International Research Journal of Plant and Crop Sciences ISSN: 1711-3490 Vol. 3 (2), pp. 085-091, October, 2017. Available online at www.advancedscholarsjournals.org © Advanced Scholars Journals

Full Length Research Paper

Effects of cowdung and potassium fertilizer on the performance of cocoyam in a tropical Ultisol in southeastern Nigeria

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Accepted 11 August, 2017

The performance of cocoyam (*Colocasia esculenta* L. Schott) to varying levels of cow dung and potassium fertilizer was investigated in 2012 and 2013 cropping seasons under field conditions at National Horticultural Research Institute (NIHORT), Imo State, Nigeria. The experiment was a 4 × 2 factorial arrangement in a randomized complete block design with three replications. The treatments were four levels of cow dung (0, 10, 20 and 30 t ha^{-1}) and potassium fertilizer (0, 20, 40 and 60 kg K_2O ha^{-1}). Application of cow dung at the highest rate of 30 t ha^{-1} significantly ($P < 0.05$) enhanced plant height, number of leaves, leaf area index, number of suckers and yield of cocoyam (23.6 t ha^{-1}) in 2012 cropping season relative to the lower rates and the control. However, in 2013 cropping season, cow dung at the lower rate of 20 t ha^{-1} gave optimum corm yield of 23.3 t ha^{-1}. In general, potassium fertilizer application did not exert much influence on growth and yield of cocoyam as significant effect was observed only in 2013 cropping season. Corm yield was significantly ($P < 0.05$) improved by the application of 60 kg K_2O ha^{-1} (22.3 t ha^{-1}) in 2013 cropping season relative to the control. The results of this study have shown the effectiveness of cow dung in improving the productivity of cocoyam, thereby enhancing food security in Nigeria.

Key words: *Colocasia esculenta*, corm yield, cowdung, food security, potassium fertilizer, soil fertility.

INTRODUCTION

Cocoyam (*Colocasia esculenta (*L) Schott) is a starchy tuber crop that has been widely cultivated and consumed in the Southeastern agricultural Zone of Nigeria for decades (Ndon et al., 2003). It is regarded as a poor man's food or a woman's crop and as such has lagged behind the preferred and highly valued staple root/tuber crops such as yam and cassava in research attention (Ikwelle et al., 2003). However, the high cost of yam and the increased awareness of the industrial and export potential of cassava has given way to high patronage

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of the relatively obscure crops like cocoyam (Shiyam et al., 2007). The current level of cocoyam production in Nigeria estimated at 5 million metric tones in 2007 (FAO, 2007) is grossly inadequate to satisfy the increasing demand for the crop as alternative food crop (Shiyam et al., 2007).

This low level of cocoyam production is attributed to increasing decline in soil fertility levels and lack of soil management practices for continuous cocoyam cultivation (Agbede and Adekiya, 2016). The use of organic and mineral fertilizers are the two major and common ways in which soils are managed since the extinction of shifting cultivation as well as reduction in bush fallow periods (Makinde et al., 2011). The impact of increased use of mineral fertilizers on crops has been high but the resulting soil physical degradation, increased soil acidity and soil nutrient imbalance, resulting in reduced crop yield (Ojeniyi, 2000; Mbah and Mbagwu, 2006), escalating cost and unavailability of mineral fertilizers (Suge et al., 2011) have drawn the attention of researchers back to the use of organic manures. These organic manures are cheaper, readily available and affordable for soil fertility management and improvement in crop yield.

In recent years, however, the focus on soil fertility has shifted towards the combined application of organic and inorganic fertilizers for judicious management of resources and soil conservation under intensive cropping (Fening et al., 2011). Sole use of organic manures to sustain cropping has been reported inadequate especially in the year of application (Patel et al., 2000). They are required in rather large quantities to meet crops' nutrient supply because of their relatively low nutrient content (Palm et al., 1997). Supply of nutrients from organic materials can be complemented by enriching them with inorganic nutrients that will be released fast and utilized by crops to compensate for their late start in nutrient release (Ayoola and Makinde, 2009).

Cocoyam responds very well to input of fertilizer whether organic or inorganic as reported by several workers (Hota et al., 2014; Ogbonna and Nwaeze, 2012; Ojeniyi et al., 2013; Shiyam et al., 2007; Uwa et al., 2011). It has a high requirement for potassium like all other tuber crops (Obigbesan, 1980). 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 (Abd El-Latif et al., 2011). Surveys in Nigeria revealed inconsistences in the amount of potassium for optimum performance of cocoyam due mainly to differences in soil types and soil potassium status (Obigbesan, 1980; Ohiri et al., 1988).

However, the Ultisols in south eastern Nigeria are low in potassium and thus require potassium fertilization for good crop yields (Unamba-Opara, 1985). The need to increase the production of cocoyam in a marginal soil using organic and inorganic sources of fertilizer necessitated this study. The objective was therefore to evaluate the effects of cowdung and potassium fertilizer on the performance of cocoyam in a tropical Ultisol in southeastern Nigeria.

MATERIALS AND METHODS

The experiment was conducted at National Horticultural Research Institute (NIHORT), Mbato sub-station, Okigwe, Imo State, Nigeria. NIHORT is located at latitude 5°33'N and longitude 7°23'E and 139 m above sea level. The area is characterized as a humid rainforest zone and the soil is sandy loam. The total annual rainfalls for 2012 and 2013 were 1902.8 and 2210.0 mm, respectively while the total rainfalls during the period of experimentation (April to December) for 2012 and 2013 were 1775.6 mm and 2009.0 mm, respectively.

The cocoyam (*Colocasia esculenta* var NCe001) cormels used in this study were sourced from National Root Crops Research Institute, Umudike, Abia State. The cow dung was obtained from the animal farm of Michael Okpara University of Agriculture, Umudike, while the potassium fertilizer (muriate of potash, K_2O) was obtained from the fertilizer unit of Abia State Ministry of Agriculture, Umuahia. Composite sample of the cowdung was air dried, crushed, sieved and then analyzed in the laboratory for its nutrient compositions. The analysis revealed that the cowdung used in this study is composed of 2.54, 1.34, 1.16, 1.56, 0.46 and 50.70%, N, P, K, Ca, Mg and organic matter, respectively in 2012 and 2.24, 1.67, 0.65, 2.80, 0.61 and 30.76%, N, P, K, Ca, Mg and organic matter, respectively in 2013.

The site was double-ploughed, ridged and marked out into three blocks, which represent the replicates. Each block was divided into sixteen experimental plots, thus a total of forty-eight plots were used. Each gross plot measured 4 m × 3 m (12 m^2) with a net plot of 2 m × 2 m. Soil samples were collected with soil auger at a depth of 0 to 20 cm from different locations of the site and bulked into composite sample. The composite soil sample was air dried, passed through 2 mm sieve, and then analyzed for its physico-chemical properties (Table 1).

The experiment was a 4 × 2 factorial arrangement in a randomized complete block design and replicated three times. The treatments comprised four rates each of application of cow dung (0, 10, 20 and 30 t ha^{-1}) and potassium fertilizer (0, 20, 40 and 60 kg K_2O ha^{-1}). A total of sixteen treatment combinations and three replications were used. The cow dung was incorporated into the soils of the experimental plots in a single application based on the treatment combinations, at two weeks before planting to allow decomposition while the Potassium fertilizer was applied to the cocoyam stands according to treatment allocation at 3 weeks after planting (WAP) using band placement method. One cormel was planted per hole at a depth of 15 cm and at a spacing of 0.5 m x 1.0 m resulting to about twenty-four plants per plot and a total of about 20,000 plants per hectare. All plots were kept weed free by manual weeding.

Five cocoyam plants were randomly selected from each of the net plots, tagged and then used for the determination of plant height (cm), number of leaves and leaf area index (LAI) at 1, 2 and 3 months after planting (MAP), number of suckers at 3 MAP, number of corms per plant, corm weight (kg/plant) and corm yield (t ha^{-1}) at physiological maturity.

The leaf area was determined using the formula of Biradar et al. (1978) as:

Leaf Area of Cocoyam = 0.917 (LW).

Where L and W are length and width of the cocoyam leaf. The leaf area index was then calculated by dividing the total leaf area by the area occupied by the plant (Biradar et al., 1978). Number of suckers and number of corms were counted and mean values

Table 1. Some physicochemical properties of soils of the experimental site in 2012 and 2013.

Property	2012	2013
Physical properties		
Sand (%)	67.80	65.80
Silt (%)	14.40	13.40
Clay (%)	17.80	20.80
Textural class	SL	SCL
Chemical properties		
pH (in H_2O)	4.6	5.5
P (mg/kg)	35.50	44.30
N (%)	0.02	0.04
OC (%)	0.19	0.81
OM (%)	0.32	1.40
Exchangeable bases (cmol kg^{-1})		
Ca	2.40	4.40
Mg	2.00	0.80
K	0.022	0.088
Na	0.31	0.497
EA (cmol kg^{-1})	0.80	0.96
ECEC (cmol kg^{-1})	5.532	6.745
BS (%)	85.53	85.76

SL = sandy soil; SCL = sandy clay loam; OC = organic carbon; OM = organic matter; EA = exchange acidity; ECEC = effective cation exchange capacity; BS = base saturation.

Table 2. Main effects of cow dung and potassium fertilizer on plant height (cm) of cocoyam at 1, 2 and 3 MAP in 2012 and 2013.

Treatment	Months after planting (MAP)					
	1	2	3	1	2	3
		2012			2013	
Cow dung (t ha^{-1})						
0	14.6	33.8	50.1	19.3	37.3	46.9
10	14.5	40.8	61.5	22.6	43.3	56.2
20	13.1	40.0	67.6	20.1	40.3	58.9
30	13.1	40.2	69.9	19.4	39.7	60.6
Mean	13.8	38.7	62.3	20.4	40.2	55.7
LSD (0.05)	NS	5.1	4.0	2.2	2.5	4.3
Potassium (kg K_2O ha^{-1})						
0	14.0	38.3	60.0	18.9	34.5	51.3
20	14.0	38.8	62.6	20.1	40.4	55.7
40	14.0	40.0	65.4	20.5	41.7	56.2
60	13.7	37.8	61.1	21.8	42.0	59.4
Mean	13.9	38.7	62.3	20.3	39.7	55.7
LSD (0.05)	NS	NS	4.0	NS	2.5	4.3
C x K	NS	NS	NS	NS	NS	NS

Ns= not significant.

recorded. Corms and cormels were harvested, weighed and the total weight recorded. Data collected were subjected to analysis of variance using Genstat Discovery Edition 3 Package of 2007. Significant means were separated using Least Significant Difference (LSD) at probability level of 0.05.

RESULTS

In 2012 cropping season, differences in plant height due to application of cow dung were significant ($P < 0.05$) at 2 and 3 MAP (Table 2). All cases of cow dung application significantly increased plant height of cocoyam compared to the control at 2 MAP. However, at 3 MAP, incremental application of cow dung up to 20 t ha^{-1} significantly increased plant height. In 2013, cocoyam plant height increased with application of cow dung at 10 t ha^{-1}, above which significant reductions in height occurred at 1 and 2 MAP. At 3 MAP, plant height increased at the highest rate of 30 t ha^{-1} compared to the lower rate of 10 t ha^{-1} or no application in both seasons.

At 3 MAP in 2012 cropping season, application of potassium at 40 kg K_2O ha^{-1} increased significantly cocoyam plant height than no potassium application (Table 2). On the other hand, at 2 and 3 MAP in 2013, application of potassium at 20 kg K_2O ha^{-1} resulted in higher plant height than the control. All cases of applied potassium produced similar plant height values.

Application of cow dung caused significant ($P < 0.05$) increase in the number of leaves per cocoyam plant from 2 MAP in both years of cropping (Table 3). In 2012 and at 2 MAP, cow dung application irrespective of rate recorded statistically similar number of leaves that were significantly ($P < 0.05$) higher than the control. At 3 MAP, incremental application of cow dung significantly ($P < 0.05$) increased the number of leaves of cocoyam compared to no application. Effect of potassium on number of leaves of cocoyam was significant only in 2013 cropping season. Application of potassium fertilizer significantly ($P < 0.05$) increased number of leaves of cocoyam compared to the control while the different rates of applied potassium fertilizer recorded statistically similar values.

In both years, application of cow dung had no effect on LAI at 1 MAP but effect was more apparent at 2 and 3 MAP (Table 4). Application of cow dung at different rates resulted in significant ($P < 0.05$) increase in LAI relative to the control at 2 MAP in 2012 and at 2 and 3 MAP in 2013. LAI increased steadily with plant age. Application of potassium produced significant effects on cocoyam LAI at 3 MAP in 2013 (Table 4). Application of potassium at 20 or 40 kg K_2O ha^{-1} resulted in significantly ($P < 0.05$)

Table 3. Main effects of cow dung and potassium fertilizer on number of leaves per cocoyam plant at 1, 2 and 3 MAP in 2012 and 2013.

Treatment	Months after planting (MAP)					
	1	2	3	1	2	3
		2012			2013	
Cow dung (t ha^{-1})						
0	4.2	7.3	17.5	4.4	7.4	17.5
10	4.3	10.1	25.7	4.9	11.7	24.8
20	3.9	10.0	29.2	4.8	11.1	26.1
30	3.9	11.9	32.4	5.0	11.5	27.7
Mean	4.2	9.8	26.2	4.8	10.4	24.0
LSD (0.05)	NS	2.1	2.9	NS	2.3	3.1
Potassium (kg K_2O ha^{-1})						
0	4.0	9.7	24.5	4.7	9.8	20.0
20	4.1	10.3	26.7	4.7	10.0	24.0
40	4.1	9.9	27.2	5.0	11.1	25.3
60	4.1	9.0	26.3	4.8	10.8	26.7
Mean	4.1	9.7	26.2	4.8	10.4	24.0
LSD (0.05)	NS	NS	NS	NS	NS	3.1
C x K	NS	NS	NS	NS	NS	NS

NS = not significant.

Table 4. Main effects of cow dung and potassium fertilizer on leaf area index (LAI) at 1, 2 and 3 MAP in 2012 and 2013.

Treatment	Months after planting (MAP)					
	1	2	3	1	2	3
		2012			2013	
Cow dung (t ha^{-1})						
0	0.15	0.77	1.87	0.25	0.79	2.02
10	0.19	1.19	3.07	0.37	1.24	3.02
20	0.13	1.22	3.60	0.30	1.21	3.28
30	0.15	1.23	3.80	0.30	1.21	3.20
Mean	0.16	1.10	3.09	0.31	1.11	2.88
LSD (0.05)	NS	0.26	0.45	NS	0.38	0.62
Potassium (kg K_2O ha^{-1})						
0	0.15	1.09	2.90	0.25	0.90	2.23
20	0.16	1.12	3.04	0.31	1.14	2.80
40	0.14	1.12	3.18	0.33	1.21	3.02
60	0.16	1.08	3.26	0.33	1.20	3.48
Mean	0.15	1.10	3.10	0.31	1.11	2.88
LSD (0.05)	NS	NS	NS	NS	NS	0.62
C x K	NS	NS	NS	NS	NS	NS

NS = not significant.

higher LAI than no application while application of the higher rate of 60 kg K_2O ha^{-1} recorded higher LAI value than the lower rate of 20 kg K_2O ha^{-1}.

Application of cow dung had significant effect on the number of suckers produced per cocoyam stand at 3 MAP in both years of cropping (Table 5). In 2012, incremental application of cow dung resulted in significant ($P < 0.05$) increase in the number of suckers produced over the control where as in 2013, application of cow dung above 10 t ha^{-1} did not result in any significant ($P < 0.05$) increase in the number of suckers. Application of potassium fertilizer did not significantly ($P < 0.05$) influence the number of suckers produced per cocoyam stand in 2012 but did influence it significantly in 2013. Potassium fertilizer applied at 40 or 60 kg K_2O ha^{-1} significantly ($P < 0.05$) increased the number of suckers compared to no fertilizer application. The different rates of applied potassium fertilizer recorded statistically similar values.

The number of corms produced per plant was significantly ($P < 0.05$) increased by the application of cow dung in both years (Table 5). In 2012, incremental application of cow dung up to the highest rate of 30 t ha^{-1} increased significantly ($P < 0.05$) the number of corms per plant. In 2013 however, increasing cow dung rate up to 30 t ha^{-1} increased significantly the number of corms per plant compared to the lower rates and the control. Application of 10 and 20 t ha^{-1} cow dung rates produced comparable number of corms. Potassium fertilizer application did not have any effect on number of corms per plant in 2012 but in 2013. All cases of applied potassium resulted in higher number of corms than no potassium application. There was no significant interaction effect between cow dung and potassium fertilizer on number of corms produced.

Similarly, application of cow dung significantly increased the weight of corms as the manure rate was raised to 30 t ha^{-1} in 2012 and 20 t ha^{-1} in 2013 (Table 5). Increasing cow dung rate above 20 t ha^{-1} in 2013 did not result in marked improvement in weight of corms. On the contrary, corm weight was not significantly influenced by potassium fertilizer in 2012 but in 2013 application of potassium fertilizer at the highest rate of 60 kg K_2O ha^{-1} increased corm weight over zero application. Interactions were not significant for corm weight in the two cropping seasons.

Corm yield response to application of cow dung followed the same trend as corm weight in both years (Table 5). There was a significant ($P < 0.05$) linear corm yield response to cow dung application in 2012. In 2013 however, application of cow dung above 20 t ha^{-1} rate did not significantly increase yield. When averaged over the two cropping seasons, cow dung application at the rates of 10, 20 and 30 t ha^{-1} gave corm yields of 17.7 t ha^{-1}, 21.3 t ha^{-1} and 24.81 t ha^{-1}, respectively while zero application gave an average yield of 11.5 t ha^{-1}. Increase in cow dung rate from 0 to 10 t ha^{-1}, increased corm yield by 54%, additional increase to 20 and 30 t ha^{-1} increased corm yield by 85 and 116%, respectively.

Table 5. Main effects of cow dung and potassium fertilizer on number of suckers per cocoyam stand at 3 MAP, number of corms per cocoyam plant, corm weight (kg plant^{-1}) and corm yield (t ha^{-1}) at harvest in 2012 and 2013.

Treatment	2012				2013			
	NSS	NC	CW	CY	NSS	NC	CW	CY
Cowdung (t ha^{-1})								
0	3.7	14.2	0.54	10.86	3.8	13.8	0.61	12.19
10	4.9	16.6	0.78	15.59	5.2	18.9	0.99	19.76
20	5.5	19.3	0.97	19.38	5.5	20.8	1.16	23.27
30	6.1	22.0	1.18	23.58	5.7	23.1	1.30	26.04
Mean	5.1	18.0	0.87	17.35	5.1	19.2	1.02	20.32
LSD (0.05)	0.5	1.9	0.12	2.35	0.5	2.1	0.16	3.50
Potassium (kg K_2O ha^{-1})								
0	4.7	17.7	0.85	17.09	4.5	17.2	0.91	18.15
20	5.2	18.3	0.88	17.64	4.9	19.5	1.02	20.33
40	5.1	18.4	0.85	17.00	5.3	19.5	1.02	20.50
60	5.1	17.8	0.88	17.67	5.4	20.4	1.11	22.27
Mean	5.0	18.1	0.87	17.35	5.0	19.2	1.02	20.31
LSD (0.05)	NS	NS	NS	NS	0.5	2.1	0.17	3.50
C x K	NS	NS	NS	NS	NS	NS	NS	NS

NSS = number of suckers; NC = number of corms; CW = corm weight; CY = corm yield; NS = not significant.

Table 6. Effect of cow dung and potassium fertilizer on mean corm yield (t ha^{-1}).

Potassium (kg K_2O ha^{-1})					
Cow dung (t ha^{-1})	**0**	**20**	**40**	**60**	**Mean**
0	8.84	12.38	11.63	18.75	11.52
10	16.00	19.46	17.17	18.04	17.67
20	21.21	20.75	21.50	21.84	21.32
30	24.42	23.37	24.71	26.75	24.81
Mean	17.62	18.99	18.75	19.97	-

$LSD_{(0.05)}$ for cow dung (C) mean =2.39 ; $LSD_{(0.05)}$ for potassium (K) mean=NS; $LSD_{(0.05)}$ for C x K mean=NS.

Increasing from 20 to 30 t ha^{-1} gave an increase of 16.5%. Potassium fertilizer effects on corm yield were not consistent in both years. Corm yield was not influenced by potassium in 2012 but in 2013. Application of 60 kg K_2O ha^{-1} resulted in significantly ($P < 0.05$) higher yield than the control. All cases of applied potassium fertilizer produced comparable corm yields. Application of potassium fertilizer at 60 kg K_2O ha^{-1} gave a yield of 22.27 t ha^{-1}, which was significantly greater than the control by 23%.

As mean across two years, corm yield increased significantly ($P < 0.05$) with incremental application of cow dung up to 30 t ha^{-1} while application of potassium had no effect on yield (Table 6). In both cropping seasons, there was no significant cow dung x potassium interaction effect on corm yield.

DISCUSSION

In general, application of cow dung resulted in increase in cocoyam plant height, the number of leaves produced per plant, LAI and number of suckers produced per cocoyam stand especially at 2 and 3 MAP. The higher growth following cow dung application would be attributed to the probable effects of the manure in improving soil physical, chemical and biological properties (Balemi, 2012; Najm et al., 2012; Khalid et al., 2014), which are important for crop performance.

The effects of cow dung on cocoyam appeared more pronounced later in crop growth at 2 MAP, due to the slow release of nutrients by the manure. This result is consistent with the findings of Miyasaka et al. (2001) who attributed the enhanced growth and yield response of the crop to organic amendment to slow release of nutrients by the organic manures, which tied the crop over the long duration of its growth.

Cow dung at 30 t ha^{-1} produced the highest corm yield in the relatively more acidic and less fertile sandy loam soil. However, for the more fertile sandy clay loam soil with higher pH of 5.5, cow dung at the lower rate of 20 t ha^{-1} gave optimum corm yield. This implies that at these rates in these soils, cow dung released and made available adequate nutrients for optimum crop development. Cocoyam like any other root and tuber crop is a heavy feeder, exploiting a large volume of soil for nutrient and water (Osundare, 2004). This could explain the high rate of cowdung (20 to 30 t ha^{-1}) required for optimum production of this crop as reported in this study. Gyllapsy et al. (1993) reported that the availability of sufficient nutrient facilitates sink function as this plays a role in the control of carbohydrate accumulation and partitioning. Plants nourished with sufficient amount of nutrients in adequate proportion are expected to have higher number and size of cells (Akanbi et al., 2007) and hence more yield.

In this study application of cow dung at 30 t ha^{-1} produced average corm yield of 24.8 t ha^{-1} and this was higher than the yields of cow dung at 0, 10 and 20 t ha^{-1} by 116, 40 and 16%, respectively. Similarly, cow dung at 20 t ha^{-1} produced average corm yield of 21.3 t ha^{-1}, which was higher than the values at 0 and 10 t ha^{-1} cow dung rates by 85 and 20%, respectively. These yields recorded in these investigations were higher than the yields obtainable in Nigeria (5 to 7 t ha^{-1}), Ghana (4 to 8 t ha^{-1}) and China (17.5 to 19 t ha^{-1}) but compared favourably with the yields obtainable in Egypt (23.5 to 35.0 t ha^{-1}) (Onyeka, 2014).

Application of 20 or 40 kg K_2O ha^{-1} potassium fertilizer recorded significantly higher plant height and number of leaves compared to the control while application of 60 kg K_2O ha^{-1} potassium fertilizer recorded the highest LAI (3.5) and was optimum for fresh cocoyam yield (22.3 t ha^{-1}). This result agrees with the earlier report by Ohiri et al. (1988) that cocoyam requires high potassium levels with the best results obtained at rates between 50 and 80 kg K ha^{-1} depending on soil type.

Okpara et al. (2010) reported improvement in root yield of cassava following application of 50 kg K_2O ha^{-1} in south eastern Nigeria with a native soil potassium level of 0.19 to 0.25 cmol kg^{-1}, while FFD (2002) observed an improvement in cassava yield at 75 kg K_2O ha^{-1} of applied potassium fertilizer when the native soil potassium was between 0 and 0.15 cmol kg^{-1}. In this study, the native soil potassium level was 0.02 cmol kg^{-1} in 2012 and 0.09 cmol kg^{-1} in 2013. According to Murata and Akazawa (1968) the beneficial effects of potassium fertilizer have mostly been attributed to the fact that potassium increases the activities of starch synthetase, which results to high yield, especially if there are inadequate native supplies of the nutrient. 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 (Abd El-Latif et al., 2011). Except for 3 MAP in 2013, potassium application had no significant effect on LAI at all sampling periods in both years and its effect on yield was only significant in 2013 cropping season. According to Brennan and Bolland (2009), yield response to potassium application depends to a great extent on the level of nitrogen supply.

In this study, the level of percentage soil nitrogen was higher in 2013 than in 2012 so also the organic matter content (Table 1), which upon decomposition releases nitrogen and other nutrients to the soil. This may perhaps explain the positive yield response of cocoyam found in 2013 cropping season. Potassium did not also exert as much influence as cow dung on cocoyam yield and only affected yield in 2013. This is expected since cow dung contains nutrients other than potassium, which are necessary for plants growth and development. In addition, cow dung being an organic manure releases nutrients slowly from decomposing organic manure, which are stored for a longer time in the soil thereby ensuring a long residual effect, improved root development and higher crop yields (Rashid et al., 2013; Agbede and Adekiya, 2016). They were lower values for organic matter, nitrogen and potassium in the cow dung but higher rainfall of 2009.0 mm in 2013, in which corm yield appeared higher by 17% compared to 2012. This supports the report by Onwueme (1987) that cocoyams require rainfall above 2000 mm per annum for optimum yields.

This study showed that both cowdung and potassium fertilizer improved growth and yield of cocoyam with cow dung having a better improvement than potassium fertilizer. Optimum yields were obtained at 20 to 30 t ha^{-1} cowdung rate and 60 kg K_2O ha^{-1} of potassium fertilizer.

Conflict of interests

The authors have not declared any conflict of interests.

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