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INFLUENCE OF FISH POND EFFLUENT AND POULTRY MANURE ON SOIL CHEMICAL PROPERTIES, GROWTH AND NUTRIENT STATUS OF MAIZE (*ZEA MAYS*) IN IGBARIAM, SOUTH EASTERN NIGERIA

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ABSTRACT

The Influence of Fish Pond Effluent and Poultry Manure on Soil Chemical Properties, Growth and Nutrient Status of Maize was investigated during 2017 farming season at the Teaching and Research Farm of the Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus, Anambra State, ,Nigeria. The experiment which was laid out in a Randomized Complete Block Design comprised four treatments and three replications. The treatments were: Control (No treatment); Poultry Manure (10t/ha).; Fish Pond Effluent (40,000 litres/ha): Fish Pond Effluent (20,000 litres/ha) + Poultry Manure (5t/ha). Data generated from the study were subjected to the analysis of variance (ANOVA) test based on Randomized complete Block Design (RCBD). The treatment means were separated using Least Significant Difference (LSD 0.05). The results obtained revealed that, Fish Pond Effluent when applied singly as well as its combination with Poultry Manure significantly influenced all the growth parameters accessed. The highest values of plant height (151.96cm), stem girth (7.06cm), Number of leaves (11.7) and Leaf Area (567.3cm2) were recorded at 8 Weeks After Planting (WAP) at the plot where Fish Pond Effluent (20,000 litres/hectare) was combined with 5tons/hectare of Poultry Manure. The Nutrient Status (N,P,K,Ca,Mg) of Maize leaf and some Soil Chemical Properties (pH, Available Phosphorus, Total Nitrogen, Organic Carbon and Organic Matter) were increased when compared with the Control by the application of Fish Pond Effluent singly and its combination with Poultry Manure. Based on the results obtained, it is recommended that, Fish Pond Effluent (20,000 litres/hectare) + poultry manure (5tons/hectare) be applied in the study area to increase plant growth, nutrient status and soil fertility level of Igbariam.

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INTRODUCTION

Maize (Zea mays L) is one of the three most important cereal crops in the world and it grows across a range of agro-ecological zones. In view of this, the land area devoted for Maize production in West and Central Africa had expanded from 3.2 million hectares in 1961 to 8.9 million hectares in 2001 which resulted to increased production from 2.4 metric tons in 1961 to 10.6 million metric tons per hectare in 2001 (Kogbe, 2003). In Nigeria, Maize is cultivated for both commercial and subsistence purposes and it is being used also for the production of indigenous and commercial food products that are relished for their unique and distinctive flavours (Olatoye and Adegbesan, 1991; Eleweanya et al, 2005). Maize has also been a priority crop in Nigeria under the flagship Agricultural programs of the Government since 2012 and as such, maize farmers had received intentional support in terms of access to subsidized fertilizer and improved seed (Federal Ministry of Agriculture and Rural Development, 2011). However, despite all these efforts, low yield of maize remains a key challenge. This could be attributed to the low soil fertility level of the Nigerian soils and therefore requires remedy. Application of inorganic fertilizers had been the quickest solution to over come the nutrient deficiencies in the soils, but due to problems associated with its continuous usage such as: high cost, reduced crop yield, increased soil acidity, nutrient imbalance and limited or untimely availability of

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inorganic fertilizers made farmers develop interest on usage of organic manure (Ojeniyi, 2002; Mbah and Mbagwu, 2006; Carlsson et al, 2005: World Bank, 2006 and John *et al*, 2004). Poultry Manure had been reported to contain essential nutrient elements that are associated with increased photosynthetic efficiency which promotes more vigorous growth, improved meristematic and physiological activities in the plants, as well as improve the soil properties, thereby resulting in the synthesis of increased photo-assimilates that enhanced maize yielding ability (Boateng et al, 2006). Results of other researchers indicated positive impact of integrated application of Poultry manure or other organic manure and mineral fertilizer on nutrient uptake, growth and yield of crops (Ayeni and Adetunji, 2010; Isitekhale, 2010; John et al, 2013; Nweke and Nsoanya, 2015). In recent times, interest has been developed by researchers towards utilization of Fish Pond Effluent as organic fertilizer since fish pond Effluent had been reported to contain high content of organic matter and plant nutrients (Zieman et al, 2007; AL-Jaloud et al, 1993). Isitekhale and Adamu (2016) reported that, Fish Pond Effluent application increased Soil contents of available P., K, Mg, Ca and ECEC significantly. Although, few experiments had been carried out on the use of Fish Pond Effluent as organic manure or irrigation water for vegetable production, yet, its effect on Nutrient Status and some Soil Chemical Properties while growing other arable crops like Maize especially in Igbariam area has not been widely studied. Hence, the objective of this study is to investigate the Influence of Fish Pond Effluent and Poultry Manure on some Soil Chemical Properties, Growth and Nutrient Status of Maize (Zea mays) in Igbariam, South Eastern, Nigeria.

MATERIALS AND METHODS

Site Location: A field experiment was carried out during 2017 farming season at the Faculty of Agriculture Teaching and Research Farm of Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus, Anambra State, Nigeria. Igbariam is situated within the derived Savanna zone of Nigeria and is located at latitude 06° 14'N and Longitude 06° 45 E (Anambra State Ministry of Science and Technology Meteorological Station Igbariam). The average temperature of the study area is between 21°C – 24°C; while the total mean annual rainfall ranges between 1500mm and 2000mm. The Relative Humidity (RH) is moderately high with the highest RH of 85% at the wet season and the lowest RH of 60% during the dry season.

Land Preparation, Experimental Design and Treatment Allocation: The site for the experiment was cleared and tilled manually with hoe. The area of the site measuring 13m x 17m ($221m^2$) was then marked out into plots. The experiment which was laid out in a Randomized complete Block Design (RCBD), comprised four levels of treatment and three replications, giving a total of 12 plots. The area of each plot was 3m x 3m = $9m^2$ with a distance of 2m between the blocks and 1m pathway between plots. The treatment materials – Fish Pond Effluent and Poultry Manure were applied to the respective plots two weeks before planting to allow for decomposition and mineralization of nutrients. The levels of treatment included the followings; Control (No treatment); Poultry manure – 10t/ha; Fish Pond Effluent – 40,000 litres/hectare; Fish Pond Effluent (20,000L/ha) + Poultry Manure (5t/ha) .Two seeds of the Hybrid Maize (Oba Super II) were planted per hole at the spacing of 75cm x 25cm and at the depth of 3cm two weeks after the application of the treatment materials. Later, the seedlings were thinned down to one plant per hole and empty stands were supplied thereafter. Weed Control was done manually using hoe at the interval of two weeks until harvest to reduce the competition between the maize plant and weeds for available nutrient, water and light.

Data Collection

Data collection on the following growth parameters (namely; plant height, stem girth, Number of leaves and leaf area) were carried out at the 6th, 7th and 8th Weeks After Planting (WAP). Five maize plants were selected randomly from each plot, tagged and were used for the measurement of the above listed growth parameters. Leaf Area was determined by the non-destructive length x width method described by Saxona and Singh (1985) using the relation; Leaf Area = 0.75 (Length x Width) where 0.75 is a constant. Data collection on Nutrient status (N, P, K, Ca, Mg) was also carried out. Five randomly selected maize leaves from each plot were dried, crushed, sieved and used for analysis of Nutrient Status. Nitrogen was determined by micro-Kjeldahl method; Determination of Phosphorus was done using vanado-molybdate colorimetry; Potassium was determined by Flame Photometer; while Calcium and Magnesium were determined by EDTA titration (Tel and Hagarty, 1984).

Table 1. Physical and Chemical Properties of the soil of the experimental site before treatment application

Soil Properties	Value
Physical characteristics:	
Particle Size (g/kg)	
Sand	66.40
Silt	20.00
Clay	13.60
Textural class	SL
Chemical characteristics	
pH (H20	5.70
Available phosphorus (mg/kg)	21.50
Total Nitrogen (g/kg)	0.78
Organic carbon (g/kg)	17.6
Organic Matter (g/kg)	30.3
Exchangeable base (Cmol kg^{-1})	
Ca 2+	6.00
Mg 2+	4.40
K +	0.174
CEC	11.60
Base saturation (%)	96.39
Exchangeable acidity (cmol kg^{-1})	
H+	0.40

Table 2. Nutrient Composition of Fish Pond Effluent before application

Nutrient	Value
pH	6.90
Calcium (mg L – 1)	36.07
Magnesium (mg L – 1)	9.72
Potassium (mg L – 1)	39.00
Phosphorus (mg L – 1)	2.50
Total Nitrogen (mg L – 1)	5.32

Soil samples were randomly collected from different locations of the experimental field, bulked together and used for the analysis of physico-chemical properties of soil of the experimental site before application of treatment materials (Table 1). Another soil samples were collected from each plot randomly at the end of the experiment, for determining some soil chemical properties (namely; pH, Organic carbon, organic

matter, Total Nitrogen and Available phosphorus). Soil pH was determined by glass electrode pH meter; organic carbon/organic matter was determined by Walkley and Black (1934) wet oxidation method. Total Niterogen was determined by using Kjeldahl digestion method of Black et al (1965) while available phosphorus was determined by the method of Bray and Kurtz (1945). Fish Pond Effluent (treatment material) was analyzed for its nutrient content (Table 2). pH was determined using digital pH meter while Ca, Mg, K, P, N were determined by the methods explained above in Nutrient Status determination. The data that were generated from the study, were subjected to the statistical Analysis of Variance (ANOVA) test according to Steel and Torrie (1980), while the treatment means were compared using the Least Significant Difference (LSD) at 0.05% level of probability.

RESULTS AND DISCUSSION

Growth Components of Maize Plant: The results on Table 3 showed that ,Fish Pond Effluent, Poultry Manure and their combination had great influence on the growth components of maize plant. The plant height, stem girth and Number of leaves increased as the Weeks After Planting (WAP) increased in all the treatments when compared with the Control. The plant height was significantly (P = 0.05) different at the 8th WAP while at 6th and 7th WAP, plant height was not significant. The highest plant height- 151.96cm was obtained at the 8th WAP at the plot where Fish Pond Effluent (20,000L/ha) was applied with Poultry Manure (5t/ha). The lowest plant height (95.77cm) was obtained at the Control. The order of increase was FPE + PM > FPE > PM > CO. Stem girth of maize also increased as the weeks after planting (WAP) increased in all the treatments and were significantly different. Similar trend was noticed on Number of leaves but was significantly different only at the 6th and 8th WAP. At the 7th WAP, no significant difference was recorded on Number of leaves. The result obtained on Leaf Area of Maize as presented on Table 4, revealed that, Fish Pond Effluent when applied singly as well as its combination with poultry manure increased the leaf area of maize when compared with the Control and was significantly different. The highest leaf area (567.3cm^2) was recorded at 8 WAP at the plot where Fish Pond Effluent (20.000 litres/hectare) was applied with poultry manure (5 tons/hectare). The lowest value of leaf area (309.8cm^2) was recorded at the Control. The order of increase was FPE + PM > FPE > PM > CO.

Nutrient Status of Maize Leaves: The results obtained on Nutrient Status of maize leaves (Table 5) indicated positive effect of Fish Pond Effluent as well as its combination with Poultry manure on all the nutrients analyzed when compared with the Control and were significantly (P=0.05) different. The highest values of Total Nitrogen (2.45%); Phosphorus (0.585%); Potassium (0.84%); Calcium (3.10%) and Magnesium (0.730%) were recorded at the plot where Fish Pond Effluent at 20,000L/ha was applied with Poultry manure at 5t/ha. While the lowest values of these nutrients (N-2.03%; P – 0.460%; K – 0.60%; Ca – 2.10%; Mg – 0.610%) were obtained at the Control.

Table 3. Influence of Fish Pond Effluent and Poultry Manure on the Growth Components of Maize Plant

Treatment	Plant height (cm) WAP			Stem girth (cm) WAP			Number of leaves WAP		
	6	7	8	6	7	8	6	7	8
CO (No treatment)	48.94	56.18	95.77	4.58	4.81	4.87	8.3	9.7	9.8
PM – 10t/ha	57.13	77.66	115.82	5.75	5.91	5.99	9.4	10.7	11.2
FPE – (40,000L/ha)	59.59	80.41	124.93	5.79	6.31	6.39	9.4	10.9	11.3
EPE (20,000L/ha) + PM (5t/ha)	65.70	89.07	151.96	6.25	6.79	7.06	10.1	11.5	11.7
LSD 0.05	NS	NS	21.67	0.77	0.91	1.09	0.96	NS	0.85

CO-Control; PM- Poultry Manure; FPE- Fish Pond Effluent ; LSD- Least Significant Difference; WAP- Weeks After Planting; NS – Not Significant, t/ha –ton/hectare.

Table 4. Influence of Fish Pond Effluent and Poultry Manure on Leaf Area of Maize

Treatment	Leaf Area (cm^2) WAP			
	5	6	7	8
Co (No treatment)	121.1	180.6	240.3	309.8
PM – 10t/ha	189.8	242.7	308.1	408.3
FPE 40,000L/ha	198.9	267.2	356.6	457.2
FPE (20,000L/ha) + PM (5t/ha)	235.7	272.5	425.1	567.3
LSD – 0.05	3.11	1.99	3.39	3.92

CO – Control. PM – Poultry Manure; FPE – Fish Pond Effluent; LSD – Least Significant Difference ; WAP- Weeks After Planting.

Table 5. Nutrient Status (%) should be moved towards the right to be the heading of N, P, K,Ca, Mg while Treatment is moved up to be the heading of CO, PM, FPE etc

Nutrient Status (%)					
Treatment	N	P	K	Ca	Mg
CO (No treatment)	2.03	0.460	0.60	2.10	0.610
PM – 10t/ha	2.17	0.560	0.75	2.40	0.670
FPE (40,000L/ha)	2.24	0.570	0.80	2.80	0.710
FPE (20,000L/ha) + PM (5t/ha)	2.45	0.585	0.84	3.10	0.730
LSD 0.05	0.07	0.01	0.04	0.08	0.009

CO- Control, PM – Poultry Manure, FPE – Fish Pond Effluent,
LSD - Least Significant Difference ;WAP – Weeks After Planting.

Table 6. Influence of Fish Pond Effluent and Poultry Manure on some Soil Chemical Properties of Igbariam

Treatment	pH (H_20)	P (Mg kg-1)	TN (g/kg)	OC (g/kg)	OM (g/kg)
CO (No treatment)	6.07	20.77	0.82	17.6	30.3
PM (10t/ha)	6.37	24.93	1.14	20.0	34.5
FPE (40,000L/ha	6.30	21.10	0.96	19.1	32.9
FPE (20,000L/ha) + PM (5t /ha)	6.50	27.60	1.21	22.9	39.5
LSD 0.05	0.08	0.63	0.03	0.07	0.11

CO – Control (No treatment); PM – Poultry Manure;
FPE – Fish Pond Effluent, LSD – Least Significant Difference
P- Available phosphorus; TN- Total Nitrogen; OC- Organic Carbon; OM- Organic Matter

Soil Chemical Properties: The results of the Soil analysis (Table 6) carried out showed that, both Poultry Manure and Fish Pond Effluent when applied singly or their combination significantly (P = 0.05) increased the values of pH; phosphorus (P); Total Nitrogen (TN); Organic Carbon (OC) and Organic Matter(OM). The highest values of pH – 6.50; P – 27.60mgkg-1; TN – 1.21g/kg; 0C– 22.9g/kg; OM – 39.5g/kg were recorded at the plot where fish pond effluent applied at the rate of 20,000 litres/hectare was combined with poultry manure at 5tons /hectare .The least values of these Soil chemical properties were obtained at the Control. The order of increase was FPE + PM > PM > FPE > CO.

DISCUSSION

Fish Pond Effluent is rich in nutrients and organic matter. It has been reported that, regular application of green manure, animal manure and formulated complete feed to fish ponds had resulted to accumulation of Organic Matter (OM); Nitrogen (N), and phosphorus (P) in sediments. Olah et al (1994) reported that, 30 – 95% of the N applied to fish ponds accumulated in the sedment while Boyd (1995) showed that a higher fraction of P compounds applied to ponds got accumulated in the sediment. Therefore fish pond effluent has been used as an organic fertilizer as it has the potential to supply plant with nutrients and act as soil conditioner. In this study, the application of fish pond effluent singly and its combination with poultry manure had shown to be positive as it resulted in improving nutrient release and uptake by the maize plant. The plant height, stem girth, number of leaves as well as leaf area, Nutrient status and some soil chemical properties (pH, Available phosphorus, Total Nitrogen, Organic Carbon, Organic Matter) of the studied area were increased by the application of Fish Pond Effluent. This could be attributed to the higher levels of organic matter and Nutrients released by both the Fish Pond sediments and Poultry Manure after decomposition and mineralization.

Conclusion

The results obtained from the study revealed that, application of fish pond effluent can be used as organic fertilizer and good soil conditioner to improve nutrient status and thereby enhance mineral nutrition and plant growth. The combination of fish pond effluent (20,000 litres / hectare) with 5tons/ hectare of poultry manure significantly increased plant height, stem girth ,Number of leaves and leaf area at 8 weeks after planting (WAP) when compared with the Control. Some Soil chemical properties such as pH, Available Phosphorus, Total Nitrogen, Organic Carbon and Organic Matter were significantly increased by Fish Pond eEfluent combined with Poultry Manure when compared with the control. Consequently, it is recommended that, fish pond Effluent at the rate of 20,000 litres/ hectare be applied with 5t/ha of Poultry manure to improve Plant growth, Nutrient status, and Soil fertility level of the study Area.

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