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RESPONSE OF COCOYAM *(COLOCASIA ESCULENTUS* (L). SCHOTT) TO MIXTURE OF ORGANIC AND INORGANIC FERTILIZERS IN MUBI, ADAMAWA STATE NIGERIA

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ABSTRACT

A field experiment was conducted at the Adamawa State University, Faculty of Agriculture Department of Crop Science Teaching and Research farm during the 2019 rainy season. To evaluate response of cocoyam (*Colocasia esculentus*(L). Schott) to mixture of organic and inorganic fertilizers, with the objective of selecting the best fertilizer mixture that can enhance the growth and yield of cocoyam. The experiments consisted of the following treatments T_1 = 504 kg ha^{-1} cow dung, T_2 = 227.65 kg ha^{-1} poultry droppings, T_3 = 210.15 kg ha^{-1} NPK, T_4 = 251.33 kg ha^{-1} cow dung +138.83 kg ha^{-1} poultry droppings, T_5 = 215. 33 kg ha^{-1} cow dung + 105.08 kg ha^{-1} NPK, T_6 = 138.83 kg ha^{-1} poultry droppings + 105.08 kg ha^{-1} NPK, T_7 = 167.55 kg ha^{-1} cow dung + 92.55 kg ha^{-1} poultry droppings + 70.05 kg ha^{-1} NPK and T_8 = Control. The experiment was laid out in a Randomized Complete Block Designed (RCBD) in three replicates. The result showed that T_4 recorded the highest number of leaves and tillers at four weeks after fertilizer application, while the T_1 recorded the highest number of leaves and tillers at ten weeks after fertilizer application. The yield characters also vary significantly across the treatments, with T_7 yielded the highest number of corm per plot (74), 100 corm weight (6.40 kg), corm yield per plot (1.77 kg) and corm yield in kg ha^{-1}(4425 kg ha^{-1}). Significant positive correlation between corm yield in kg ha^{-1} with corm yield per plot (r = 0.9395**), 100 corm weight (r= 0.9555**) and number of corm per plot (r = 0.9453**). Suggest that improvement in these characters will enhance the yield of cocoyam. From the results of this research therefore, T_7 the blend of 167.55 kg ha^{-1} Cow dung + 92.55 kg ha^{-1} Poultry droppings + 70.05 kg ha^{-1} NPK performed better, for yield character, and hence recommends as the best fertilizer mixture that can enhance the growth and yield of cocoyam in Mubi and environ.

KEYWORDS

Response, cocoyam, fertilizers, correlation, yield.

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INTRODUCTION

Cocoyam (*Colocasia esculenta* L. Schott.) is a member of *Araceae* family, is a subsistence and emergency food source in many parts of the world, but a major staple food crop in Nigeria, South Pacific islands and some parts of Asia [18]. The corms and cormels are eaten in the same way as yam *(Dioscorea spp)* and sweet potato (*Ipomoea batatas*), boiled, fried, baked and roasted. In West Africa, the boiled cocoyam is sometimes pounded to produce a paste similar to pounded yam and eaten in the same manner. The cormels are grated and used alone or mixed with grated water yam (*Dioscorea alata)* to prepare a rich popular Nigeria diet called *ekpang nkukwo.* Cocoyam are the cheapest and most handy carbohydrate source of meals for diabetics, convalescents and most gastrointestinal disorder patients and a good carbohydrate source for infant foods on account of their small-sized starch grains which are easily digested compared to those of yam, cassava *(Manihot spp)* or sweet potato [39]. The young leaves and petioles which contain more protein than the corms in addition to vitamin A and C and minerals are used as human food, while the corms, cormels and leaves after curing can also be used as animal feed [33].

Cocoyam is a stem tuber that is widely cultivated in the tropical regions of the world and is well known food plant which has a long history of cultivation with Nigeria being the largest producer in the world accounting for about 40% of the total world output [4]. The crop has been reported to possess high ability to produce high energy food, protein, vitamins and minerals as well as cash income to most food insecure households [2].

Bush fallow which had been an efficient, balanced and sustainable system for soil productivity and fertility restoration in the past is presently unsustainable due to high population pressure and other human activities which have resulted in reduced fallow period [40].

A major constraint to intensive production of cocoyam in Nigeria is the low level of inherent fertility of the acid sandy soils. Due to the porous nature of the soils, their low organic matter, pH and clay contents; native soil N, K and Ca are equally very low. To ameliorate these problems, complementary use of organic manures and mineral fertilizers which has proved to be a sound soil fertility management strategy in many countries of the world is advocated [42]. Apart from enhancing crop yield, the practice has a greater beneficial residual effect that can be derived from the use of either inorganic fertilizer or organic manure when applied alone [13].

Cocoyam responds very well to input of fertilizer whether organic or inorganic as reported by several workers [17; 28; 31; 38; 42]. It has a high requirement for potassium like all other tuber crops [27]. In tuber crops, potassium plays a vital role in the movement of sugars produced in the leaf by photosynthesis to the tubers where the sugars are converted to starch [1]. Surveys in Nigeria revealed inconsistencies in the amount of potassium for optimum performance of cocoyam due mainly to differences in soil types and soil potassium status [27; 29]

Nutrient use efficiency has also been reported to increase through the combination of poultry manure and mineral fertilizer [8]. Cocoyam being a root crop has a high requirement for potassium as yam and cassava [33]. The K content of poultry manure is usually very high depending on the animal type, feed ration, storage and handling practice which makes it very suitable for root crops. That is why this research is carried out to determine the effect of organic and inorganic fertilizer on the growth and yield of Cocoyam with the objective of selecting the best fertilizer type and rate that can enhance the growth and yield of cocoyam.

MATERIALS AND METHODS

Description of study area

The research was conducted at Adamawa State University Faculty of Agriculture, Department of Crop Science, Teaching and Research Farm during the 2019 rainy season. Latitude 10°10' and 10° 30' North of the Equator longitude 13° 10' and 13°30' East of Greenwich meridian altitude of 696m above sea level.

Land Preparation

The land was disk ploughed and harrowed to fine tilt. Total land area was 144 m^2. The land was raised using hoe, 6 heaps was made in each sub plot (2x2 m^2) at 15 cm height with intra row spacing of 60 cm and inter row spacing of 120 cm, 50 cm gap was left in between sub plot to allow for easy passage of water.

Experimental Design

The experiments were laid out in a Randomized Complete Block Design (RCBD) in three replicate.

Table 1: Treatments combinations used during the study

Treatment code	Fertilizer Combinations
T1	504 kg ha^{-1} CD
T2	277.65 kg ha^{-1} PD
T3	210.15 kg ha^{-1} NPK
T4	251.33 kg ha^{-1} CD + 138.83 kg ha^{-1} PD
T5	251.33 kg ha^{-1} CD + 105.08 kg ha^{-1} NPK
T6	138.83 kg ha^{-1} PD + 105.08 kg ha^{-1} NPK
T7	167.55 kg ha^{-1} CD + 92.55 kg ha^{-1} PD + 70.05 kg ha^{-1} NPK
T8	Control

Cultural Practices

Weeds were controlled manually wherever they emerged. Strict agronomic practices were followed to allow for full expression of the plant characters.

Data Collection and Analyses

Data were collected on 5 randomly selected plants from each treatments on the following characters: Plant height (cm), number of leaves per plant, number of tillers per plant, leaf length per plant (cm), leaf width per plant (cm), number of corm per plot, corm yield per plot (kg), 100 corm weight, corm yield in kg ha^{-1}. The data collected was subjected to Analysis of Variance (ANOVA) using Statistical Package for Scientific and Engineer SPSE (2012).. Analytical software manual version 9.1 USA. Significant means were separated using Duncan Multiple Range test (DMRT) at $P < 0.05$. Correlation was computed to reveal the relationship between yield and other related traits.

RESULTS

Effect of Fertilizer Mixture on Plant Height

The Analysis of Variance showed no significant difference at P ≤ 0.05 for plant height at 2,4,6,8 and 10 weeks after fertilizer application across the different fertilizer mixture and the control Table 3.

Effect of Fertilizer Mixture on Number of Leaves

Significant difference was recorded for number of leaves at 4 and 10 weeks after fertilizer application. At 4 Weeks after Fertilizer Application (WAFA) the treatment T_7 recorded the highest number of leaves 9.40 while T_2 recorded the least number of leaves of 5.58. At 10 WAFA, T_1 recorded the highest number of leaves of 30.96, while T_3 had the least number of leaves of 19.31 Table 4.

Effect of Fertilizer Mixture on Leaf Length

The Analysis of Variance showed no significant difference at P ≤ 0.05 for leaf length at 2,4,6,8 and 10 WAFA Table 5.

Effect of Fertilizer Mixture on Number of Tillers

The number of tillers at 2 and 6 WAFA does not show variation at P ≤ 0.05 across the different treatments. However, significant difference was found for number of tillers at 4, 8 and 10 WAFA. At 4 WAFA, T_4 recorded the highest number of tillers 8.33, while T_3 recorded the least number of tillers 6.22. At 8 WAFA, T_1 recorded the highest number of tillers 30.96, while the control recorded the least number of tillers 16.60. At 10 WAFA, T_1 recorded the highest number of tillers 29.34, while the control recorded the least number of tillers of 15.80 Table 6.

Effect of Fertilizer Mixture on Leaf Width

The leaf width at 2, 4 and 8 weeks after fertilizer application does not vary across the different treatment at P ≤ 0.05. However, significant difference was recorded for leaf width at 6 and 10 WAFA. At 6 WAFA with T_2 recorded the highest leaf width 33.85, while T_1 yielded the least number of leaves 14.81. 10 WAFA, T_6 recorded the highest leaf width of 20.70, while T_1 recorded the least 15.51 Table 7.

Effect of Fertilizer Mixture on Corm Yield kg ha^{-1}, Corm Yield Per Plot, 100 Corm Weight and Number of Corm Per Plot

The corm yield in kg ha^{-1}, corm yield per plot, 100 corm weight and number of corm per plot showed significant difference at P ≤ 0.05 across the various treatments. T_7 recorded the highest yield of 4425 kg ha^{-1}, while the least yield was recorded by the control 137.00 kg ha^{-1}. For corm yield per plot, T_7 recorded the highest yield of 1.77 kg, while the least Corm yield per plot was recorded by T_2 = 0.28 kg. The highest 100 corm weight was recorded in T_7=6.40kg while the least was recorded in $T_{2=}$ 2.10kg. The highest number of corm per plot was recorded in T_7 =74.00, while the least was recorded in $T_{2=}$ 18.00 Table 8.

Pearson Correlation for Growth and Yield Character of Cocoyam

Corm yield kg ha^{-1} is significantly correlated with corm yield per plot (r = 0.9395**), 100 corm weight (r = 0.9555**) and number of corm per plot (r = 0.9453**). Corm yield per plot significantly correlated with 100 corm weight (r = 0.8923**) and number of corm per plot (r = 0.8902**). The 100 corm weight is significantly correlated with number of corm per plot (r = 0.8472**). Leaf length at 10 weeks after fertilizer application is significantly correlated with leaf width at 10 weeks after fertilizer application (r = 0.9327**), plant height at 10 weeks after fertilizer application (r = 0.9072**) and plant height at 10

weeks after fertilizer application (r = 0.8277**). Number of leaves at 10 weeks after fertilizer application is significantly correlated with number of tillers at 10 weeks after fertilizer application (r = 1.0000**) and plant height at 10 weeks after fertilizer application (r = 0.5578**) Table 9.

Table 2: Effect of Fertilizer Mixture on Plant Height

Treatments	PLH_2WAFA	PLH_4WAFA	PLH_6WAFA	PLH_8WAFA	$PLH_{10}WAFA$
Control (no fertilizer added)	22.52[a]	29.63[a]	32.57[a]	35.90[a]	35.55[a]
T1=504 kg/ha CD	17.54[a]	22.96[a]	27.02[a]	33.09[a]	34.42[a]
T2=227.65 kg/ha PD	23.03[a]	30.05[a]	31.54[a]	33.58[a]	33.89[a]
T3=210.15 kg/ha NPK	91.44[a]	28.66[a]	30.36[a]	34.21[a]	34.91[a]
T4=251.33 kg/ha CD +138.83 kg/ha PD	17.66[a]	25.03[a]	26.93[a]	30.20[a]	30.27[a]
T5=215. 33 kg/ha CD + 105.08 kg/ha NPK	20.31[a]	27.62[a]	28.52[a]	31.97[a]	37.63[a]
T6=138.83 kg/ha PD + 105.08 kg/ha NPK	23.69[a]	30.24[a]	42.22[a]	36.69[a]	38.13[a]
T7=167.55 kg/ha CD + 92.55 kg/ha PD + 70.05 kg/ha NPK	22.53[a]	29.25[a]	31.27[a]	36.31[a]	38.13[a]

PD = poultry droppings, CD = cow dung, NPK = Nitrogen, Phosphorus and Potassium (15:15:15)
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
PLH = Plant Height
WAFA = Weeks After Fertilizer Application

Table 3: Effect of Fertilizer Mixture on Number of Leaves

Treatments	NL_2WAFA	NL_4WAFA	NL_6WAFA	NL_8WAFA	$NL_{10}WAFA$
Control	5.87[a]	7.00a[b]	15.07[a]	24.40[a]	26.60[ab]
T1=504 kg/ha CD	5.47[a]	6.68[b]	16.72[a]	26.51[a]	**30.96[a]**
T2=227.65 kg/ha PD	6.14[a]	5.58[ab]	12.25[a]	18.72[a]	22.42[ab]
T3=210.15 kg/ha NPK	5.44[a]	6.58[b]	14.36[a]	19.16[a]	**19.31[b]**
T4=251.33 kg/ha CD +138.83 kg/ha PD	5.52[a]	9.40[a]	13.83[a]	20.68[a]	23.68[ab]
T5=215. 33 kg/ha CD + 105.08 kg/ha NPK	5.38[a]	6.63[b]	17.18[a]	26.51[a]	29.35[a]
T6=138.83 kg/ha PD + 105.08 kg/ha NPK	5.70[a]	6.98[ab]	16.17[a]	24.40[a]	27.77[ab]
T7=167.55 kg/ha CD + 92.55 kg/ha PD + 70.05 kg/ha NPK	6.13[a]	7.47[ab]	16.40[a]	24.07[a]	26.80[ab]

PD = poultry droppings, CD = cow dung, NPK = Nitrogen, Phosphorus and Potassium (15:15:15)
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
NL = Number of Leaves
WAFA = Weeks After Fertilizer Application

Table 4: Effect of Fertilizer Mixture on Leaf Length

Treatments	LL_2WAFA	LL_4WAFA	LL_6WAFA	LL_8WAFA	LL_{10}WAFA
Control	19.00[a]	24.07[a]	25.59[a]	26.62[a]	24.98[a]
T1=504 kg/ha CD	16.44[a]	19.15[a]	20.65[a]	22.78[a]	23.15[a]
T2=227.65 kg/ha PD	20.32[a]	24.31[a]	25.51[a]	26.86[a]	25.51[a]
T3=210.15 kg/ha NPK	19.33[a]	22.23[a]	23.67[a]	26.27[a]	24.98[a]
T4=251.33 kg/ha CD +138.83 kg/ha PD	16.10[a]	20.54[a]	21.72[a]	23.66[a]	22.96[a]
T5=215. 33 kg/ha CD + 105.08 kg/ha NPK	18.79[a]	22.83[a]	24.45[a]	25.32[a]	26.95[a]
T6=138.83 kg/ha PD + 105.08 kg/ha NPK	19.79[a]	24.69[a]	24.10[a]	27.67[a]	27.56[a]
T6=167.55 kg/ha CD + 92.55 kg/ha PD + 70.05 kg/ha NPK	19.37[a]	23.61[a]	25.03[a]	23.79[a]	26.65[a]

PD = poultry droppings, CD = cow dung, NPK = Nitrogen, Phosphorus and Potassium (15: 15: 15)
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
LL = Leaf Length WAFA = Weeks After Fertilizer Application

Table 5: Effect of Fertilizer Mixture on Number of Tillers

Treatments	NT_2WAFA	NT_4WAFA	NT_6WAFA	NT_8WAFA	NT_{10}WAFA
Control	5.67[a]	**6.60[b]**	15.20[a]	**16.60[ab]**	**15.80[d]**
T1=504 kg/ha CD	5.47[a]	6.68[ab]	16.19[a]	**30.96[a]**	**29.34[a]**
T2=227.65 kg/ha PD	6.06[a]	7.47[ab]	11.69[a]	22.42[ab]	18.72[cd]
T3=210.15 kg/ha NPK	5.31[a]	6.44[b]	14.16[a]	19.31[b]	18.82[bcd]
T4=251.33 kg/ha CD +138.83 kg/ha PD	5.68[a]	**8.33[a]**	13.33[a]	23.68[ab]	20.00[bcd]
T5=215. 33 kg/ha CD + 105.08 kg/ha NPK	5.32[a]	6.22[b]	16.03[a]	29.35[a]	25.71[ab]
T6=138.83 kg/ha PD + 105.08 kg/ha NPK	5.77[a]	6.62[b]	15.15[a]	27.77[ab]	23.97[abc]
T7=167.55 kg/ha CD + 92.55 kg/ha PD + 70.05 kg/ha NPK	6.00[a]	7.27[ab]	16.00[a]	26.73[ab]	23.67[abc]

PD = poultry droppings, CD = cow dung, NPK = Nitrogen, Phosphorus and Potassium (15: 15: 15)
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
NT = Number of Tillers ,WAFA = Weeks After Fertilizer Application

Table 6: Effect of Fertilizer Mixture on Leaf Width

Treatments	LW_2WAFA	LW_4WAFA	LW_6WAFA	LW_8WAFA	$LW_{10}WAFA$
Control	14.46^{a}	17.61^{a}	17.05^{ab}	19.76^{a}	18.49^{ab}
T1=504 kg/ha CD	11.42^{a}	13.77^{a}	14.81^{b}	16.27^{a}	**15.51^{b}**
T2=227.65 kg/ha PD	15.37^{a}	18.11^{a}	18.65^{ab}	20.54^{a}	18.93^{ab}
T3=210.15 kg/ha NPK	14.11^{a}	16.29^{a}	21.52^{ab}	19.49^{a}	18.30^{ab}
T4=251.33 kg/ha CD +138.83 kg/ha PD	12.20^{a}	14.58^{a}	15.49^{b}	17.27^{a}	16.69^{ab}
T5=215. 33 kg/ha CD + 105.08 kg/ha NPK	13.80^{a}	16.59^{a}	18.24^{ab}	19.86^{a}	19.94^{ab}
T6=138.83 kg/ha PD + 105.08 kg/ha NPK	15.31^{a}	17.78^{a}	17.72^{ab}	20.44^{a}	**20.70^{a}**
T7=167.55 kg/ha CD + 92.55 kg/ha PD + 70.05 kg/ha NPK	14.81^{a}	17.39^{a}	**33.85^{a}**	**20.96^{a}**	19.63^{ab}

PD = poultry droppings, CD = cow dung, NPK = Nitrogen, Phosphorus and Potassium (15: 15: 15)
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
LW = Leaf Width WAFA = Weeks After Fertilizer Application

Table 7: Effect of Fertilizer Mixture on Corm Yield kg ha^{-1}, Corm Yield Per Plot (kg), 100 Corm Weight (kg) and Number of Corm Per Plot

Treatments	CY kg/ha	CYPP(kg)	100 CW (kg)	NCPP
Control	137.00^{c}	1.33^{b}	5.16^{ab}	64.00^{ab}
T1=504 kg/ha CD	1008.30^{c}	0.40^{c}	2.17^{d}	26.67^{de}
T2=227.65 kg/ha PD	700.00^{c}	0.28^{c}	2.10^{d}	18.00^{e}
T3=210.15 kg/ha NPK	2566.70^{b}	1.36^{b}	$4.13b^{c}$	63.67^{cd}
T4=251.33 kg/ha CD +138.83 kg/ha PD	983.30^{c}	0.39^{c}	2.59^{cd}	27.67^{de}
T5=215. 33 kg/ha CD + 105.08 kg/ha NPK	3325.00^{ab}	0.55^{c}	2.85^{cd}	30.00^{de}
T6=138.83 kg/ha PD + 105.08 kg/ha NPK	3675.00^{ab}	1.47^{b}	6.31^{a}	56.00^{bc}
T7=167.55 kg/ha CD + 92.55 kg/ha PD + 70.05 kg/ha NPK	**4425.00^{a}**	**1.77^{a}**	**6.40^{a}**	**74.00^{a}**

PD = poultry droppings, CD = cow dung, NPK = Nitrogen, Phosphorus and Potassium (15: 15:15)
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)

Table 8: Pearson Correlation for Growth and yield Character of Cocoyam

	CY kg/ha	CYPP(kg)	100CW	LLTW	LWTW	NCPP	NLTW	PHTW
CYPP	0.9395**							
	0.0000							
100CW	0.9555**	0.8923**						
	0.0000	0.0000						
LLTW	0.3209	0.3043	0.3038					
	0.1263	0.1482	0.1489					
LWTW	0.3663	0.3272	0.3880	0.9327**				
	0.0783	0.1186	0.0610	0.0000				
NCPP	0.9453**	0.8902**	0.8472**	0.3196	0.3441			
	0.0000	0.0000	0.0000	0.1279	0.0997			
NLTW	-0.0206	-0.0784	-0.0141	0.3324	0.2822	0.0608		
	0.9238	0.7157	0.9478	0.1125	0.1815	0.7776		
NTTW	-0.0215	-0.0791	-0.0146	0.3325	0.2823	0.0589	1.0000**	
	0.9207	0.7133	0.9462	0.1124	0.1813	0.7846	0.0000	
PHTW	0.3224	0.3429	0.2872	0.9072**	0.8277**	0.3411	0.5578**	
	0.1244	0.1010	0.1736	0.0000	0.0000	0.1028	0.0046	0.4579
								0.0046

** Correlation is significant at 0.01 level of probability (2-tailed): * Correlation is significant at 0.05 level of probability
CY kg/ha = Corm Yield in Kilogram Per Hectare 100CW = One Hundred Corm Weight LLTW = Leaf Length at Ten Weeks
LWTW = Leaf Width at Ten Weeks NCPP = Number of Corm Per Plot NLTW = Number of Leaves at Ten Weeks PHTW = Plant Height at Ten Weeks
NTTW = Number of Tillers at Ten Weeks CYPP = Corm Yield Per Plot

DISCUSSION

The soil of the experimental site is a sandy soil with 70% sand and pH 8.0, which is slightly basic. The soil is lacking in major nutrients like nitrogen, phosphorus and potassium. This finding agrees with [42], who stated that a major constraint to intensive production of cocoyam in Nigeria is the low level of inherent fertility of the acid sandy soils. Due to the porous nature of the soils, their low organic matter, pH and clay contents; native soil N, K and Ca are equally very low. To ameliorate these problems, complementary use of organic manures and mineral fertilizers which has proved to be a sound soil fertility management strategy in many countries of the world is advocated.

The Analysis of Variance showed no significant difference at $P \leq 0.05$ for plant height and leaf length at 2,4,6,8 and 10 weeks after fertilizer application across the different fertilizer mixture and the control. This is an indication that all fertilizer mixtures produced similar effects on plant height and leaf length. Fertilizer mixtures have increased plant height and leaf length in cocoyam. The results of this study are consistent with the findings by [23], who also observed no significant effects of mineral NPK fertilizer neither on the number of storage roots per plant nor on the tuberous root yields in a study conducted in DR Congo with both an improved and a local variety of cassava. However, findings by [36], are opposite to this, as they reported significant responses of cassava to fertilizer in a study carried out in the Bas-Congo province of DR Congo.

The result for number of leaves revealed that 504 kg/ha cow dung significantly increased number of leaves of cocoyam. The result for number of number of tillers revealed that 504 kg/ha cow dung significantly increased number of tillers of cocoyam. The result for leaf width revealed that 138.83 kg/ha poultry droppings + 105.08 kg/ha NPK mixture significantly increased leaf width of cocoyam. However, corm yield kg/ha corm yield per plot, 100 corm weight and number of corm per plot recorded with control. The significant effect caused by application of fertilizer mixtures to the cocoyam plants showed that soil in the study area lacked essential nutrients, especially those that enhance growth and development in cocoyam. This is supported by the result of the physicochemical properties of the soils of the sites prior to the establishment of the experiments. The result indicated low content of organic matter and major nutrient elements. Further increases in growth and yield observed as fertilizer rate was increased indicated that the initial rates failed to meet the optimum requirement. This finding agrees with [41; 38], whose studies revealed that application of NPK fertilizers increased growth and corm yield in cocoyam. [25], have also noted varying responses of cocoyam cultivars to fertilization. Nutrient use efficiency has also been reported to increase through the combination of poultry manure and mineral fertilizer [8]. Studies elsewhere have revealed that application of NPK fertilizers increased growth and corm yield in cocoyam [41; 38]. [25], have also noted varying responses of cocoyam cultivars to fertilization.

The significant correlation between leaf length at 10 weeks and plant height at 10 weeks, number of leaf at 10 weeks and number of tillers at 10 weeks. Also, there was significant correlation between corm yield in kg/ha, 100 corm weight, number of corm per plot and corm yield per plot directly increased the yield of cocoyam. Therefore, those characters are very important characters to consider when planning for breeding work aim at improving the yield of cocoyam. This result agrees with [15], also found significant correlation between weight of corm and cormels per hectare was highly correlated with number of leaf ($r=0.25^{**}$), number of shoot per hectare ($r=0.91^{***}$), leaf area ($r=0.55^{***}$), leaf area index ($r=0.76^{***}$) and cumulative leaf area index ($r=0.84^{***}$) in cocoyam.

CONCLUSION

The findings from the research revealed that, the soil form the experimental site is sandy clay which is slightly basic and deficient in major nutrients.

There was no significant different for most of the growth characters observed in this research such as plant height and leaf length a cross the fertilizer mixture and the control, while number of leaves showed significant different at 4 and 10 WAFA with T4 yielded the highest number of leaves at 4 WAFA and T1 recorded the highest number of leaves at 10 WAFA.

Number of tiller also varies significantly across the different fertilizer mixture with T4 recorded the highest number of tillers at 4v WAFA while T1 recorded the highest number of tillers at 8 and 10 WAFA.

Leaf width also varies significantly across the various fertilizer mixture and the control with T2 recorded the highest leaf width at 6 WAFA and T6 recorded the highest leaf width at 10 WAFA.

Yield characters such as corm yield per plot, 100 corm weight, number of corm per plot and corm yield in kilogram per hectare also varies significantly across the different fertilizer mixture with the control recorded the highest mean values in all the yield characters compared with the other fertilizer mixture.

There was high significant correlation between corm yield in kg/ha with corm yield per plot, 100 corm weight and number of corm per plot suggest that improvement in those characters will enhance the yield of cocoyam.

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REFERENCES

1. Abd El-Latif, K. M., Osman, E. A. M., Abdullah, R. and Abd El-Kader, N. (2011). Response of potato plants to potassium fertilizer rates and soil moisture deficit. *Advances Applied Science Resource*, **2**(2):388-397.

2. Ademiluyi, B. O. (2013). Evaluation of weed management strategies in cocoyam (*Colocosia esculentus* L.) production in Ado-Ekiti, Nigeria. *International Journal of Agriculture and Soil Sciences*, **3**(2), 38 – 42.

3. Adesoji, S. A. and Farinde, A. J. (2006). Socio-economic factors influencing yield of arable crop in Osun State, Nigeria. *Asian Journal of Plant Sciences*, **5**:630-634.

4. Anjana, D, and Kumar, J. P. (2013). Effect of integrated manuring on the growth and yield of (*Centella asiatica* L.). *Tropical Ecology*, **54**(1): 89 - 95.

5. Anikwe, M. A. N., Mbah, C. A., Ezeaku, P. I. and Onyia, V. N. (2007). Tillage and plastic mulch effects on soil properties and growth and yield of cocoyam (*Colocasia esculenta*) on an Ultisol in southeastern Nigeria. *Soil Tillage Research* **93**: 264–272.

6. Ano, A. O. and Agwu, J. A. (2005). Effect of animal manure on selected soil chemical properties (I). *Nigerian Journal Soil Science*, **15**:14–19.

7. Ashraf, A. A. E. and Mahmoud, G. O. (2013). Modeling the influence of nitrogen rate and plant population density on seed yield, yield components and seed quality of safflower. *American Journal of Experimental Agriculture*, **3**(2): 336 -360.

8. Ayoola O. T. and Adeniyan O. N. (2000). *African J. Biotech.*, **5**:1386-1392.

9. Ayoola, O. T. and Makinde, E. A. (2009). Maize growth, yield and soil nutrient changes with N-enriched organic fertilizers. *African Journal of Food Agriculture and Nutritional Development*, **9**(1):580-592.

10. De la Pena, R. S. nd Plucknet, D. L. (1972). Effect of N fertilization on growth, composition and yield of upland and lowland taro (*Colocasia esculenta*). *Exp. Agric.*, **8**:187-194.

11. Druilhe, Z. & Barreiro-Hurle, J. (2012). Fertilizer subsidies in sub-Saharan Africa. Europe and South America Working paper No. 12-04. Rome, FAO.

12. Ekwe, K. C., Nwosu, K. I., Ekwe, C. C., & Nwachukwu, I. (2009). Examining the underexploited values of cocoyam (*Colocasia* and *Xanthosoma* spp.) for enhanced household food security, nutrition and economy in Nigeria. In H Jaenicka, J. Ganry, I. Zeledon Hoeschle & R Kahara (Eds.), Proceedings of the international symposium on underutilized plants for food security, income and sustainable development. *Acta Horticulture*, **86**, 71–78.

13. Eneji A. E., Honna T., Yamamoto S. and Masuda T. (2003) *Journal of Plant Nutrition*, **26**(8): 1595-1604.

14. FAO, (2013). B Adaptation to climate change in agriculture, forestry, and fisheries perspective flam work of Africa TKP. press.

15. Gebre, A., Bizuayehu, T. and Kassahun, B. M. (2015). Effect of Corm Size and Plant Population Density on Corm Yield of Taro (Colocasia Esculenta L.). *International Journal of Advanced Biological and Biomedical Research*, **3**(3), 309-315.

16. Harrison, K. D., Judith, G. A. K. and Eliezer, B. B. (2014). Influence of poultry manure and NPK fertilization on growth, yield and storability of onion (*Allium cepa* L.) grown under rain fed conditions. *American Journal of Experimental Agriculture*, **4**(8): 860 – 878.

17. Hota, R., Jena, A. K. and Narayana, K. L. (2014). Effects of inorganic and organic amendments on yield of cocoyam (*Colocasia esculenta*) and on soil properties. *World Journal Agricultural Resources*, **2**(2):70-81.

18. IFA (1992). *World fertilizer Use Manual. Publication of International Fertilizer Industry Association, Paris* pp 148-160.
19. IFPRI. (2011) A Review of Literature on Agricultural Productivity, Social Capital and Food Security in Nigeria. International Food Policy Research Institute (IFPRI), NSSP Working Paper 21.

20. Ikpe, F. N. and Powel, J. M. (2003). Nutrient cycling practices and changes in soil properties in the crop livestock farming system of west Niger Republic of West Africa. *Nutritional Cycle Agroecology*, **62**:37–45.

21. Kay D. E. (1972). *Tropical Development and Research Institute*, 380pp.

22. Lebot, V. (2009). *Tropical root and tuber crops: Cassava, sweet potato, yams and aroids*. UK: CABI Publishing.
23. Lema, K. M., Tata-Hangy, K. and Bidiaka, M. (2004). Management of African root and tuber scale using improved cassava genotypes and mineral fertilizers Afr. *Crop Science Journal*, **12**(24): 217-221.

24. Lim, T. K. (2016). *Edible medicinal and non-medicinal plants*, 1st edn. New York, London: Springer.

25. Mare, R. and Modi, A. T. (2009). Influence of planting date and organic fertilization on growth and yield of Taro landraces. *African Crop Sci. Conf. Proc*., **9**:179-189.

26. Mera, U. M., Singh, B. R., Magaji, M. D., Singh, A., Musa, M. and Kilgori, M. J. S. (2009). Response of Roselle to farm yard manure and nitrogen fertilizer in the semi arid zone of Nigeria. *Nigerian Journal of Basic and Applied Science*, **17**(2): 246-251.

27. Obigbesan, G. O. (1980). Nutrient requirements of yams. Agriculture Research Bulletin, University of Ibadan, Nigeria **12**(1):1–20.

28. Ogbonna, P. E. and Nwaeze, N. J. (2012). Evaluation of growth and responses of cocoyam (*Colocasia esculenta*) cultivars to rates of NPK 15:15:15 fertilizer. *African Journal of Agricultural Resources*, **7**(49):6553-6561.

29. Ohiri A. C., Ogbonnaya J. C., Enyinnaya A. M., Ojinaka, T. L., Chukwu G. O. (1988). *Annual Report, NRCRI, Umudike*, pp75-77.

30. Ohiri, A. C. (1996). Soil physical and chemical conditions favourable for yam (Dioscorea sp.) growth and tuber development in Nigeria. *African Soil*, **28**:231–242.

31. Ojeniyi, S. O., Amusan, O. A. and Adekiya, A. O. (2013). Effect of poultry manure on soil physical properties, nutrient uptake and yield of cocoyam (*Xanthosoma sagittifolium*) in South west Nigeria. *American-Eurasian Journal of Agriculture Environmental Science*, **13**(1):121-125.

32. Okoroafor, I. B., Okelola, E. O., Edeh, O., Nemehute, V. C., Onu, A., Nwaneri, T. C. and Chinaka, G. (2013). Effect of organic manure on the growth and yield performance of maize (*Zea mays* l.) in Ishiagu. *Journal of Agriculture and Veterinary Science*, **5**(4): 28 -31.

33. Onwueme I. C. and Sinha T. O. (1991). *Field crop production in Tropical Africa, CTA Ede, The Netherlands*, pp 276-288.

34. Plucknet, A. E., (1972). Effect of organic extracts on the growth and flowering of marigold plants (*Calendula officinalis* L.). *Journal of Organics*, **1**(1): 22-30.

35. Purseglove, J. W. (1975). Tropical Crop Monocotyledonous. Longman Group Ltd., Britain.

36. Pypers, P., Bimponda, W., Lodi-Lama, J. P., Lele, B., Mulumba, R., Kachaka, C., Boeckx, P., Merckx, R. and Vanlauwe, B. (2012). Combining mineral fertilizer and green manure for increased: profitable cassava production**.** *Agronomy Journal*, **104** (12): 178-187.

37. Roberts, T. L. (2007). Right product, right time, right rate and right place…the foundation of best fertilizer management practices. Proceedings of the IFA International Workshop on Fertilizer Best Management Practices: General Principles, Strategy for Their Adoption and Voluntary Initiatives Vs Regulations, March 7-9, 2007, Brussels, Belgium, pp: 29-32.

38. Shiyam J. O. and Binang, W. B. (2013) Effect of poultry manure and plant population on productivity of fluted pumpkin (Telfaiaria occidentalis hook f.) in Calabar, Nigeria. *Journal of Organic Systems*, **8**(2): 29-35.

39. Som, D. (2007). *Handbook of Horticulture, Indian Council of Agricultural Research, New Delhi*, pp 507-508.

40. Steiner K. G. (1991). *In: Mokwunye A. U. (ed.) Alleviating soil fertility constraints to increased crop production in West Africa* pp69-91.

41. Udoh, D. J., Ndon. B. A., Asuquo, P. E. and Ndaeyo, N. U. (2005). Crop Production Techniques for the Tropics. Concept Publications, Nigeria. p. 464.
42. Uwa, D. F., Udoh, A. U. and Iwo, G. A. (2011). Effect of organic and mineral fertilizers on the growth and yield of cocoyam (*Colocasia esculenta* (L.) Schott). *International Journal of Agricultural Science*, **3**(1):1-6.