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ASSESSMENT OF PHYSICAL AND CHEMICAL PARAMETERS OF MODAL SOIL IN RELATION TO POND CONSTRUCTION AND PRODUCTIVITY IN NIGERIA

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ABSTRACT

A study was carried out for five weeks to examine physical and chemical parameters of modal soil in selected areas in relation to pond setting and productivity in Lagos State, Nigeria. Physical (water temperature, soil permeability, bulk density and textural) and chemical parameters (p^H, nitrogen and phosphorus) were determined according to standard. Results showed that the soil of the study area belongs to four different textural classes: sandy, sandy clay, clay loam and sandy clay loam. The sandy clay was dominant with 38 % proportion, sandy (28 %), sandy loam (28 %) and sandy clay loam was least with 6 % proportion of the prevalent soil textural class in the study area. Soil permeability (6.2 – 24.9 mm/hr) exceeded the permissible value 4mm/hr, Soil bulk density and p^H (1.20 – 1.57g/cm^3) and (5.3 – 7.3) were within acceptable limits of 1,4g/cm^3 and 7.5 respectively. Nitrogen (20.20 – 29.30 ppm) and phosphorus (1.93 – 6.57 ppm) contents for different soil locations were less than the recommended values of 50.0 and 9.0ppm respectively. These results revealed that the soil locations were not suitable for pond construction and productivity. Pond to be built in these areas requires special techniques such as building of clay core, puddle and compaction and application of lime and fertilizer.
Keywords: Parameters, Modal soil, pond construction, productivity, Lagos State

INTRODUCTION

A fish pond is an earthen or concrete enclosure built to retain water so that the bottom soil will minimize seepage for the purpose of growing fish to table-size for food and source of livelihood (Kumar, 2004; Boyd, 2009). Soil and water are two major parameters considered for pond construction. These parameters determined the suitability and productivity of earthen pond at given location. Coche and Muir (2002) and Wheaton (1999) classified soils into three major types for fish pond construction purpose: pervious, impervious and peaty soils. Pervious soil has very little water retaining capacity, and are very sandy or of mixed gravel and sand. Such soils should be avoided. It would then be possible to construct ponds by complete excavation in these sites since there will be no seepage as the soil must have been soaked with water. Impervious soils consist of silt or clay or a mixture of one or both of these with a small percentage of sand and or gravel. Such soils have good water retaining properties and sites with these types of soil are suitable for constructing fish ponds. Often the soil condition may be a mixture of pervious and impervious soils. The selection would then depend on the amount of seepage. Where seepage is excessive the water retaining property of the pond bottom can be improved by spreading a layer of clay or silt, if they are available close by and if it is economical to do so. Alternatively, concrete ponds may be constructed in such places with complete flooring of pond wall and bottom. Soil permeability and bulk density parameters can be used to differentiate the three classes. Both the parameters depend texture of the soil Coche (2006) reported that soil bulk density is perhaps the most important intrinsic characteristics of peat because many other properties are closely related to it, for this reason it is used as a parameter for classifying peat at high categorical levels and it is affected by the pore spaces, texture and organic matter content. The bulk density of organic soil ranges 0.05g.cm^3 in very fibric undecomposed materials to less than 0.5g/cm^3 in well decomposed materials (Coche, 2006). A soil with bulk density less than 1.4g/cm^3 should be treated as peat soil (Kumar (2004), Coche (2006) and Boyd (2009). A good soil for fish culture must be able to hold water and provided the nutrient needed for phytoplankton and zooplankton. Kumar (2004), Coche (2006) and Boyd (2009) reported that clayey- loam soils proved to be the best soil for pond construction and also highlighted that swampy, marshy and peaty soil should be avoided for pond construction. The aquatic environment supports various communities of living organisms which constitute the biotic load of a pond. Natural productivity is the capacity to increase this biotic load (all biomass) over time. Singh (2007) and Capper et-al., (2005) reported that other environmental factors remaining favorable, nutrient concentrations of the soil determine the magnitude of primary production in a water body. Pond productivity depends on the physical, chemical and biological properties of the pond water and also influenced by bottom soil Pond productivity can be classified into primary and secondary. Primary productivity is dependent on light, carbondioxide, temperature and essential nutrients, each of which can be a limiting factor. Of these factors affecting primary productivity in ponds, the one that can be manipulated easily is the quantity of nutrient elements through the application of fertilizers (Kumar, 2004; Boyd, 2001). The secondary productivity is dependent on turbidity, p^H, salinity, dissolved oxygen, plankton, phytoplankton, zooplankton, bacteria and algae. Pond water governing the biological production cycle which is the reflection of the bottom soil (Boyd, 2009; Barnejee, 2001). Pond bottom soil also provides necessary environment for the microbial decomposers (the living fertilizer of the pond (Coche, 2006). The texture of soil that is, the mechanical composition of various components (sand, silts and clay) along with the organic matter, influence the chemical and biological properties to a great extent. The p^H of the soil and water is the critical factors affecting pond productivity. It also influences transformation of phosphates into available forms and controls the absorption and release of essential nutrients at the soil - water interface (Kumar, 2004). Kumar (2004) and Singh (2007) reported that phosphorus is a single critical element for maintaining aquatic productivity. Boyd (2009) and Barnejee (2001) reported that improper selected location and construction of fish ponds resulted to various problems such as seepage, subsidence and crack of dike that arose during operation. Omofunmi (2010) reported that fish ponds in Lagos faced problems such as dryness of pond during dry season, over flood during rainy season, crack and subsidence of the dike which hindered pond operation and resulted loss of investment. This study was conducted to examine the physical and chemical parameters of soil and water in selected areas in Lagos State, Nigeria.

MATERIALS AND METHODS

Site Description

Lagos State is geographically situated in South Western Nigeria. It spans the Guinea Coast of the Atlantic Ocean for over 180km on the South, from the Republic of Benin on the West to its boundary with Ogun State in the North. It falls within longitudes 030 50`E and 030 38`E and latitudes 060 20`N and 060 18`N.The total territorial area of 3,577sq km, about 787sq km or twenty-two percent (22%) is wetland area. The altitude of the State is approximately 4.6m above the sea level. The State is divided into twenty Local Government Areas (Fig. 1)

Figure 1: Map of Lagos State showing the study areas.

Soil samples collection

Seventeen locations were chosen in the study areas. At each location, pits with straight sides of approximate dimensions of 0.8m x 1.5m x 2m depth were dug. Soil samples at specified thickness of soil horizon were carefully collected in separated piles (to avoid mixing) and left to dry before they were packed in polythene bag. The bags were tied and tagged for easy identification of the sampling locations, upper and lower depth of the horizon sampled and the date of collection. The required physical and chemical properties were measured at various depths (00 cm to 160 cm) at 40cm intervals by auger and were taken to the laboratory for analysis. Measured physical and chemical soil quality parameters were textural class, bulk density, p^H, total nitrogen and total phosphorus. All measurements were replicated four times .The collected samples were used for field and laboratory tests. Permeability of the soil was measured as follow: The sides of dug pit were lined with the polythene sheet to prevent horizontal seepage. Water was poured into the hole until the pores of the soil were filled. A meter rule was inserted into the hole to measure the exact water depth (cm). The final water level in the hole was taken at one-hour interval for several hours until hourly measurements became nearly the same. The coefficient of permeability (k) was determined by the equation below as obtained from Coche, (2006).

$$K = \frac{d/2 \log_e (h_1/h_2)}{2 (t_1 - t_2)}$$

Where,

d = Diameter of the soil pit (cm)

h_1 = Initial depth of water (cm)

h_2 = Final depth of water (cm)

t_1 and t_2 = Initial and final time (seconds)

The results of physical and chemical parameters of soil are presented in Table 2.

Water samples were collected at the end of dry season to the beginning of wet season. Water samples were collected from the top and bottom at a depth of 16cm. Samples collected in 250 ml glass bottle were analyzed for dissolved oxygen (DO) and other samples were collected in sterilized 1-litre plastic bottles for other physical and chemical parameters. The required quality parametric analyses were done next day. Measured physical and chemical water quality parameters were Temperature, p^H, DO, free carbondioxide, total suspended solids (TSS), total nitrogen and total phosphorus and p^H was measured in situ using pH meter. The others analyses were conducted according to standard method as presented in Table 2. All samples were replicated four

Determination of Soil Parameters.

The soil parameters measured include the following:

p^H: the p^H of the soil was determined with 10 g of air – dried finely powered soil sample put in a beaker and mixed well with 25ml of distilled water and kept for about half an hour with occasional stirring. The electrode of p^H meter (Model 3510) was dipped into the solution and the reading was taken. (APHA, 2005).

Bulk density of the Soil: Bulk density was determined by gravimetric method. The samples were weighed empty, and later weighed with the soil. The sample was placed in an oven at temperature 105°C for 24 hours and cool in a desiccator.

The bulk density was determined by the formula:

Bulk density of soil (g/cm³) = Mass of oven dry soil (FAO/IIASA. 2008)Volume of core

Soil Texture: 100g of air-dried finely powered soil was put in a 500 ml of conical flask and 15ml of 0.5N sodium oxalate was added. 200 ml of distilled water was added to the mixture and shaken for 20 minutes. The content was transferred to one litre capacity measuring cylinder and made it up to one litre by adding enough water. Hydrometer (Model p10090) was dipped into the suspension after 5 minutes given direct reading of the percentage of clay and silt. Hydrometer reading after 5 hours of sedimentation gives percentage of clay directly. Hydrometer given the reading in g/l percentage of sand was determined by deducting the percentage of clay and silt from 100. Similarly percentage of Silt was determined by subtracting the hydrometer reading for Clay from clay and Silt (APHA, 2005).

Nitrogen: 10g of air-dried soil was put in Kjehdahl flask. 100 ml of 0.32 % potassium permanganate and 100 ml of 2.5 % sodium hydroxide solutions were added to the mixture. The mixture was distilled after adding 2ml of paraffin and 10 – 15 ml of glass beads. 75 ml of 0.02N, sulphuric acid with a few drop of methyl red indicator were titrated with 0.02N sodum hydroxide to a colorless end point.

Nitrogen (ppm) = (25-no. of 0.02N sodium hydroxide solution required) × 2.8 (APHA, 2005).

Phosphate: 1.0g of dried and powered soil sample was put in a glass bottle with a stopper. 200ml of 0.002N sulphuric acid solution was added and shaken for 30 minutes with a mechanical shaker. The mixture was filtered using Whatman 42 filter paper. 25ml of the clear filtrate were used to find out the concentration of phosphate in that solution through the standard curve.

Phosphate (ppm) = phosphate in solution × 20 (APHA, 2005).

Determination of Water Quality Parameters

Water Temperature: It was measured in situ using thermometer (Model 4500) at 16cm depth of water.

p^{H}: The p^{H} (Hydrogen ion concentration) value were measured directly by a p^{H} meter by dipping the electrode into the pond water (APHA 2005).

Dissolved oxygen: DO was determined by Winkler's method. Water sample for DO were collected at each location in 100ml DO sample bottle without agitating. The stopper was carefully removed. 1ml each of sodium iodide solution and magnesium sulphate solution were added with aid of 1ml pipette, the stopper was replaced and the content was thoroughly mixed, 2.0 ml of concentrated sulphuric acid was added to the mixture, of the solution was titrated with 0.025N of sodium thiosulphate with starch solution as indicator.

DO (ppm) = ml of 0.025(N) sodium thiosuphate used x 4 (APHA, 2005).

Free carbon dioxide: 50ml of the samples were collected in a conical flask. Drops of phenolphthaline indicator (reagent) and 10ml of solution were added drop by drop and were stirred simultaneously with a glass rod till the color changed pink. Free carbon dioxide was expressed as follows:

Free CO_2 (ppm) =ml of N/44 sodium carbonate
Where:
N = molarity of sodium carbonate (APHA, 2005)

Nitrogen: 100ml of filtered water sample was collected in Kjeldahl flask fitted with distillation unit. 1g of magnesium oxide was added and 5ml was collected. 1g of devards alloy was added to the remaining volume of the flask and distillation started again. 25ml of distilled was taken in two separate Nessler tubes and 0.5ml Nessler reagent was added to each tube. The mixed solution started developing. This colour after 10-15 minutes was matched against colour discs of a Nesslenizer (BDH Nesslenizer). Nitrogen content (ppm) was expressed as follows:

Nitrogen (ppm) = number of matchng division of the standard dics × 100 × 0.01 (APHA, 2005).

Phosphate (ppm): 50 ml of filtered water sample was put in a nessler tube. 2ml of sulphomolybdic acid and 5 drops of stannous chloride solution were added. The mixtures were mixed thoroughly. The colour after 3-4 minutes was compared with nesslenizer standard colour discs. The phosphate content ($P_2 0_5$) in ppm was expressed as follows:

Phosphate (ppm) = disc reading for 50mm × 2 × 0.01 (APHA, 2005).

Suspended solid: 50 ml of samples through pre – weighted glass fibre paper dried. The suspended solid content of the sample is the difference in the weight of filters. For a given sample location, the experiments were repeated three times and average reading were taken (APHA, 2005).

Data Analysis

Data were analyzed using descriptive statistics. Simple and multiple regression equations were used to describe relationship between nitrogen / and phosphorus with p^H of the soil.

Mathematically, these were expressed as follows:

$$N = a + b\sum p^H \quad (1)$$

$$\sum' N = na + b\sum p^H \quad (2)$$

$$\sum p^H N = \; = a\sum p^H + b\sum p^{H2} \quad (3)$$

OR

$$P = a + b\sum p^H \quad (1)$$

$$\sum P = nab\sum p^H \quad (2)$$

$$\sum p^H P = a\sum p^H + b\sum p^{H2} \quad (3)$$

OR

$$\sum N = na_0 + a_1\sum p^H + a_2\sum p^{H2} \quad (1)$$

$$\sum Np^H = na_0\sum p^H + a_1\sum p^{H2} + a_2\sum p^{H3} \quad (2)$$

$$\sum Np^H = a_0\sum p^H + a_1\sum p^{H3} + a_2\sum p^{H4} \quad (3)$$

OR

$$\sum P = na_0 + a_1\sum p^H + a_2\sum p^{H2} \quad (1)$$

$$\sum Pp^H = na_0\sum p^H + a_1\sum p^{H2} + a_2\sum p^{H3} \quad (2)$$

$$\sum Pp^{H2} = a_0\sum p^H + a_1\sum p^{H3} + a_2\sum p^{H4} \quad (3)$$

Where

N= Nitrogen content (ppm)
P= Phosphorus content (ppm)
p^H= Hydrogen ion concentration
N= Number of samples
∑= Summation
a_0, a, b, a_1 and a_2= constants

Coefficient of correlation (r) and standard error (S.E)

$$r = \frac{ssp^H N}{\sqrt{(ssp^H ssN)}} = \frac{ssp^H P}{\sqrt{(ss\,p^H ssP)}}$$

$$S.E = \sqrt{(1 - r^2)} / (n - 2)$$

RESULTS AND DISCUSSION

Soil Composition

The physical and chemical parameters of soil in the studied areas are presented in Table 1. During the studies carried out in Ajido, Agbara, Kemberi, Ilogbo and Ijanikin (Badagry Local Government Area), two types of soil, viz, sandy loam and sandy soil encountered. The soil of the areas studied were the same except in the percentage of sandy (66.7 – 93.8), silt (1.4 – 17.0) and clay (4.8 – 8.8). Lagos State University (LASU) and some areas in Ojo have two soil types (sandy loam and sandy clay). Sandy loam was dominant. The p^H ranged from (6.9 -7.3) and was higher than that of Badagry areas. Generally, the areas are fairly good for pond construction but it requires special technique to reduce soil permeability which enhanced seepage. In Agege, Alagbado and Iju areas, there are two classes of soil types viz, sandy loam and sandy clay. The 75% textural class was sandy clay, which was found at deeper layer of the horizon. The soils are suitable for pond construction but they require special technique to reduce soil permeability. Soil of Ibeju Lekki area has almost the same textural classes with Badagry areas, but the percentage of sand (95.2 – 98.2) in this area was higher than the Badagry areas. The area was not suitable for pond construction due to high soil permeability. In Ikorodu agric, Owode, Majidun, Ibeshe, Igbogbo and Ijede areas, there are three types of soil viz, sandy loam, sandy clay loam and sand clay. These areas are suitable for pond construction due to high soil permeability. However, compaction must be applied during construction to reduce their permeability in order to reduce seepage to barest minimum. Application of lime and fertilizer also needed. Soil permeability (6.2 – 24.9 mm/hr) exceeded the permissible value 4 mm/hr, Soil bulk density and p^H (1.20 – 1.57g/cm^3) and (5.3 – 7.3) were within acceptable limits of 1.4g/cm^3 and 7.5 respectively. Nitrogen (20.20 – 29.30 ppm) and phosphorus (1.93 – 6.57 ppm) contents for different soil locations were less than the recommended values of 50.0 and 9.0ppm respectively. Coche (2006) reported that soils with permeability greater than 4 mm/hr are prone to seepage almost immediately after construction. For such soil, adequate compaction during construction will reduce seepage to the barest minimum. Pond productivity depends on soil texture and p^H (Coche, 2006, Boyd, 2009; Huet, 2002, Kumar, 2004). Kumar (2004) reported that potassium is always present and enough in soil and water except in acid peat soil. Coche (2006), Barnejee (2001) and Huet (2002) reported that the pond productivity depend on the level of nitrogen and phosphorus contents. Least square regression equations for Nitrogen versus p^H and Phosphorus versus p^H are detailed in Tables 3 and 4 respectively. The analysis generally indicates that the nitrogen and phosphorus contents tend to increase with increase in p^H. The data also linked the phosphorus level with the inherent status of soil. However, the nitrogen content sometimes does not have any correlation with the inherent status of the soil. The presence of micro-organism such as bacteria and algae has contributed to the increase of nitrogen level in the soils (Barnejee, 2001). Both the linear and non-linear regression equations confirm positive correlation between Nitrogen, Phosphorus and p^H of the soils. This findings support those of Coche (2006); Barnejee, (2001) and Kumar, (2004) that p^H level of soils was an indication of biological productivity in the pond. It is thus a valuable index of phosphorus and nitrogen contents in the soil was presented in Table 2. The general equations predicting the Nitrogen and Phosphorus contents in relation to p^H for the study areas was presented in Tables 3 and 4. The findings corroborate those of Boyd (2009) and Barnejee (2001) that improper selected location and construction of fish ponds resulted attributed to problems (seepage, subsidence and crack of dike) arose during operation

CONCLUSION

The physical and chemical parameters of modal soil at selected areas in Lagos State were assessed. The results showed that soil areas in Badagry and Ibeju Lekki were not good for fish pond construction. The others areas (Ojo, LASU, Agege, Alagbodo, Iju, Agric., Owode, Majidun, Igbogbo, Ijede and Ibeshe) were better for pond construction, hence though compaction are needed during construction. Application of fertilizer should be applied to enhance pond productivity.

Table1: Physical and chemical parameters of modal soil at selected areas in Lagos State.

Station	Depth (cm)	Nitrogen (ppm)	Phosphorus (ppm)	Sand (%)	Silt (%)	Clay (%)	p^H	Texture	Perm. (mm/hr)	Bulk density (g/cm^3)
AJIDO										
A_1	0-40	26.4	3.6	86.7	16.4	8.8	6.2	SL	24.8	1.57
A_2	40-80	25.6	2.8	85.3	8.5	6.5	6.0	S	24.8	1.58
A_3	80-120	24.6	2.6	84.6	8.6	6.6	5.9	S	24.8	1.59
A_4	120- 160	22.2	2.6	84.5	8.8	6.4	5.8	S	24.8	1.59
KEMBERI										
B_1	0-40	24.4	3.7	75.8	16.8	7.4	6.5	S L	24.8	1.56
B_2	40-80	23.4	2.6	88.3	5.8	5.9	6.4	S	24.8	1.56
B_3	80-120	23.3	2.4	85.9	7.9	6.2	6.3	S	24.8	1.57
B_4	120-160	23.2	2.3	88.6	7.3	7.3	6.3	S	24.8	1.57
ILOGBO										
C_1	0-40	27.1	4.9	75.5	17.0	7.4	6.5	SL	24.9	1.56
C_2	40-80	26.3	4.3	85.8	7.4	4.8	6.5	S	24.9	1.58
C_3	80-120	25.2	3.6	89.6	3.6	6.3	6.4	S	24.9	1.59
C_4	120-160	25.1	2.6	88.3	4.6	5.3	6.4	S	24.9	1.59
AGBARA										
D_1	0-40	26.3	4.8	75.7	15.4	8.7	6.6	SL	24.6	1.55
D_2	40-80	26.2	4.7	66.7	8.4	4.9	6.4	S	24.6	1.57
D_3	80-120	24.0	3.2	84.8	8.3	6.9	6.3	S	24.6	1.57
D_4	120-160	23.6	2.6	85.3	8.4	6.3	6.3	S	24.6	1.57
IJANIKIN										
E_1	0-40	28.4	2.6	75.8	17.0	7.2	6.2	SL	24.5	1.54
E_2	40-80	24.2	2.4	85.8	7.4	4.8	6.1	S	24.5	1.55
E_3	80-120	23.4	1.8	93.8	1.4	4.8	5.8	S	24.5	1.56
E_4	120-160	20.4	0.93	89.8	3.4	6.8	5.3	S	24.5	1.56
OJO										
F_1	0-40	28.4	6.2	74.8	17.6	12.2	7.3	SL	17.3	1.45
F_2	40-80	27.4	6.1	73.6	17.8	18.6	7.3	SL	17.3	1.45
F_3	80-120	27.0	4.8	70.5	7.8	21.7	7.1	SL	17.3	1.44
F_4	120-160	26.2	3.8	69.2	7.6	22.2	7.1	SL	17.3	1.44

LASU										
G_1	0-40	28.4	6.3	74.6	16.7	8.3	7.1	SL	13.5	1.43
G_2	40 - 80	27.5	6.1	74.8	16.5	9.7	7.1	SL	13.5	1.43
G_3	80-120	26.2	4.8	70.6	17.5	10.3	6.9	SL	13.5	1.43
G_4	120-160	26.2	3.6	70.2	17.6	11.2	6.9	SL	13.5	1.43
AGEGE										
H_1	0-40	29.3	6.5	55.2	5.4	38.4	6.0	SC	11.7	1.37
H_2	40-80	26.3	6.3	56.0	7.4	32.4	6.0	SC	11.7	1.37
H_3	80-120	26.3	6.2	55.2	5.4	39.4	5.8	SC	11.7	1.37
H_4	120-160	26.2	6.2	55.2	7.4	37.5	5.6	SC	11.7	137
ALAGBADO										
I_1	0-40	28.3	5.8	85.8	5.4	7.8	6.2	SL	12.8	1.39
I_2	40-80	27.6	5.6	63.8	11.4	24.8	6.2	SL	12.8	1.39
I_3	80-120	26.3	5.3	51.8	9.4	38.8	6.4	SC	12.8	1.34
I_4	120-160	26.2	5.2	47.8	7.4	44.8	6.4	SC	12.8	1.33
IJU										
J_1	0-40	27.3	6.1	78.8	17.4	14.8	6.2	SL	8.4	1.32
J_2	40-80	25.3	5.3	65.8	17.4	26.8	6.1	SL	8.4	1.32
J_3	80-120	24.2	5.2	55.8	7.4	36.8	6.1	SC	8.4	1.32
J_4	120-160	24.1	5.1	59.8	7.4	32.8	6.1	SC	8.4	1.32
IBEJU LEKKI										
K_1	0-40	24.3	4.3	95.2	3.4	1.4	5.7	S	24.8	1.58
K_2	40-80	22.4	4.2	98.2	3.4	1.4	5.5	S	24.8	1.58
K_3	80-120	20.2	3.0	95.2	3.4	1.4	5.3	S	24.8	1.58
K_4	120-160	20.2	2.9	96.2	2.4	0.9	5.2	S	24.8	1.59
IKORODU LGA SECTION OF AGRIC. IKORODU										
L_1	0-40	29.3	5.3	65.2	20.0	14.8	6.8	SL	6.2	1.27
L_2	40-80	26.3	4.3	51.2	8.0	40.8	6.0	SC	6.2	1.27
L_3	80-120	24.3	4.3	51.2	8.0	40.8	5.9	SC	6.2	1.27
L_4	120-160	24.3	4/3	52.2	7.9	40/6	5/8	SC	6.2	1.27
OWODE										
M_1	0-40	28.3	4.4	64.2	23.4	13.4	6.4	SL	6.8	1.28
M_2	40-80	26.3	4.3	55.4	12.4	35.4	6.4	SC	6.8	1.27
M_3	80-120	26.3	3.8	53.2	5.4	41.4	6.3	SC	6.8	1.26
M_4	120-160	24.8	3.7	52.2	7.1	40.2	6.2	SC	6.8	1.26
MAJIDUN										
N_1	0-40	25.5	5.8	66.3	14.0	19.7	6.5	SCL	8.4	1.25
N_2	40-80	24.3	5.3	55.3	9.0	38.2	6.5	SC	8.4	1.25
N_3	80-120	23.4	5.2	51.8	9.0	38.2	6.5	SC	8.4	1.25
N_4	120-160	23.1	4.1	51.5	9.9	36.6	6.5	SC	8.4	1.25

IGBOGBO										
O_1	0-40	28.3	5.1	60.5	18.0	19.5	6.5	SCL	8.4	1.24
O_2	40-80	24.3	5.3	55.3	9.0	38.2	6.5	SC	8.4	1.25
O_3	80-120	23.4	5.2	51.8	9.0	38.2	6.5	SC	8.4	1.24
O_4	120-160	23.1	3.3	50.6	10.3	36.0	6.4	SC	8.4	1.24
IBESHE										
P_1	0-40	26.3	4.3	60.2	19.4	16.8	6.4	SCL	8.6	1.24
P_2	40-80	24.1	3.4	55.6	11.4	30.9	6.3	SC	8.6	1.24
P_3	80-120	23.8	3.2	51.8	11.2	32.8	6.3	SC	8.6	1.24
P_4	120-160	23.6	3.1	50.2	19.0	30.8	6.3	SC	8.6	1.23
IJEDE										
Q_1	0-40	27.8	4.6	61.3	15.3	17.8	6.5	SCL	8.4	1.23
Q_2	40-80	24.8	4.2	56.3	11.6	38.1	6.4	SC	8.4	1.23
Q_3	80-120	24.3	4.1	54.2	11.0	30.8	6.4	SC	8.4	1.23
Q_4	120-160	24.1	3.8	53.6	11.0	31.6	6.4	SC	8.4	1.23

Keys:

SL = Sandy loam

SC = Sandy clay

SCL = Sandy clay loam

S = Sandy

Table 2: Productivities index of Nitrogen and Phosphorus in the Soil to p^H for Fish Ponds in the Study areas.

Soil type	Nitrogen Index (N)	Phosphorus Index (P)
Sandy	1.00	1.00
Sandy clay	1.05	1.02
Sandy loam	1.20	1.04
Sand clay loam	1.20	1.10

Table 3: Linear correlation parameters for variation of Nitrogen and Phosphorus with p^H in some locations in Lagos State.

Station	Regression equation Linear correlation	Coefficient of correlation	Standard error
Ajido	$N = 6.36 + 3.3p^H$	0.62	0.45
	$P = 8.8 + 2.2p^H$	0.48	0.50
Kemberi	$N = -35.1 + 9.2p^H$	0.66	0.35
	$P = -44.8 + 9.2p^H$	0.88	0.34
Ilogbo	$N = -34.5 + 10.4p^H$	0.65	0.33
	$P = -53.8 + 10.1p^H$	0.86	0.32
Agbara	$N = -34.5 + 10.3p^H$	0.70	0.41
	$P = -52.8 + 10.1p^H$	0.84	0.34
Ijanikin	$N = -36.5 + 10.2p^H$	0.68	0.31
	$P = -54.8 + 10p^H$	0.90	0.30
Ojo	$N = 20.5 + 1.2p^H$	0.68	0.29
	$P = -53.9 + 10p^H$	0.81	0.31
LASU	$N= 20.1 + p^H$	0.68	0.23
	$P = -54.8 + 10p^H$	0.80	0.32
Agege	$N = -76.8 + 19p^H$	0.75	0.30
	$P = -18.4 + 2p^H$	0.90	0.30
Alagbado	$N = 12.1 + 3.02p^H$	0.88	0.30
	$P = -34.8 + 6.74p^H$	0.90	0.30
Iju	$N = 12 + 2.12p^H$	0.93	0.26
	$P =-35 + 6.72p^H$	0.98	0.30
Ibeju Lekki	$N = 13.5 + 1.5p^H$	0.89	0.40
Ikorodu Agric,	$N = -71.3 + 15p^H$	0.91	0.21
	$P = 59 – 8.3p^H$	0.76	0.32
Owode	$N = 21.1 + 0.86p^H$	0.88	0.34
	$P = 0.43 + 0.57p^H$	0.46	0.63
Majidun	$N = 13.63 + 1.63p^H$	0.81	0.34
	$P = 0.43 + 0.46p^H$	0.52	0.45
Igbogbo	$N = 15.5 + 2.2p^H$	0.78	0.21
	$P = 4.8 + 0.02p^H$	0.60	0.47
Ibeshe	$N = 14 + 2.2p^H$	0.86	0.22
	$P = 3.01 + 0.01p^H$	0.52	0.48

Table 4: Non-Linear correlation parameters for variation of Nitrogen and Phosphorus with pH in some locations in Lagos State..

Station	Regression equation (Non-Linear correlation)
Ajido	$N = 10.2 + 6.88p^{H} + 0.09p^{H2}$
	$P = 2.24 – 2.06p^{H} + 0.34p^{H2}$
Kemberi	$N = 23.84 + 0.06p^{H} - 0.36p^{H2}$
	$P = -0.03 + 0.69p^{H} -0.06p^{H2}$
Ilogbo	$N = 24.02 + 0.07p^{H} - 0.32p^{H2}$
	$P = -0.03 + 0.75p^{H} -0.09p^{H2}$
Agbara	$N = 25.01 + 0.10p^{H} - 0.33p^{H2}$
	$P = -0.01 + 0.78p^{H} -0.07p^{H2}$
Ijanikin	$N = 24.24 + 0.09p^{H} - 0.34p^{H2}$
	$P = -0.02 + 0.79p^{H} -0.07p^{H2}$
Ojo	$N = -60.94 + 1.3p^{H} + 2p^{H2}$
	$P = -1155.02 + 173p^{H} -0.5p^{H2}$
LASU	$N = -61 + 1.4p^{H} + 2p^{H2}$
	$P = -1156.8 + 173p^{H} – p^{H2}$
Agege	$N = 3.4 + 1.36p^{H} + 0.27p^{H2}$
	$P = -532.8 – 30p^{H} + 14.6p^{H2}$
Alagbado	$N = 14.04 + 40.09p^{H} - 5.34p^{H2}$
	$P = -6.02 + 2.39p^{H} -0.2p^{H2}$
Iju	$N = 13.33 + 39.96p^{H} – 6.24p^{H2}$
	$P = -6.13 + 2.42p^{H} – 0.1p^{H2}$
Ibeju Lekki	$N = 0.31 + 0.2p^{H} + 0.65p^{H2}$
	$P = -47 + 4.8p^{H} + 0.64p^{H2}$
Ikorodu Agric.	$N = 0.86 – 0.76p^{H} + 0.85p^{H2}$
	$P = 3.4 – 0.7p^{H} + 0.01p^{H2}$
Owode	$N = 12.2 + 1.67pH - 0.06pH^{2}$
	$P = 3.02 + 0.39p^{H} + 0.03p^{H2}$
Majidun	$N = 12.4 + 1.69p^{H} + 0.02p^{H2}$
	$P = 2.21 + 0.44p^{H} + 0.004p^{H2}$
Igbogbo	$N = 0.04 - 0.003p^{H} - 0.06p^{H2}$
	$P = -12.2 + 3p^{H} + 0.04p^{H2}$
Ibeshe	$N = 0.05 – 0.004p^{H} + 0.63p^{H2}$
	$P = -12.3 + 3p^{H} + 0,03p^{H2}$

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