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Effect of Moringa and Poultry Manure on Soil, Growth and Yield of (*Amaranthus Cruentus*) in Afikpo, Nigeria

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Abstract

A Greenhouse trial was conducted in Research farm of Akanu Ibiam Federal Polytechnic, Nigeria, to investigate the effects of composted moringa leaves and poultry manure on soil chemical properties, growth and yield of amaranthus. Treatments consisted of three rates of composted moringa leaves (MC), (0, 1 and 2-ton ha^{-1}) and three rate of poultry manure (PM) (0, 1- and 2-ton ha^{-1}). The experiment was laid out in a Complete Randomized Design in a factorial pattern with three replications. The test soil was marginal in organic matter, inadequate in available P, acidic and general low in fertility. The results obtained showed that all rates of the manure significantly improved the soil nutrient status relative to control. All manure rates significantly increase the growth and yield of amaranthus. Relative to control, 2-ton ha^{-1} MC and 2-ton ha^{-1} PM increased number of leaves, plant height, and stem girth by 50%, 74.3% and 81% respectively. Generally, treatment combination of 2-ton ha^{-1} MC and 2-ton ha^{-1} PM gave the most appreciable increase in both soil nutrient and plant yield and it is therefore recommended for optimum and sustained amaranthus production in soils of Southeastern Nigeria.

Keyword: Moringa, Compost, Poultry manure and soil fertility

Introduction

Soil fertility deterioration occasioned by nutrient loss through leaching, acidity, erosion, sorption and aggressive mineral fertilizer use has led to loss soil quantity and quality (Osodeke, 1996; Azu *et al*., 2018; Awodum, 2007) in southeastern Nigeria. This has not only limited food production, but has also affected the socio-political variables in this region. Therefore, to sustain food production to meet the food need of the rapidly growing population, concerted effort should be taken to increase and sustain the fertility and productivity of these soils. Consequently, the interest of soil Scientist within this region has been drawn to this problem. Several studies have been carried out to improve the soil fertility conditions of the region. Such studies have reported increased soil fertility with the application of both organic and inorganic materials into soils (Onwuka *et al*., 2007; Eneje and Azu, 2009; *Azu et al*., 2018).

Different sources of organic manure have been used to promote soil productivity and one of such plant materials which has received limited attention with respect to its potential in enhancing soil fertility is the moringa plant. Moringa plant has traditionally been used in the treatment of various human ailments. But due to the recent promotion of organic agriculture, researches have shown that moriga apart from its medicinal uses, also has the potentials of improving the soil conditions for plant growth (Utietiang, *et al*., 2013). According to Brockman and Brennan (2017), leaf extracts from different varieties of moringa improved the soil chemical conditions and crop performance in field experiment. Similarly, Uttietiang *et al.,* (2013), has reported reduced acidity and increased yield of Egg plant as a result of moringa leave application to soil.

However, there is still dearth of information on potentials of moringa in soil fertility restoration in Southeastern Nigeria. This study therefore was aimed at assessing the combined effect of composted moringa leaf and poultry manure on soil fertility, growth and yield of Amaranthus in Unwana, Southeastern Nigeria.

Materials and Method

The study was carried out in the Green House of Akanu Ibiam Federal Polytechnic, Unwana, (latitudes 5^{o} 48N and longitude 7 ^{o} 55E). The climate and vegetation types are generally humid tropical rainforest with mean annual rainfall of about 3,500mm and mean daily temperature range of 27^{o}C to 38^{o}C (Njoku *et al*., 2006).

The soil sample was collected from the Research Farm of Horticulture and Landscape Technology Department using soil auger at 0 – 20cm. 5Kg of each was weighed into polyethylene bags perforated at the bottom. Compost of the moringa leaf was formed by decomposing the leaves in a closed container, ensuring adequate aeration and moistening for two months.

Appropriate weights of composted moringa leaf (MC) and Poultry manure (PM) were added to each polyethylene bag (plant pot). The treatments comprised of three rates (0, 1 and 2 t/ha) MC and three rates (0, 1 and 2 t/ha) PM arranged factorially in Complete Randomised Design in three replications. Amaranthus seeds were sown in drills one month after soil amendment and later thinned down to one seedling per pot after germination.

The following growth and yield parameters were taken six weeks after planting: Plant height, Numbers of leaves and stem girth. Post-harvest soil samples were

collected from each pot and the following chemical analysis were carried out: soil pH was determined in soil to water and soil to $CaCl_2$ at a ratio 1:2 soil water and soil $CaCl_2$ respectively using glass electrode P^H meter (Udo *et al*; 2009).Organic carbon was determined by the wet oxidation method according to Pansu and Gautheyrous (2006) and converted to organic matter by multiplying by 1.792. The total nitrogen determination was done by the macro Kjeidahl digestion method (Simmone *et al.,* 1994). Available P was determined using the Bray II method of Bray as described by Udo *et al*; (2009). Exchangeable acidity was determined by the nikel extraction procedure as described by Udo *et al*., (2009). Exchangeable basic cations (K^+, Ca^{2+}, Mg^{2+}, Na^+) were determined by the ammonium acetate method (Carter and Gregoich, 2008). Ca and Mg in the extract were determined using the atomic absorption spectrophotometer, while K and Na were determined using the flame photometer. Effective cation exchange capacity **(**ECEC) was obtained by summation of all the exchangeable cations and exchangeable acidity as described by Udo, *et al*; (2009). The base saturation was obtained mathematically with

$$BS\ (\%) = \text{Total cation} \times \frac{100}{ECEC\quad 1}$$

Statistical Analysis

Data from agronomic parameters and soil chemical properties were subjected to analysis of variance (ANOVA) and the means separated using FLSDO 0.005.

Result and Discussion

The textural class was a clayey-loam and the pH indicated acidic both in water and in $CaCl_2$ (Table 1). These results corroborated with the findings of earlier researchers on soils of Unwana, (Azu *et al*., 2017; Azu *et al*., Eneje and Azu, 2009). The organic carbon, organic matter and total nitrogen were moderately high, the available phosphorus was low (7.53 mg/kg). The high clay content with their corresponding high concentrations of Fe^{2+} and Al^{+3}oxides favour P sorption and thus low available P (Osodeke and Ubah, 2005; Azu *et al*., 2017;). Total exchangeable bases were moderately high, with Ca^{2+} occurring more than others (3.21 cmol/ kg). This may be related to high occurrence of limestone in most soils of Ebonyi State (Azu etal., 2018). The exchangeable acidity was high (3.04 cmol/ kg), owing to the high concentration of sexquoxides in the soil. High concentration of sexquoides has been known to increase soil acidity (Brady and Weil, 2008). The effective cation exchange capacity (ECEC) and base saturation were moderately high (8.36 cmol/ kg and 63.64%), respectively.

Table 1: Some properties of the Soil, Poultry manure and Composed moringa leaf used for the Study

Properties	Soil	PM	Composted Mornga Leaf
Sand %	39.98	-	-
Silt %	16.35	-	-
Clay %	43.67	-	-
Texture	Clayey-loam	-	-
pH (H_2O)	5.14	7.78	7.46
pH ($CaCl_2$)	4.08	6.59	7.09
Organic carbon (%)	2.55	3.99	4. 23
Organic matter (%)	4.42	6.95	7.31
Total nitrogen (%)	0.23	1.27	1.55
Available phosphorus (mg/kg)	7.53	12.00	17.02
Ca^{2+} cmol/kg	3.21	4.11	3.78
K^{+} cmol/kg	0.16	2.00	3.00
Mg^{2+} cmol/kg	1.94	1.72	2.62
Na^{+} cmol/kg	0.01	1,45	2.22
TEA cmol/kg	3.04		-
ECEC cmol/kg	8.36		-
BS (%)	63.64		-

Chemical analysis of the poultry manure and the composted Moringa leaves both materials were alkaline in water and salt (Table 1) This is an indication of their potentials in reducing soil acidity and suitable replacements for commercial lime. Organic carbon and organic matter were higher in Moringa compost. Other researchers have also reported high concentration of organic carbon and organic matter in moringa leaf extract (Brockman and Brennan, 2017; Utietiang *et al*, 2013). Except Ca+, other nutrients including nitrogen, available P and the basic cations were higher in Moringa compost. Thus high nutrient content in Moringa compost if appropriately harnessed can provide nutrients to both soil and growing plants in the nutrient deficient and poor structured soils of South-eastern Nigeria.

Effect of Composted Moringa Leaf and Poultry Manure on Selected Soil Fertility Properties

The mean effect of composed moringa leaf and poultry manure no selected soil properties is presented in Table 2. Results showed that the pH was significantly improved ($P<0.05$) with the addition of these materials as single and combined treatments. The increase in pH was proportional to the rate of amendment and the highest pH value of 6.85 was obtained in the pot that had treatment combination of $2tonha^{-1}$ MC and $2tonha^{-1}$ PM. The observed improvement on soil pH owing to these treatment application

may be adduced to increased organic matter mineralization and subsequent release of basic cations needed to increase soil pH. Akanbi and Ojeniyi (2007) and Ogeh (2010) reported increased soil pH due to incorporation of Chromolaena and almond leaves respectively. The mechanism responsible for this increase in soil pH was probably due to ion exchange reactions which occur when terminal OH^- of Al^{3+} and Fe^{2+} hydroxyl oxides are replaced by organic anions which are products of decomposition of organic manures (Bell and Besho, 1993).

Organic carbon (OM) and organic matter (OM) were significantly increased ($P<0.05$) with all treatments including their interactions. These increase relative to control were proportional to the treatment rates. The treatment combination of $2tonha^{-1}$ MC and $2tonha^{-1}$ gave the most appreciable increase of organic carbon and organic matter (5.39 and 9.43 % respectively). Organic manures have been reported to increase the organic matter content of soils (Azu *et al*., 2018).

The total nitrogen (TN) was significantly increased by the application of these materials. Increase in soil pH encourages microbial activities which are responsible for organic matter breakdown and subsequent release of nitrogen and other elements in soils (Brady and Weil, 2008).

The available P (AP) was also significantly increased with the application of these manures and the increase was proportional to amendment rate. Organic matter release due to these treatments may be responsible for this observation. Organic matter is known to compete with P at adsorption sites in the soil colloid, thus reduces P fixation (Osodeke and Ubah, 2005).

The Total exchangeable acidity (TEA) declined with rate of manure application and this effect was statistically significant ($P<0.05$). This observed reduction in TEA could be as a result of replacement of H+ and Al+3 by basic cations present in MC and PM, occurring at the exchange sites. This consequently increased the pH of the soil solution. Other studies have reported reduced exchangeable acidity consequent of organic manure application (Awodun, 2007: Azu *et al*., 2018: Onwuka *et al*., 2007).

The basic cations (K, Mg, Ca and Na) increased significantly ($P<0.05$) with all treatments. The implication of this observation is that the nutrients contained in the treatments were mineralized by soil microbes (Brady and Weil, 2008) and made available in soil for subsequent plant uptake. Similarly, the Effective Cation Exchange Capacity (ECEC) and base saturation (BS) were also influenced significantly ($P<0.05$) with the lone and combined application of the MC and PM. These findings agreed with reports

of other studies on the improvement of soil fertility by organic manure application (Azu *et al., 2018;* Onwuka *et al., 2007).*

From the results, it could be adduced that proper combination of Moringa compost and Poultry manure in soil management has great potential in improving soil fertility conditions for optimum crop growth and treatment combination of 2tonha^{-1} MC and 2tonha^{-1} was adjudge to gave the most appreciable improvement in soil nutrient indices.

Effect of Composed Moringa Leaf and Poultry Manure on the growth and yield properties of Amaranthus.

The effect of moringa leaf compost and poultry manure on growth and yield of *Amaranthus* is present in Figure 1. Results showed that relative to control, significant improvement on number of leaves, plant height and stem girth were observed. While the plant height and stem girth were highest in the pot that had 2tonha^{-1} MC and 1tonha^{-1} PM, the number of leaves were highest in the pot that had 2tonha^{-1} MC and 2tonha^{-1} PM. This yield response showed that the higher the nutrient indices in the soil, the higher the yield of Amaranthus. These unique attributes may be in connection with the fact that the applied manures enhanced the organic matter and other soil physical, chemical and biological properties of the soils (Brady and Weil, 2008). This further collaborates the findings and assertions of Isitekhale and Osemota (2010) that organic manures are important short-term suppliers of nutrients as well as for long-term maintenance of soil organic matter

Table 2. **Mean effect of composed moringa leaf and poultry manure on selected soil fertility properties.**

Treatments MC + PM		Soil Properties								
	ECEC	pH		OC	OM	TN	AP	TEA	TEB	BS
		H_2O	$Cacl_2$	%	%	%	mg/kg	Cmol/kg		%
0 + 0	4.92	4.37	0.78	1.81	0.11	13.44	1.96	5.02	6.98	71.82
0 + 1	5.41	4.98	1.03	1.79	0.15	20.00	1.61	5.91	7.52	78.63
0 + 2	5.88	5.06	2.38	4.16	0.25	23.65	1.02	6.53	7.55	86.48
1 + 0	5.17	4.46	0.94	1.64	0.19	17.47	1.65	6.13	7.78	78.82
1 + 1	5.91	5.14	3.41	5.93	0.43	26.37	0.87	8.04	8.91	90.29
1 + 2	6.10	5.24	4.23	7.37	0.51	32.72	0.56	9.74	10.30	94.57
2 + 0	5.94	5.06	2.35	4.10	0.46	31.30	0.60	7.84	8.45	92.85
2 + 1	6.41	5.88	4.52	7.85	0.60	35.92	0.36	11.12	11.48	96.88
2 + 2	6.85	6.24	5.39	9.43	0.67	42.02	0.28	12.78	13.06	97.88
Mean	5.84	5.16	2.78	4.90	0.38	26.99	0.99	8.12	9.11	87.58
LSD(0.05)MC	0.915	0.190	0.165	0.344	0.528	0.036	0.919	0.079	0.377	0.396
LSD(0.05)PM	0.396	O.190	0.165	0.344	0.528	0.036	0.919	0.079	0.377	
(MC X PM)	0.686	0.330	0.286	0.596	0.914	0.063	1.592	0.137	0.653	

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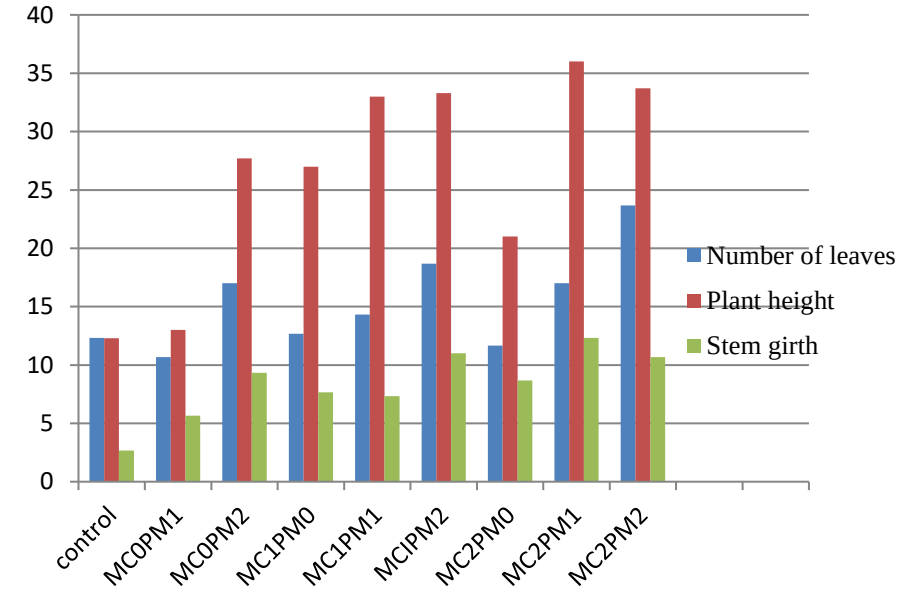

Figure 1. Effect of MC and PM on number of leaves, plant height and stem girth of Amaranthus.

Where MC=Moringa Compost and PM= Poultry manure.

The increase in pH due to MC and PM application corroborated the Amaranthus response to these manures since pH been has regarded as the most important indicator of soil fertility in tropical soils (Ojeniyi *et al.,* 1999; Sanchez and Logan 1992)).

Also, Booth and Wickens (1988) reported that the high protein biomass of Moringa oleifera is suited for use and acts as a natural fertilizer while Davis (2006) reported that the use of Moringa as a green manure significantly improved soil fertility.

Conclusion

The study demonstrated the effectiveness of using composted Moringa leaves and poultry manure for improving soil fertility conditions, growth and yield of Amaranthus in a Green House condition. Results showed that the soil fertility and productivity enrichment potentials of Composted Moringa leaves and poultry manure, their positive effects on soil nutrient indices were found to be efficient in increasing the growth and yield of Amaranthus. Application of these manure sources significantly increased the soil nutrient elements and yield of Amaranthus over the control. The higher the rate of application, the more increase on soil nutrient properties and yield of Amaranthus. Composed Moringa leaves combined with poultry manure can therefore serve as alternative source of soil nutrient and suitable replacement for inorganic fertilizers, with fantastic effect on soil fertility indices and plant nutrients release for optimum production of Amaranthus. Treatment combination of 2tonha^{-1} MC and 2tonha^{-1} PM gave the most appreciable improvement on soil nutrient indices, growth and yield of Amaranthus and is therefore recommended.

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