COMPARATIVE EFFECT OF ORGANIC AND MINERAL FERTILIZER TYPES ON SOIL PROPERTIES, GROWTH AND YIELD OF YAM IN ONDO, SOUTH WESTERN NIGERIA

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Abstract: Two field experiments were conducted at the Teaching and Research Farm of Agricultural Science Department, Adeyemi College of Education, Ondo Southwestern Nigeria in 2014 and 2015 to compare the effect of organic, organomineral and mineral fertilizers on soil properties, growth and yield of yam. The treatments used were 10 t/ha each of Wood Ash (WA) Cattle Dung (CD), Poultry Manure (PM), Manufactured Organic Fertilizer (OG) and Organomineral fertilizer (OMF); 400 kg/h each of NPK 15:15:15, Single Super Phosphate (S.S.P), Urea and Muriate of Potash (MOP). The treatments were laid out in randomized complete Block Design and replicated three times. Compared with control, OG, OMF and NPK at all rates significantly increased ($P<0.05$) leaf area, biomass and yield of yam. Compared with control, all the treatments significantly increased soil and plant nutrients at different rates. Organomineral fertilizer significantly ($P<0.05$) increased the soil moisture content while PM and WA significantly decreased (<0.05) the bulk density. Organomineral fertilizer and organic manure increased yam production with better residual effects on soil chemical properties compared with mineral fertilizer.

Keywords: Chemical properties, major nutrients, vines, yam tubers

Introduction

The yearning for diversification of Nigeria economy from petroleum product to other fields, in order to conserve the country's economy is a great concern. Nigeria is an agrarian community known to produce tree crops and arable crops. On the discovery of petroleum products in the early sixties, agricultural sectors were neglected. There are a number of arable crops that are predominant in Nigeria such as yam, cocoyam, cowpea, rice, cassava, soya beans and maize. Yam is principally cultivated in West Africa where about 93% of the world total yam production is achieved (FAO, 2004). Six hundred species of yam exist while only six are important as staple crop. These are white yam *Dioscorearotundata*, yellow yam (*DioscoreaCayenensis*), water yam (*Dioscoreadumentorum*), aerial yam (*Dioscoreabulbifera*) and chinese yam *(Dioscoreaesculatentum*). Among the six species of yam white yam is most commonly grown because it attracts market.

In the early sixties, famers were not prone to the use of synthetic fertilizers in yam production due to the existence of shifting cultivation and bush fallowing system. At present, the wide spread of soils infertility in Nigeria have called for the use of synthetic fertilizers for yam production, despite the fact that the famers complain of the adverse effect of synthetic fertilizers on the texture and quality of yam. Most Nigerian small scale famers embark on indiscriminate fertilizer application in yam production. There is need to determine the fertilizer type best suitable for yam production. Hence, the aim of this study was to compare the effect of various fertilizers on soil properties, growth and yield of yam in Ondo, Southwestern Nigeria.

Materials and Methods

The two field experiments were conducted at the Teaching and Research farm of Adeyemi College of Education, Ondo (070 05'N, 040 55E) in the South West Nigeria in 2014 and 2015. The sites of the experiment were dominated by weed such as *Talinumtriangulare* and *Aspilliaafricana* interspersed with shrubs. The soil is sandy loam and belongs to the order Alfisol (USDA, 1975).

The sites were cleared, stumped and laid out into plots. There were 10 treatments, i.e. control (no fertilizer), NPK 15:15:15 fertilizer, urea, muriate of potash, cattle dung, single super phosphate (SSP), Organomineral fertilizer, manufactured organic fertilizer, poultry manure and wood ash.

Heaps were prepared by heaping the soil surface layer using the traditional hoe. Each plot consisted of 10 stands of yam spaced at 1 by 1 m to which a treatment was applied and each treatment was replicated three times.

The experiments were arranged in a randomized complete block design. There were 2 m gaps between blocks and 1 m alley way between plots. Healthy white yam tubers were obtained from the market in Ondo.

White yam (*Dioseoreaalata*) was selected because of its popularity among farmers in Nigeria. The yam tubers were sliced into sets of 250 g; the cut surface was coated with wood ash in line with farmers practice and allowed to air dry for 24 h. This prevented rotting of the yam setts. Planting yam setts was carried out with the use of hand held hoe. The vines were supported with strong 2.5 m pole bamboo stick. The plots were weeded at three weeks interval.

10 t/ha of each of the organic fertilizers were applied two weeks before planting while the mineral fertilizer were applied at 400 kg/ha three weeks after planting in ring form.

Five plants were selected and tagged per plot for the measurement of growth and yield parameters. The parameters included leaf area, vine girth, vine length, number of leaves and number of branch per plant, tuber yield, tuber length and girth.

At 7 months after planting, leaves were collected from sampled plants per treatment. The number of leaves and branches per plant were also obtained by counting from the five selected plants per replicate. The vine girth was measured with vernier caliper and measuring tape.

Surface soil samples (0-20 cm) were taken prior to the application of the treatments. The pre-treatment soil samples and post soil samples were taken per plot with soil auger. Soil pH was determined in 1:1 soil – water by pH meter (Mclean, 1976), organic matter was determined by Walkely Dichromate Oxidation method, total N was determined by Mickrockjedahl method, available P was determined by Bray 1- method (Bray

and Kurtz, 1945) while exchangeable K, Ca, Mg and Na were extracted with ammonium acetate (pH 7). Exchangeable K was determined by photometer while Ca and Mg were determined by atomic absorption spectrophotometer (AAS). The micronutrients were extracted with HCl and determined with AAS.

Statistical analysis

The mean value of soil properties, leaf nutrient content growth and yield data for the two years were generated, computed, statistically analysed and separated by Duncan Multiple Range Test (DMRT) using SPSS version 17.

Results and Discussion

The chemical and physical characteristics of the soil used for the conduct of the experiment are presented in Tables 1 and 2. The soil was sandy loam with high proportion of sand.

The chemical properties of the soil showed that, the soil was slightly acidic. The soil Ca, Mn and Zn were fairly adequate (Agboola*et al*., 1992; Ayeni, 2008; Ayeni*et al.*, 2010). Soil of this nature is characterized by low water and nutrient retention capacity and ability to easily leach soil nutrient. The slightly acidic nature of the soil was expected to have enhanced leaching of exchangeable bases. Based on the established critical level of nutrients in Southwest Nigeria, the soil was deficient in OM, N, P, K and Mg but adequate in Ca and Mg (Sobulo and Osiname, 1987). The low soil OM, N, P, and K status and its acidic nature were expected to benefit from application of organic, Organomineral and NPK 15:15:15 fertilizers.

The analysis of organic manure in this study was also in line with the work of Adeleye and Ayeni (2010), Adeniyan and Ojeniyi (2005 and 2006) that organic manure composed of macro nutrients with little micro nutrients.

Table 1: Initial soil chemical properties

Soil properties	Soil values
pH	6.08
CaCmol/kg	3.89
Mg, (Cmol/kg,)	1.83
K Cmol/kg)	0.18
Na (Cmol/kg)	0.35
Al+H (Cmol/kg)	0.07
Org C %	1.12
P mg/kg	4.23
Micronutrients (mg kg)	
Fe ,,	4.82
Cu ,,	0.56
Zn ,,	2.30

Table 2: Initial soil physical properties

Soil properties	Soil values (%)
Sand	90.50
Silt	5.60
Clay	3.90
Textural class	Sandy loam

Table 3: Nutrient composition of organic, organomineral and mineral fertilizer (%)

Nutrient	Cattle dung	Manure organic	Wood ash	MOP	NPK	OM	PM	SSP	Urea
N	1.2	3.5	0.15	-	15	3.5	2	-	46
P	0.67	1.0	0.75	-	15	2.5	1.7	22	-
K	1.4	1.2	10	60	15	4.0	0.4	-	-

The nutrient composition of mineral, Organomineral and organic fertilizers are presented in Table 3. The mineral fertilizer had higher N, P and K than organomineral fertilizer this would affect the nutrient released to the soil for yam use.The data in Table 4 shows that application of organic and organomineral fertilizers had effect on the yield of yam. Relative to control, all the treatments significantly increased agronomic parameters of yam. Such as leaf area, weight, length, diameter of yam and biomass of yam. Compared with control all the treatments significantly increased ($P<0.05$) leaf area, weight, length, diameter of yam and biomass of yam.The study conducted by Ojeniyi*et al.* (2002 and 2007) showed that organic and organomineral fertilizers increased the yield of yam. Organic and organomineral fertilizers were also found to increase significantly the yield of crop (Olowookere, 2004).

Table 4: Effect of organic, organomineral and mineral fertilizer on agronomic parameter on yam

Treatment	Leaf area (cm)	Weight tuber (kg)	Diameter tuber (cm)	Length tuber (cm)	Biomass (kg)
Control	21.89^{c}	1.9^{d}	19^{c}	29^{b}	0.8^{c}
Cattle dung	23.19^{c}	4.6^{a}	24^{ab}	32^{a}	1.5^{a}
Manufacture Organic	21.50^{c}	3.5^{b}	25^{a}	34^{a}	1.4^{a}
Muriate of Potash	20.81^{c}	2.4^{c}	25^{a}	28^{b}	1.0^{b}
NPK	27.19^{b}	1.9^{d}	22^{b}	27^{b}	1.0^{b}
Organomineral	35.99^{a}	4.3^{a}	26^{a}	33^{a}	1.2^{ab}
Poultry Manure	20.81^{c}	1.8^{e}	25^{a}	28^{b}	1.0^{b}
SSP	20.77^{c}	3.5^{b}	29^{a}	33^{a}	1.5^{a}
Urea	28.21^{bc}	3.0^{b}	28^{a}	31^{ab}	1.2^{ab}
Wood Ash	20.81^{c}	1.6^{e}	12^{d}	18^{c}	0.6^{c}

Means with the same superscript were not significantly different at 5% level using DMRT

Table 5: Effect of mineral, organic and organomineral fertilizers on major nutrient

Treatment	pH	OC	N	P	K	Ca	Mg	Na
	--------	% ----------		mg	----------	Cmol kg ----------		
Control	5.15^{d}	1.03^{f}	.07^{c}	5.66^{d}	.26^{d}	4.81^{b}	1.84^{d}	0.37^{c}
Cattle dung	5.41^{c}	1.31^{d}	.11^{b}	8.38^{d}	.26^{e}	5.50^{b}	2.80^{a}	0.44^{c}
Manufacture Organic	5.74^{b}	1.39^{d}	.13^{b}	18.04^{c}	.32^{cd}	3.74^{c}	1.82^{d}	0.56^{c}
Muriate + P	5.71^{b}	1.41^{c}	.11^{b}	33.61^{b}	.31^{d}	3.44^{c}	1.61^{d}	0.63^{c}
NPK	5.05^{c}	1.41^{c}	.11^{b}	30.17^{b}	.36^{c}	3.69^{c}	1.68^{d}	0.68^{c}
Organo Mineral	5.71^{b}	1.57^{b}	.13^{b}	38.95^{a}	.34^{c}	5.20^{b}	2.17^{c}	1.06^{b}
Poultry Manure	6.02^{b}	1.35^{d}	.13^{b}	31.83^{b}	.50^{b}	6.99^{a}	2.11^{c}	0.96^{b}
SSP	5.03^{d}	1.18^{e}	.11^{b}	16.30^{c}	.24^{cd}	4.12^{b}	2.99^{b}	0.53^{c}
Urea	5.49^{c}	1.10^{e}	.18^{a}	6.84^{d}	.20^{e}	6.10^{ab}	2.24^{b}	0.45^{c}
Wood Ash	7.31^{a}	1.40^{d}	.11^{b}	18.01^{c}	.90^{a}	8.39^{a}	3.21^{a}	1.89^{a}

Means with the same letter were not significantly different at 5% level using DMRT

It was observed that Organomineral fertilizer recorded the highest leaf area, tuber weight, tuber diameter and tuber length. This might be as a result of balanced plant nutrition enjoyed by the yams grown with Organomineral fertilizer especially N, P and K that are very vital for both vegetative and reproductive growth of crops. Generally, it was observed that the yams treated with organic manures i.e. manufactured organic fertilizer, organomineral fertilizer, cattle dung and poultry manure were higher in yield than the yam treated with mineral fertilizers. This might be as a result of other nutrients apart from N, P and K that were present in the organic fertilizers. Ayeni*et al*. (2008) and (Ayeni and Adetunji, 2010) asserted that organic manures, are composed of N, P, K, Ca and Mg as well as little micronutrients. Calcium is known to enhance tuberisation. The presence of Ca along with other plant nutrients might have enhanced the performance of the yams treated with organic fertilizers compared with mineral fertilizers which were lacking in one nutrient or more in its composition. There was also sufficient time for the organic fertilizers to mineralize since the yam spent up to five months before harvesting was done.

Ayeni (2010) affirmed that the C/N ratios of organic manures such as cattle during and poultry manure and Organomineral fertilizer ranged between 6 and 15. This range is good for microbial activities on the decomposition of organic matter to release plant nutrients. The soil pre-treatment pH and exchange acidity were in favour of the release of the soil essential nutrients for optimum utilization by plants.

The fact that wood ash recorded the highest pH shows its potential in raising soil alkalinity, thus it could be used to reduced soil acidity or as a liming material. The plots fertilized with organic manures especially cattle dung had better residual effects on soil nutrients compared to mineral fertilizers. This might be as a result of nutrient volatilization from the mineral fertilizer. Phosphorous, Ca and Mg are still adequate for growing arable. Going by the critical nutrient requirement for optimum production of arable crops in Southwestern Nigeria recommended by Sobulo and Osiname (1987), Adenawoola and Adejoro (2005), the soils fertilized with organic fertilizer still have adequate available P, Ca and Mg for the incoming crop.

Conclusion

This experiment shows that Organomineral fertilizer and organic manure increased yam production with better residual effects on soil chemical properties compared with mineral fertilizer. Application of organic and Organomineral fertilizers improved leaf area, weight of yam, length of yam, diameter of yam and biomass. However organomineral fertilizer and manufactured organic fertilizer in the industry required higher quantity to be applied to the soil than mineral fertilizer.

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