**CHAPTER FOUR**

**RESULTS AND DISCUSSIONS**

**4.1 Soil pH**

Soil pH is a measure of the acidity or basicity (alkalinity) of a soil. Soil pH is a key characteristic that can be used to make informative analysis both qualitative and quantitatively regarding soil characteristics. From the study, there was no significant difference (p>0.05) in soil pH among the sampled soils as shown in Table 4.1. NVR1 (Non-vertivar grass soil 1) recorded the highest mean value (7.54) while VR1 (Vertivar grass soil 1) had the lowest mean value (6.71). Among the soil profiles at varied soil depth, there was no significant difference (p>0.05) in soil pH. The soil profile at a depth of 0-15cm recorded highest mean value (7.25) while the soil profile at 30-45cm had the lowest mean value (6.98). It could be noted that the soils had high pH values which could be attributed to several biological and chemical changes in the soils, that are important in crop yield improvement. The high pH values of the soils can be attributed to the nature of the parent materials and the resistance of the vegetative cover (vertivar grass) to erosion, runoff or leaching effect which could have cause the basic cations in the soil to leach intensively (Fageria and Beligar, 2008).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SAMPLES** | **pH**  **H20** | **OC**  **%** | **OM**  **%** | **TN**  **%** | **AP**  **Mg/kg** | **BASIC CATIONS** | | | | **EA**  **cmol/kg** | **CEC**  **cmol/kg** | **BS**  **%** |
| **K**  **cmol/kg** | **Ca**  **cmol/kg** | **Na**  **cmol/kg** | **Mg**  **cmol/kg** |
| **NVR1** | **7.54** | **1.90** | **3.30** | **0.195** | **0.016** | **0.827** | **6.50** | **0.074** | **2.11** | **0.054** | **0.151** | **31.5** |
| **NVR2** | **7.19** | **1.86** | **3.21** | **0.303** | **0.019** | **0.574** | **7.20** | **0.079** | **1.95** | **0.086** | **0.208** | **50.4** |
| **NVR3** | **7.46** | **1.70** | **2.93** | **0.222** | **0.016** | **0.886** | **7.06** | **0.060** | **2.56** | **0.085** | **0.181** | **44.7** |
| **VR1** | **6.71** | **1.52** | **2.62** | **0.224** | **0.014** | **0.891** | **7.05** | **0.074** | **2.40** | **0.061** | **0.141** | **64.7** |
| **VR2** | **7.06** | **1.57** | **2.71** | **0.117** | **0.012** | **1.144** | **6.36** | **0.069** | **2.55** | **0.029** | **0.084** | **45.7** |
| **VR3** | **6.79** | **1.73** | **2.98** | **0.198** | **0.014** | **0.832** | **6.49** | **0.088** | **1.95** | **0.030** | **0.111** | **51.5** |
| **SDM** | | | | | | | | | | | | |
| **0-15** | **7.25** | **2.06** | **3.54** | **0.220** | **0.016** | **0.993** | **7.29** | **0.078** | **2.35** | **0.018** | **0.092** | **49.1** |
| **15-30** | **7.15** | **1.78** | **3.07** | **0.254** | **0.016** | **0.832** | **6.48** | **0.085** | **2.26** | **0.070** | **0.160** | **42.9** |
| **30-45** | **6.98** | **1.31** | **2.26** | **0.156** | **0.015** | **0.752** | **6.56** | **0.059** | **2.15** | **0.084** | **0.187** | **52.3** |
| **GM** | **7.13** | **1.71** | **2.96** | **0.210** | **0.015** | **0.859** | **6.78** | **0.074** | **2.25** | **0.057** | **0.146** | **48.1** |
| **F – LSD P<(0.05)** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** |

**Table 4.1 Results of soil chemical properties of non-vertiver and vertiver grass soils and soil profiles at varied depths.**

**NVR – Non-vertiver Soil Sample; VR – Vertiver Soil Sample OC = Organic carbon, OM =Organic matter, TN = Total Nitrogen, Av. P = Available Phosphorus, K = Potassium, Ca = Calcium, Mg = Magnesium, Na= Sodium, EA = Exchangeable acidity, ECEC = Effective Cation Exchange Capacity, BS= Base Saturation, NS – Not Significant, GM – Grand mean, SDM – Soil Depth Means,**

**4.2 Organic Carbon (OC)**

From the results, no significant different (p>0.05) was observed among the sampled soils as shown in Table 4.1. NVR1 (Non-vertivar grass soil 1) recorded the highest mean value (1.90%) while VR1 (Vertivar grass soil 1) had the lowest mean value (1.54%) of organic carbon. Among the soil profiles at varied depth, there was no significant different (p>0.05). The soil profile at a depth of 0-15cm recorded highest mean value of organic carbon (1.78%) while the soil profile at 30-45cm had the lowest mean value (1.31%) of organic carbon. The presence of low organic carbon in a soil is usually attributed to high amount of sand fraction obtained from particle size distribution due to the non-degradation of compostable materials in the soil and vice Versace (Ruth *et al.,* 2011; Ogala *et al.,* 2019).

**4.3 Organic Matter (OM)**

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition). From the results of the study, there was no significant different among the sampled soils. NVR1 (Non-vertivar grass soil 1) recorded the highest mean value (3.30%) while VR1 (Vertivar grass soil 1) had the lowest mean value (2.62%) of organic matter as shown in Table 4.1. Among the soil profiles at varied depth, there was no significant different (p>0.05) in organic matter as shown in Table 4.1. The soil profile at a depth of 0-15cm recorded highest mean value of organic matter (3.54%) while the soil profile at 30-45cm had the lowest mean value (3.07%) of organic matter. Organic matter (OM) improves the importance of soils for agricultural use. An increase in Organic matter (>2.0%) in the soils may be due to the decomposition of plant or animal residues and high organic matter favors crop growth and development, i.e.; increased fertility and can also favor heavy metal chelation formation (Ayolaghaand and Onwugbata, 2001).

**4.4 Total Nitrogen (TN)**

The results of the study showed no significant different (p>0.05) among the sampled soils as shown in Table 4.1.NVR2 (Non-vertivar grass soil 2) recorded the highest mean value (0.303%) of total nitrogen while VR2 (Vertivar grass soil 2) had the lowest mean value (0.117%) of total nitrogen. Among the soil profiles at varied depth, there was no significant different (p>0.05) in total nitrogen. The soil profile at a depth of 15-30cm recorded highest mean value of total nitrogen (0.254%) while the soil profile at 30-45cm had the lowest mean value (0.156%) of total nitrogen. These low levels of total nitrogen among the soil would require application of nitrogen fertilizer along with organic waste if any commercial crop production is to be undertaken. This low level of nitrogen is the most limiting element in arable crop production in these soils (Anake *et al.,* 2009).

**4.5 Available Phosphorus (AP)**

The results of the study, no significant different (p>0.05) among the sampled soils was observed.NVR2 (Non-vertivar grass soil 2) recorded the highest mean value (0.019mg/kg) of available phosphorus while VR2 (Vertivar grass soil 2) had the lowest mean value (0.012mg/kg) of available phosphorus as shown in Table 4.1. Among the soil profiles at varied depth, there was no significant different (p>0.05) in available phosphorus. The soil profile at a depth of 0-15 and 15-30cm recorded highest mean values of available phosphorus (0.016mg/kg) while the soil profile at 30-45cm had the lowest mean value (0.015mg/kg) of available phosphorus. Therefore, low Phosphorus value was observed which could be attributed to low percentage of clay and sand fractions (Sandeep, 2019). According to FAO (1976) soil fertility evaluation rating, the soils are moderately suitable for crop production. These soils will require little additional application of phosphate fertilizer for optimum crop yield. However, liming this soil will make available large quantity of phosphorus to plant.

**4.6 Exchangeable potassium (K)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1.VR2 (Vertivar grass soil 2) recorded the highest mean value (1.144Cmol/kg) while NVR2 (Non-Vertivar grass soil 2) had the lowest mean value (0.574Cmol/kg) of exchangeable potassium. Among the soil profiles at varied depth, there was no significant different (p>0.05) of exchangeable potassium. The soil profile at a depth of 0-15cm recorded highest mean values (0.993Cmol/kg) while the soil profile at 30-45cm had the lowest mean value (0.752Cmol/kg) of exchangeable potassium. The higher mean value of Exchangeable K in the vertivar grass soil could be an indicator of high soil fertility in the soil according to Akinrinde and Obigbesan, (2000).

**4.7 Exchangeable calcium (Ca)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1. **N**VR2 (Non-Vertivar grass soil 2) recorded the highest mean value (7.20 Cmol/kg) while VR2 (Vertivar grass soil 2) had the lowest mean value (6.36 Cmol/kg) of exchangeable calcium. Among the soil profiles at varied depth, there was no significant different (p>0.05) of exchangeable calcium. The soil profile at a depth of 0-15cm recorded highest mean values (7.29 Cmol/kg) while the soil profile at 30-45cm had the lowest mean value (6.48 Cmol/kg) of exchangeable calcium.

**4.8 Exchangeable magnesium (mg)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1. **N**VR3 (Non-Vertivar grass soil 3) recorded the highest mean value (2.56 Cmol/kg) while VR3 (Vertivar grass soil 3) had the lowest mean value (1.95 Cmol/kg) of exchangeable magnesium. Among the soil profiles at varied depth, there was no significant different (p>0.05) of exchangeable magnesium. The soil profile at a depth of 15-30cm recorded highest mean values (2.26 Cmol/kg) while the soil profile at 30-45cm had the lowest mean value (2.15 Cmol/kg) of exchangeable magnesium. The results revealed that the samples were above the critical limits of Exchangeable Mg. The critical exchangeable magnesium level is in the range of 0.2-0.4 cmol/kg (Adeoye and Agboola, 1985).

**4.9 Exchangeable Sodium (Na)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1.VR3 (Vertivar grass soil 3) recorded the highest mean value (0.088 Cmol/kg) while NVR3 (Non-Vertivar grass soil 3) had the lowest mean value (0.060 Cmol/kg) of exchangeable sodium. Among the soil profiles at varied depth, there was no significant different (p>0.05) of exchangeable sodium. The soil profile at a depth of 15-30cm recorded highest mean values (0.085 Cmol/kg) while the soil profile at 30-45cm had the lowest mean value (0.059 Cmol/kg) of exchangeable sodium. The results revealed that the samples were above the critical limits of Exchangeable sodium. The critical exchangeable magnesium level is in the range of 0.01-0.04 cmol/kg (Adeoye and Agboola, 1985).

**4.10 Exchangeable Acidity (EA)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1. **N**VR3 (Non-Vertivar grass soil 3) recorded the highest mean value (0.086 Cmol/kg) while VR3 (Vertivar grass soil 3) had the lowest mean value (0.029 Cmol/kg) of exchangeable acidity. Among the soil profiles at varied depth, there was no significant different (p>0.05) of exchangeable acidity. The soil profile at a depth of 30-45cm recorded highest mean values (0.084 Cmol/kg) while the soil profile at 0-15cm had the lowest mean value (0.018 Cmol/kg) of exchangeable acidity. The results obtained from this study shows that the soil sampled were below the critical level/value (4.1cmol/kg) reported by (Holland *et al.,* 1989).

**4.11 Cation Exchange Capacity (CEC)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1. **N**VR2 (Non-Vertivar grass soil 2) recorded the highest mean value (0.208 Cmol/kg) while VR2 (Vertivar grass soil 3) had the lowest mean value (0.084 Cmol/kg) of cation exchange capacity (CEC). Among the soil profiles at varied depth, there was no significant different (p>0.05) of cation exchange capacity (CEC). The soil profile at a depth of 30-45cm recorded highest mean values (0.187 Cmol/kg) while the soil profile at 0-15cm had the lowest mean value (0.092 Cmol/kg) of cation exchange capacity (CEC). This is in line with Iren *et al.,* (2014), the low CEC and nutrients reserves of this studied area have been attributed to the fact that soils of South eastern Nigeria are strongly weathered. These values obtained was below the critical value of (2.0 cmol/kg) regarded to be suitable for crop production (Chude *et al.,* 2011).

**4.12** **Base Saturation (BS)**

From results of the study, no significant different (p>0.05) among the sampled soils was observed as shown in Table 4.1.VR1 (Vertivar grass soil 1) recorded the highest mean value (64.7%) while NVR1 (Non-Vertivar grass soil 1) had the lowest mean value (31.5%) of Base Saturation. Among the soil profiles at varied depth, there was no significant different (p>0.05) of Base Saturation. The soil profile at a depth of 30-45cm recorded highest mean values (52.3%) while the soil profile at 15-30cm had the lowest mean value (42.9 Cmol/kg) of Base Saturation.

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

**5.1 Conclusion**

Thestudy profile analysis of soil chemical properties on vertiver and non-vertiver grass soil was conducted. From the results obtained there was no significant differences among vertiver and non-vertiver soils and the soil profile at varied depth on soil chemical properties; soil pH, total nitrogen, available phosphorus, organic matter, organic carbon, base saturation, exchangeable acidity, exchangeable calcium, exchangeable potassium, exchangeable magnesium, exchangeable sodium and cation exchange capacity. Hence, vertiver has no adverse or negative effect of soil chemical properties.

**5.2 Recommendation**

From the study, it could be recommended that;

* Vertiver grass could be used to improve soil properties and soil fertility
* Vertver grassland is suitable for agricultural activity for increased productivity
* Vertiver grass could be used as a better control from soil erosion to reduce surface runoff
* Further research could be carried out using vertiver grass for increased yield and productivity in the agricultural sector

**REFERENCES**

# Adeoye, G. O., & Agboola, A. A. (1985). Critical levels for soil pH, available P, K, Zn and Mn and maize ear-leaf content of P, Cu and Mn in sedimentary soils of South-Western Nigeria. *Fertilizer research,* 6(1), 65-71.

# Akinride, E. A. and Obigbesan, G. O. (2000). Evaluating Fertility Status of Selected Soil for Crop Five Ecological Zones of Western, Nigeria. Proc 26 Annual Conference of the Soil Sci. Soc. of.Nio at the University of lbadan, from October 30-No 3. 279-288.

Chude, V. O., Malgwi, W. B., Amapu, I. Y., & Ano, A. O. (2011). *Manual on soil fertility assessment.* federal fertilizer department. collaboration with National Programme for Food and Security, Abuja–Nigeria. 62pp.

Holland, H. D., Feakes, C. R., & Zbinden, E. A. (1989). The Flin Flon paleosol and the composition of the atmosphere 1.8 BYBP. *American Journal of Science, 289(4), 362-389.*

FAO. (1976). World Reference Base for Soil Resources: A Framework for International Classification, Correlation and Communication. Food and Agriculture Organization, Rome, Italy, ISBN-13: 9789251055113, Pages: 128.

Fageria, N. K., Baligar, V. C. and Li, Y. C. (2008). The role of nutrient efficient plants in improving crop yields in the twenty first century. *Journal of plant nutrition, 31(6), 1121-1157.*

Sandeep, G. (2019) Influence of prolonged disposal of municipal solid waste on soil productivity factors. *Journal of Applied and Natural Science*, 11(4), 816-822

Ogala, J.E., Kalaitzidis, S., Rizos, A.M., Christanis, K., Omo-irabor, O.O., Adaikpoh, E.O., Ejeh, O.I., Papaefthymiou, H. (2019). Petrographic and mineralogical study of extended out crops of lignite layers in Agbor area, southern Nigeria, *Journal of African Earth Sciences,*45: 89-98.

Ruth O., Eyankware U., Wisdom U., Moses E. (2011). Quantitative analysis of physical and chemical attribute of soil around power-line dumpsite at Boji-Boji Owa, Delta State, Nigeria. *WNOFNS* **35** 118-134.

Ayolaghaand, G.A. and Onwugbata, G.C. (2001). *Suitability comparison of waste disposal site.* 27th proceedings of the Annual Conference of the Soil Science of Nigeria, University of Calabar, Nigeria. November, 5-9 2001.

Anake, W.U., Adie G.U., Osibanjo, O. (2009). Heavy Metals pollution at Municipal Solid Waste Dumpsites in Kano and Kaduna States in Nigeria". *Bulletin of the Chemical Society of Ethiopia*, 23(2), 281-289.