E-ISSN: 2664-6773
P-ISSN: 2664-6765
Impact Factor: RJIF 5.6
IJCBS 2023; 5(1): 26-30
www.chemicaljournal.org
Received: 02-12-2022
Accepted: 06-01-2023

Udeozo PI
Department of Chemistry, Enugu State University of Science and Technology, Enugu State, Nigeria

Okeke MU
Science Laboratory Technology (Chemistry Option), Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria

Okeke HC
Department of Geological Sciences, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

Aniobi CC
Department of Community Medicine, University of Nigeria, Enugu Campus, Enugu State, Nigeria

Okeke OR
Plastic Production Unit, Scientific Equipment Development Institute, Akwuke, Enugu State, Nigeria

Offor EN
Department of Chemistry, Federal College of Education, Eha-Amufu, Enugu State, Nigeria

Corresponding Author:
Udeozo PI
Department of Chemistry, Enugu State University of Science and Technology, Enugu State, Nigeria

Effect of soil fertilizer amendment on the physicochemical properties of two studied land surfaces (Upland and lowland) after rice harvest in Ishiagu, Ivo L.G.A., of Ebonyi state

Udeozo PI, Okeke MU, Okeke HC, Aniobi CC, Okeke OR and Offor EN

DOI: https://doi.org/10.33545/26646765.2023.v5.i1a.57

Abstract
Studies were carried out to evaluate the effect of soil fertilizer amendment on the physicochemical properties of two land surfaces (upland and lowland) after rice harvest in Ishiagu, Ivo local government area of Ebonyi State, using standard analytical procedures. For each of the land surfaces, samples D_1, D_2, D_3 and D_4 denoted 0, 50, 100 and 150 kg NPK amendments respectively. The obtained data were subjected to one way analysis of variance at 5% confidence level.
The upland soil samples D_{1-4} had mean range of pH, organic matter, organic carbon, cation exchange capacity, N, P and clay values after harvest as 6.82- 7.30, 2,581-2.832%, 1,170.1.587%, 8.030 -9.860 Meq/100g, 0.116 – 0.158%, 9.303 -20.331% and 13.071 – 14.730% respectively.
Also, the lowland soil samples D_{1-4} had mean range of pH, organic matter, organic carbon, cation exchange capacity, N, P and clay values after harvest as 6.32 - 6.92, 2.607 -2.811%, 1.103 – 1.280%, 9.123 – 9.853 Meq/100g, 0.00 – 0.190%, 9.701 – 12.879% and 17.40 – 20.404% respectively. The mean values of the studied physicochemical parameters of the amended upland and lowland soil samples after harvest were within their respective permissible limits. With the exception of the organic matter content, the other studied physicochemical parameters of the lowland and upland soil samples D_{1-4} showed statistical significance.

Keywords: Physicochemical properties, upland soil samples, lowland soil samples, soil amendment and inorganic fertilizer (NPK)

Introduction
There is concern about the long-term sustainability of staple crop production in Africa, especially Nigeria due to production decline despite the use of organic and inorganic fertilizers. According to Okeke *et al*., (2019) [4], for any stable and sustainable food production to be maintained on any soil, the fertility status of that soil is very critical. Ajayi *et al*., (2012) [1], opined that enhanced crop yield arising from the use of fertilizers have completely justified its use as addictive in agriculture.
Farmers in West Africa, especially Nigeria usually apply fertilizers at different measurements on farmlands to engender healthy crop growth and yield. Many of this farmer believe that increased application of fertilizer would translate to increased soil fertility and crop yield, not minding the impact of the application on the physicochemical properties of the soil. According to Nemara *et al.*, (2018) [3], balanced and integrated application of organic and inorganic fertilizers on farmlands could increase the percentage of organic matter in the soil and thereby increase the soil physical and chemical properties for a sustainable high crop production.
Yeshpal *et al*., (2017) [9], observed that fertilizer application could affect soil physical and chemical properties directly or indirectly and this include aggregate stability, water holding capacity, porosity, hydraulic conductivity, pH, bulk density and organic carbon content etc.
Adverse alteration of some of the most important soil physical and chemical properties owing to fertilizer application could affect soil fertility and threaten increased crop yield. According to Nemara *et al.*, (2018) [3], undue and excessive application of inorganic fertilizer have resulted in adverse soil pH balance, which kills favourable soil microbes that enhances fertility.
In Ishiagu, Ivo local government area of Ebonyi State, local rice farmers often apply inorganic fertilizer at excessive levels on rice farmlands to increase yield but gets the opposite result in most cases. This is because by applying inorganic fertilizer excessively on the soil,

the critical soil properties responsible for fertility and the anticipated increased crop yield becomes jeopardized. Once the soil physical and chemical properties enabling soil fertility and crop yield becomes dangerously altered as a result of anthropogenic activities such as excessive use of inorganic fertilizer, sustainability of increased crop yield to meet basic economic needs would be therefore threatened. Hence, this study was done to evaluate the effect of various weight amendment with NPK, on the physicochemical properties of two studied land surfaces (upland and lowland) after rice harvest in Ishiagu, Ivo local government area of Ebonyi State.

Materials and Methods

Sample collection and preparation

Immediately after the harvesting of the rice grains from the studied upland and lowland soil surfaces, composite surface (0-20cm) soil samples were collected from four spots for each of the land surfaces with the amendment with fertilizer of the following weights 0 (control), 50, 100 and 150 kg of NPK and denoted as D_1, D_2, D_3 and D_4 respectively.

The soil samples were air-dried, disaggregated with porcelain pestle and mortar and finely powdered to pass through 2mm mesh sieve. Samples were analyzed for the following parameters; pH, organic matter, organic carbon, cation exchange capacity, nitrogen, phosphorus and clay contents. All the reagents used were of analytical grade.

Determination of physicochemical parameters

The pH of the soil samples were determined using pH meter in 1:1 soil water suspension; the cation exchange capacity, organic matter, nitrogen, phosphorus, organic carbon and clay contents were determined according to standard analytical procedures as described by Chopra and Kaizer, (1988).

Statistical Analysis:The obtained data were represented in mean ± standard deviation and subjected to one way analysis of variance (ANOVA) at 5% confidence level using IBM SPSS 22.0.

Results and Discussion

Table 1: Mean physicochemical properties of the upland soil samples after harvest

Parameter	Mean values of the upland soils D_1 D_2 D_3 D_4				WHO Standard (2011)	F test P value
pH	6.82± 0.01	7.21±0.02	7.01± 0.03	7.30±0.05	6.5- 8.5	0.02
Organic Matter (%)	2.581±0.241	2.731±0.143	2.832±0.162	2.764±0.114	50	0.06
Organic Carbon (%)	1.497±0.312	1.587±0.401	1.331±0.272	1.170±0.130	50	0.03
Cation Exchange Capacity (Meq/100g)	9.411±0.241	9.860±0.310	8.616±0.314	8.036±0.212	100	0.03
Nitrogen (%)	0.116±0.011	0.158±0.010	0.130±0.040	0.136±0.021	-	0.01
Phosphorus (%)	9.303±0.120	9.621±0.144	19.831±2.140	20.331±1.734	50	0.01
Clay (%)	14.730±0.320	13.404±1.011	13.101±0.422	13.071±0.127	-	0.01

Where D_1 =control; D_2= 50kg NPK amendment; D_3 = 100kg NPK amendment; D_4= 150kg NPK amendment

Table 2: Mean physicochemical properties of the lowland soil samples after harvest

Parameter	Mean values of the lowland soils D_1 D_2 D_3 D_4				WHO Standard (2011)	F test P value
pH	6.32± 0.01	6.71±0.02	6.60± 0.02	6.92±0.01	6.5- 8.5	0.02
Organic Matter (%)	2.607±0.301	2.811±0.202	2.620±0.413	2.766±0.331	50	0.05
Organic Carbon (%)	1.280±0.044	1.173±0.310	1.157±0.212	1.103±0.170	50	0.03
Cation Exchange Capacity (Meq/100g)	9.220±0.101	9.853±0.361	9.613±0.166	9.123±0.038	100	0.02
Nitrogen (%)	0.180±0.010	0.190±0.002	0.090±0.010	0.135±0.020	-	0.01
Phosphorus (%)	9.701±0.121	13.701±1.402	12.879±0.104	10.203±0.147	50	0.01
Clay (%)	20.404±1.711	20.111±0.523	19.403±0.382	17.409±0.220	-	0.02

Where D_1 =control; D_2= 50kg NPK amendment; D_3 = 100kg NPK amendment; D_4= 150kg NPK amendment

pH: Result of Table 1 shows that the mean pH values of the upland soil samples D_1, D_2, D_3 and D_4 were 6.82±0.01, 7.21±0.02, 7.01±0.03 and 7.30±0.05 respectively. Although amendment with NPK showed significance ($p<0.05$) on the pH of the soil samples from the control (D_1) standpoint, they were within the recommended threshold limits for the purposes agriculture. Soil sample D_4 gave the highest pH value probably caused by the higher application (150 kg) of inorganic fertilizer (NPK). Okeke *et al.*, (2019), obtained a lower pH range of 6.09 – 6.16 in soil samples applied organic ash in Ishiagu, Ebonyi State, than what was reported as pH mean values in the amended upland soil samples studied after harvest. Result of Table 2 shows that the mean pH values of the lowland soil samples D_1, D_2, D_3 and D_4 were 6.32±0.01, 6.71±0.02, 6.60±0.02 and 6.92±0.01 respectively. It can be observed from Table 2 that amendment of the lowland soil samples had a significant ($p<0.05$) impact on their pH values after harvest. The pH of the un-amended soil sample D_1 was below the threshold limits for a soil ideal for agricultural purposes as stated by WHO, (2011), however amendments with inorganic fertilizer brought the pH of the lowland soil samples (D_{2-4}) to be within the threshold limits that encourages soil fertility and crop yield.

Organic matter content: Organic matter content of a soil is one of the most critical parameters influencing the bioavailability of metals and essential nutrients and their uptake by plants as observed by Osakwe and Okolie, (2015). Soils with high organic matter content is an indication of a large deposition of minerals that engenders soil fertility and increased crop yield. Result of Table 1 shows that the mean organic matter values of the upland soil samples D_1, D_2, D_3, D_4 were 2.581±0.241, 2.731±0.143, 2.832±0.162 and 2.764±0.114% respectively. From the standpoint of the control soil sample (D_1), the result of Table 1 indicates that the various weight amendments with inorganic fertilizer did not significantly ($p<0.05$) enhance the organic matter content of soil samples D_2 to D_4 as shown in Figure 1.

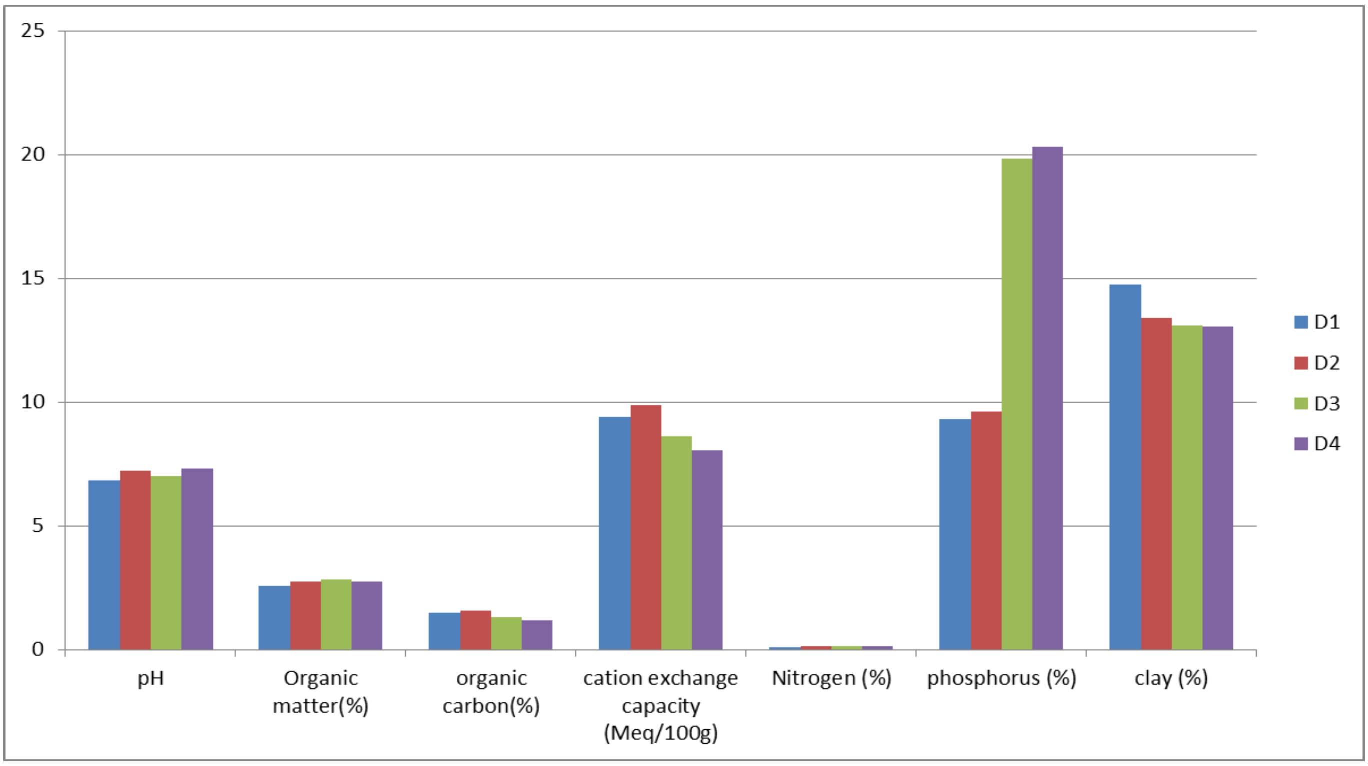

Fig 1: Bar chart representation of the mean physicochemical properties of the upland soils after harvest.

The organic matter mean values of the upland soil samples D_1 to D_4 after harvest were within the permissible limits for agricultural purposes. The findings of this research that soil amendments with inorganic fertilizer could not significantly improve the organic matter content of the soil was corroborated by Tadesse *et al*., (2013) [10], in their studies on the effect of farm yard manure and inorganic fertilizer on the soil physicochemical properties after harvest. Result of Table 2 shows that the organic matter mean values of the lowland soil samples D_1, D_2, D_3 and D_4 after harvest were 2.607±0.310, 2.811±0.202, 2.620±0.413 and 2.766±0.331% respectively. The organic matter mean values did not significantly differ from one another on account of the various amendments with NPK, which corroboratively has been previously reported for the organic matter contents of the upland soil samples in Table 1. The organic matter mean values of the lowland soil samples were within the permissible limits. Okeke *et al*., (2019) [4], reported a higher organic matter mean range of 3.003-3,234% in the ash amended soil samples in Ivo Local Government Area of Ebonyi State, than what was gotten as mean organic matter mean values in the studied soil surfaces amended with NPK. The impact of ash application on the textural and structural characteristics of any soil could have accounted for the observed variations in the two findings.

Organic carbon content: Organic carbon presence in the soil contributes immensely to the levels of the acidity of the soil and hence the solubility of metal solutes in the soil. Result of Table 1 shows that the organic carbon mean values of upland soil samples D_1, D_2, D_3 and D_4 were 1.497±0.312, 1.587±0.401, 1.331±0.272 and 1.170±0.130% respectively. This result shows that amendment at D_2 (50kg NPK) resulted to an increased organic carbon level in the soil, which could mean increased acidity of the soil and therefore increased solubility of mineral elements in the soil. However, soil samples D_3 and D_4 resulted in decreased organic carbon contents respectively, which could have been as a result of the poor textural characteristics and holding capacity of the soil samples probably occasioned by the increased fertilizer application, which could be termed to be in excess. The implication of this for soil samples D_3 and D_4 is that translocation of mineral elements to the parts of the plants grown on such soil would be difficult due to the formation of insoluble salts of the mineral elements. Therefore, amendments on the upland soil samples could be said to have significantly (p<0-05) lowered the organic carbon content of the soil samples after harvest.

Result of Table 2 shows that the organic carbon mean values of the lowland soil samples D1, D2, D3 and D4 were 1.280±0.044, 1.173±0.310, 1.157±0.212 and 1.103±0.170% respectively. The weight amendment with NPK at soil samples D_2 to D_4 led to a significant decrease in their organic carbon mean values from the control (D_1) standpoint as shown in Figure 2.

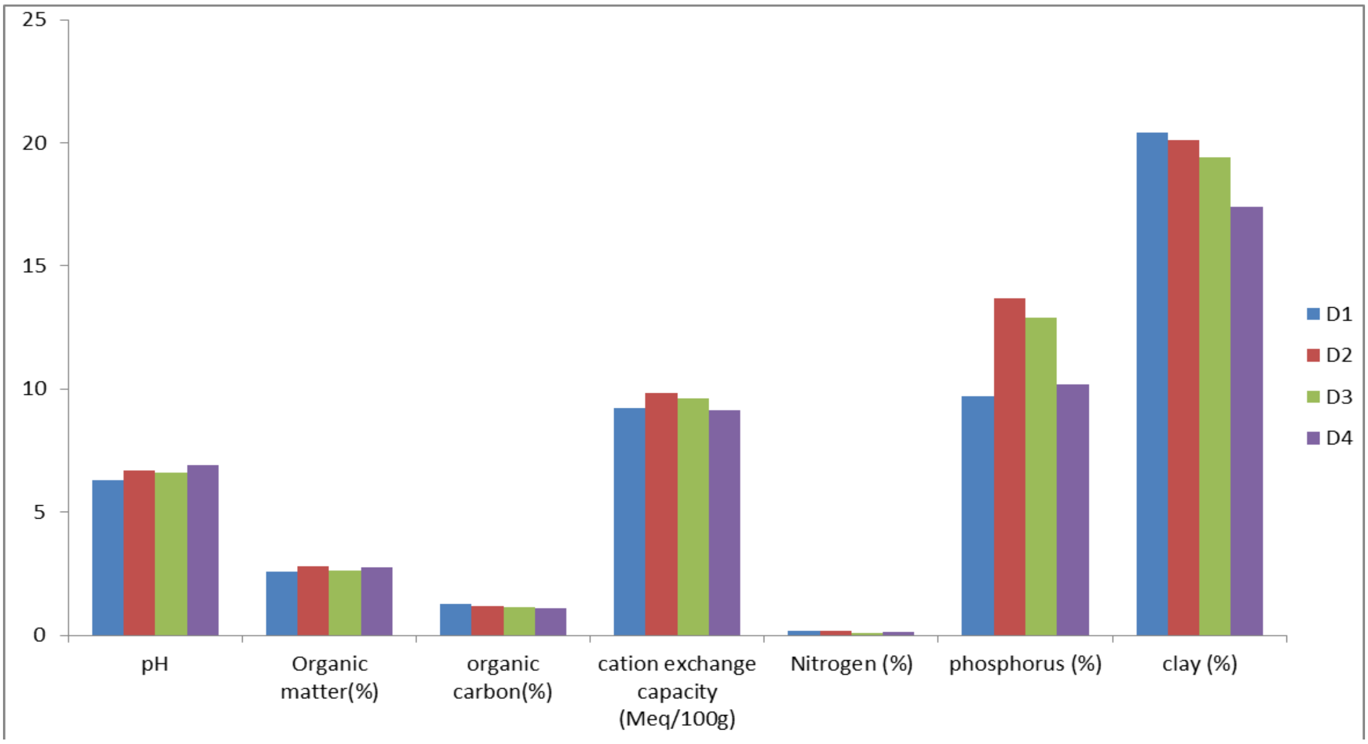

Fig 2: Bar chart representation of the mean physicochemical properties of the lowland soils after harvest

Additionally, extraneous environmental factors such as undue leaching could have given rise to this observation. The organic carbon mean values of both the upland and lowland soil samples after harvest were within the permissible limits. Okeke *et al*., (2019) [4] reported a higher organic carbon mean range of 6.48- 7.14% in soils close to abattoir in Nnobi, Anambra State, than what was gotten as organic carbon mean values in the studied upland and lowland soil samples after harvest.

Yeshpal *et al*., (2017) [9] reported an organic carbon mean range of 2.2 - 3.4% in soils amended with different levels of NPK in Bulandshahar, India, which compares favourably with the mean values gotten for organic carbon in the amended upland and lowland soil samples after harvest

Cation exchange capacity: Result of Table 1 shows that cation exchange capacity mean values of the upland soil samples D_1, D_2, D_3 and D_4 after harvest were 9.414±0.241, 9.860±0.310, 8.616±0.314 and 8.036±0.212 Meq/ 100g respectively. The cation exchange capacity mean values of soil sample D_2 was significantly higher than the other soil samples especially D_3 and D_4 despite higher weight amendments. This observation could have been the summation of the consequence of the values of the other previously discussed parameters especially organic carbon, which were in lower amounts in soil samples D_3 and D_4 and therefore could have resulted in the formation of insoluble metallic salts and hence less availability of such cations in the soil. The cation exchange mean values of the upland soil samples after harvest were within the threshold limits(100 Meq/100g). Result of Table 2 shows that the cation exchange capacity mean values of the lowland soil samples D_1, D_2, D_3 and D_4 after harvest were 9.220±0.101, 9.853±0.361, 9.613±0.166 and 9.123±0.038 Meq/100g respectively. Increased weight amendment at soil samples D_3 and D_4 significantly decreased their cation exchange capacity mean values in similar trend observed for upland soil samples D_3 and D_4. The cation exchange capacity mean values of the lowland soil samples were within the recommended threshold limits.

Nitrogen content: The mean nitrogen values of the upland soil samples D_1, D_2, D_3 and D_4 after harvest were 0.116±0.011, 0.158±0.010, 0.130±0.040 and 0.136± 0.021% respectively. Amended upland soil sample D_2 had a significantly higher mean nitrogen content than the other samples. It can be seen from this result that after harvest, the amendment with NPK at varying weights significantly enhanced the nitrogen availability in the soil samples. Decreased nitrogen mean values were recorded at soil samples with higher weight amendment with NPK and this could be due to the increased loss of soil textural characteristics thus precipitating the leaching of this essential element. Result of Table 2 shows that the lowland soil samples D_1, D_2, D_3 and D_4 after harvest were 0.180±0.010, 0.190±0.002, 0.090±0.001 and 0.135±0.02% respectively. From this result it can be observed that the increased weight amendment of the lowland soil samples with NPK has significantly decreased their nitrogen mean values after harvest.

Phosphorus content: Result of Table 1 shows that the phosphorus mean values of the upland soil samples D_1, D_2, D_3 and D_4 after harvest were 9.303±0.120, 9.621±0.144, 19.831±2.140 and 20.331±1.734% respectively. It can be seen from this result that amendment with inorganic fertilizer significantly increased the presence and availability of P in the amended soil samples after harvest. The phosphorus mean values of the upland soil samples after harvest were within the threshold limits. Result of Table 2 shows that the phosphorus mean values of the lowland soil samples D_1, D_2, D_3 and D_4 after harvest were 9.701±1.402, 13.701±1.402, 12.879±0.104 and 10.203±0.147% respectively. This result indicates that amendment of the lowland soil samples did significantly increase the availability of P in the soil samples after harvest, however, the trend of the increase was not upwardly consistent. The phosphorus mean values of the soil samples were within the permissible limits.

Clay content: Result of Table 1 shows the clay mean contents of the upland soil samples D_1, D_2, D_3 and D_4 after harvest were 14.730±0.320, 13.404±1.011, 13.101±0.422 and 13.071±0.127% respectively. The result of Table 1 shows that the various weight amendments with NPK significantly

(p<0.05) influenced a gradual but consistent decrease in the clay mean levels of the soil samples after harvest as shown in Figure 1. The level of clay in any soil represents its water holding capacity, hence, the increased weight amendment with NPK in soil samples D_2 to D_4 could have decreased their water holding capacities as represented by the above result. The implication of this is that leaching and loss of nutrients in the soils, which gives rise to poor yield becomes highly probable. Result of Table 2 shows that the clay mean values of the lowland soil samples D1, D2, D3 and D4 after harvest were 20.404±1.711, 20.111±0.523, 19.403±0.382 and 17.409±0.220% respectively. It can be observed from Table 2 that the clay mean values of the soil samples significantly decreased as the weight amendment with NPK increased. This observation was similar to what was recorded as clay mean levels for the upland soil samples shown in Table 1.

Conclusion

This research showed that the various weight amendments with NPK on both the upland and lowland soil samples did not alter adversely their pH levels as to impact negatively on future agricultural practices on the soils after the harvest. The amendment with NPK did not significantly enhance the organic matter content of the studied soil surfaces after the harvest. Physicochemical parameters such as organic carbon, cation exchange capacity, nitrogen, phosphorus and clay contents decreased significantly with increase in weight amendment with NPK from 50 to 150kg and it was a conclusion common to both the upland and lowland soil samples at the end of the harvest. This study therefore concludes that an ideal weight amendment (in this case 50kg of NPK) is necessary to keep the soil physical and chemical characteristics in the best condition for an improved soil fertility and sustainable crop production system.

References

1. Ajayi SO, Odesanya BO, Avwioroko AO, Adebambo GS, Okafor B. Effects of long-term fertilizer use on trace metal levels of soils in a farm settlement. E3 Journal of Agricultural Research and Development. 2012;2(2):44-51.
2. Wakuma Biratu, Derbew Belew, Edossa Ettissa. Evaluation of hot pepper (*Capsicum annuum* L.) cultivars for growth and dry pod yields against different blended fertilizer and nitrogen rates in Raya Azebo, Southern Tigray. Int. J Res. Agron. 2021;4(2):15-22.
3. Nemara F, Zewdu T, Ebro A. Effect of organic and inorganic fertilizer application on the highland grasslands of the acidic soil physical and chemical properties. The case of Meta-Robi District. Journal of Biology, Agriculture and Healthcare. 2018;8(3):15-22.
4. Okeke MU, Chime CC, Okeke OR, Alieze AB, Nwankwo OD. Effect of ash application on the physicochemical properties and heavy metal contents in farmlands in Federal College of Agriculture, Ishiagu, Ivo L.G.A., Ebonyi State. Journal of Chemical, Biological and Physical Sciences. 2019;9(4):370-383.
5. Okeke O, Ndubuisi JO, Ozuah AC, Aniobi CC, Okeke MU. Physicochemical characteristics, heavy metal levels and pollution index status in soil samples around Nnobi abattoir in Anambra State. Journal of Environmental Science, Computer Science and Engineering and Technology. 2020;9(3):471-480.
6. Osakwe SA, Okolie LP. Physicochemical characteristics and heavy metal contents in soils and cassava plants from farmlands along a high way in Delta State, Nigeria. Journal of Applied Science and Environmental Management. 2015;9(4):695-704.
7. Taminaw Zewdie Nigatie. Review on effect of N and P fertilizer rates on yield and yield components of common bean [*Phaseolus vulgaris* (L.)] varieties. Int. J Res. Agron. 2021;4(1):32-40.
8. World Health Organization. Joint FAO/WHO food standard programme, codex committee on contaminants in food and additives, 5th session, Geneva, Switzerland; 2011. p. 64-89.
9. Yeshpal S, Duhan BS, Sharma NI. Physicochemical properties of soil, influenced by different levels of NPK, FYM and sulphur in mustard –moong cropping sequence. International Journal of Current Methodology and Applied Sciences. 2017;6(12):4187-4195.
10. Tadesse T, Dechassa N, Bayu W, Gebeyehu S. Effect of farmyard manure and inorganic fertilizer application on the soil physicochemical properties and nutrient balance in rain fed lowland rice eco system. American Journal of plant Science. 2013;4:309-316.
11. Jaishi Ajay, Marahatta Santosh, Jha Ritesh Kumar. Production economics and technology adoption of spring rice at Eastern Chitwan of Nepal. Int. J Res. Agron. 2020;3(1):13-18.
12. Chopra G, Kaizar C. Analytical Agricultural Chemistry, 2nd Edition, Prince Hall, India; c1988. p. 83-84.