soil available level of Nitrogen and Phosphorus.

This increment could be attributed to increase in microbial activities as a result of increased concentration of nutrient. The pH values favour the optimum condition for microbial proliferation. Also poultry manure contains easily decomposed material, most of which are in the form of urea and uric acid (Bornke *et al.*, 1999).

Effect of the addition of poultry manure on exchangeable bases of the soil: The effect of different rate of poultry manure application on the exchangeable bases after various days are shown in Fig. 5-7. There were increases in exchangeable bases with time. Potassium had the highest value, follow by Magnesium and Calcium in that order. This is due to the presence of exchangeable cation in the poultry manure.

Effect of the addition of poultry manure on extractible micronutrients of the soil: Figure 8-11 show the effect of

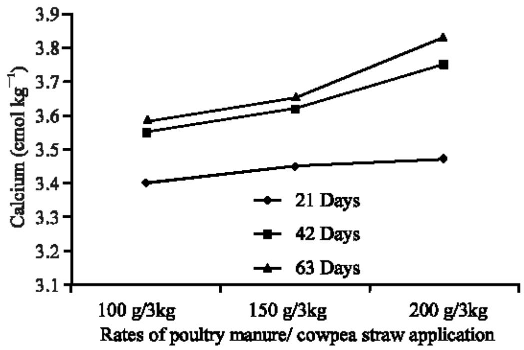

Fig. 5: The value of calcium for different rates of poultry/cowpea straw application

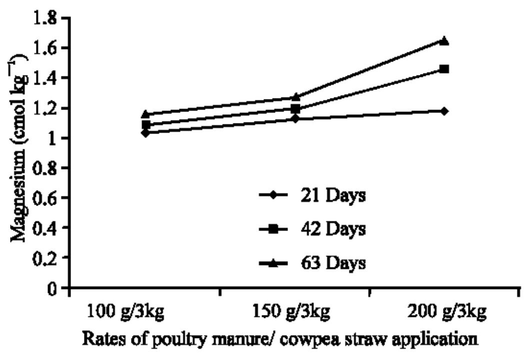

Fig. 6: The value of magnesium for different rates of poultry/cowpea straw application

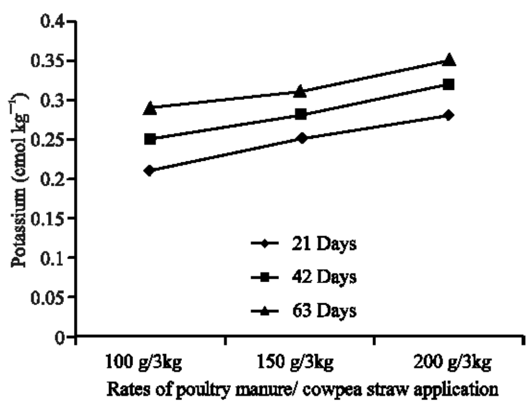

Fig. 7: The value of potassium for different rates of poultry/cowpea straw application

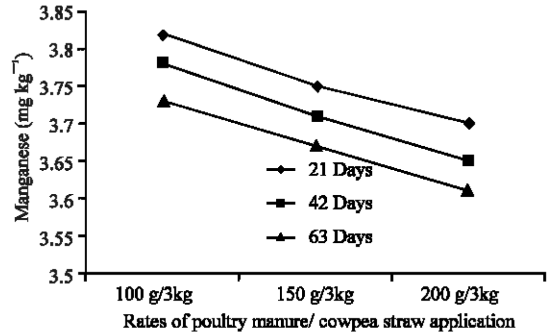

Fig. 8: The value of manganese for different rates of poultry/cowpea straw application

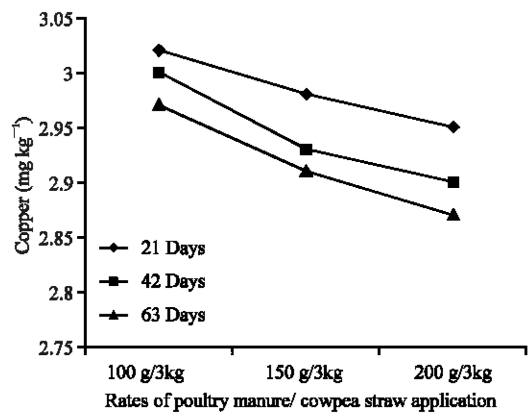

Fig. 9: The value of iron for different rates of poultry/cowpea straw application

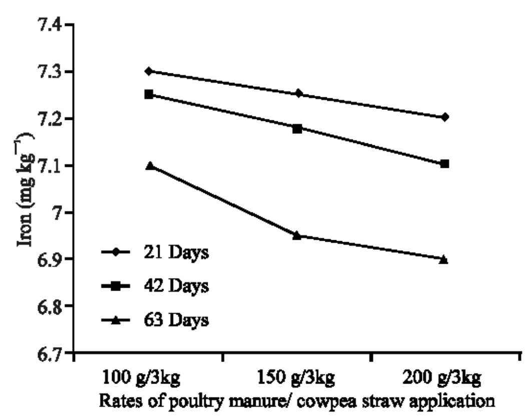

Fig. 10: The Value of Copper for Different Rates of Poultry/Cowpea Straw Application

poultry manure on the extractable micronutrient after various days of application. The poultry manure was able to bioremediate all the heavy metal with time. The highest effect was within the first three weeks while its effect was not much with time. The effect on zinc was highest among the heavy metals.

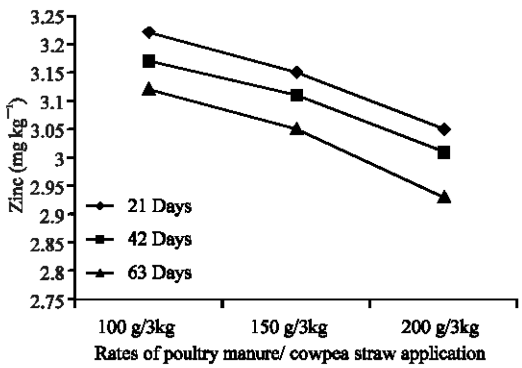

Fig. 11: The Value of Zinc for different rates of poultry/cowpea straw application

CONCLUSION

The results of the different soils parameters determined from the study showed that the essential nutrients to sustain plant growth were highly deficient in the mined-out soil. However, the stockpile mine top soil was rich in nutrients. The soil nutrients status was low in the farms in the study area and it increased with increasing distance from the mines. The result of the experiment showed the efficacy of poultry manure on the Itakpe Iron ore mined-out soil. The application of poultry manure enhanced microbial activities and increased soil nutrients. The cowpea straw which was used for mulching also assists in improving the soil quality.

Leguminous plant such as groundnut was found to improve the soil quality. Hence, poultry manure and cropping on the soil affected bioremediation by reducing heavy metal concentration. A planting medium was established with the treated mined out soil and the stockpile mine topsoil. Tomato had the best performance out of the three crops used for the experiment. It did well on the treated soil, but the three crops could not survive on the untreated mined out soil. Out of all the heavy metals in the study soil, the concentration of iron is relatively high typical of the soil in an iron ore mining area, while others are moderate. The heavy metal concentrations decreased even as the distance from the mines increases. The moderate concentrations of metals in this study do not indicate serious contamination due to iron ore mining. The reason may be because the iron ore mining activities in the area had not fully taking off at full capacity during the period of the study. The concentrations of heavy metals were below the critical level and as such, do not constitute serious hazard. However there could be a gradual build-up with time as the tempo of mining activities pick up.

ACKNOWLEDGEMENT

The contribution of Mr. Afolabi Olabisi in the area of data collection is hereby acknowledged.

REFERENCES

Abrahams, A.D., 1991. Dictionary of Geological Terms. Cambridge University Press, England, pp: 162.

Abdul-Kereem, A.W. and S.G. Mcrae, 2002. The Effect on Topsoil of Long term Storage in Stockpiles. Plant and Soil, 76: 352-363.

Adepoju, S.O. and G. Flemming, 1987. Pre-mine Baseline Data: An essential Tool in Reclamation of Colliery Wastes. Proceedings of 2nd International Symposium on Reclamation and Treatment and Utilization of Coal Mining wastes, University of Nottingham, U.K Elsevier Publishers, pp: 471-488.

Bornke, A.A. and L.M. Lavkulish, 1999. Composition of Poultry Manure and Effect of Heavy Application on Soil. Chemical Properties Plant Nutr., pp: 611-637.

Bradshaw, A.D. and M.J. Chadwick, 1980. The Restoration of Land: The Ecology and Reclamation of Derelict and Degraded Land. University of California Press, Los Angels, USA, pp: 317.

Brady, N.C and R.R. Weir, 1999. The Nature and Properties of Soil. 12th Edn. Prentice Hall, New Jersey, pp: 8-9.

Deeangelis, D.L., 2002. Dynamics of Nutrient Cycling and Food webs. Chap man and Hall, London, pp: 47-49.

FAO, 2000. Food and Agriculture Organization Soil Bulletin, 63: 3-5.

Fitzpatrick, E.A., 1 996. An Introduction to Soil Science. Longman Scientific and Technical, England, pp: 353-370.

Jackson, A.H., 1992. Determination of Soil Nutrients, Cambridge University Press, Cambridge, pp: 97.

Kasthuri, V., H. Tanaka, S. Komukai, H. Toki, J. Iwabuchi and S. Miyachi, 2003. Ecodynamics of Oil Degrading Bacteria and Significance Of Manure Mixed Populations in the Degration of Petroleum Compound. Marine Inst, Kamaishi Laboratory, Japan, pp: 427-432.

Keller, E.A., 1996. Environmental Geology. Charles F.M. Publication Company Columbus, Ohio., pp: 11-13.

Maraere, A.P., G.G. Kimbi and D.M. Nonga, 2001. Comparative Effectiveness of Animal Manures on Soil Chemical Properties. Yield and Root Growth of Amaranthus, pp:14-19.

McCormack, D.E., 2001. Soil Reconstruction: Selecting Materials for Placement in Mine Reclamation. Mining Congress J., 62: 32-36.

Odum, E.P., 2003. Ecology and Our Endangered Life-Support Systems. 2nd Edn. Sunderland, Massachesetts, pp: 51-54.

Prado-Jata, M., M. Correa, J. Rodirignex-Grau and M. Carnoeiro, 2003. Oil Sludge Land Farming Bioremediation Experimental. Venezuala Waste Manag. Res., pp: 97-106.

Ramsay,W.J.H, 1998. Bulk Soil Handling for Quarry Restoration, pp: 65.

U.S.D.A., 1998. Department of Agriculture Users Guide to Soils-Mining and Reclamation in the West. General Technical Report, 68: 7-12.