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Performance of cocoyam (*Colocosia esculentus* L.) as influenced by organic and inorganic manure in Samaru, Zaria, Nigeria

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Abstract

A field trial was conducted to study the performance of cocoyam as influenced by organic and inorganic manure during the 2014 cropping season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria. Treatments consist of no manure (control), goat manure, cow dung, and poultry manure each at 10 tons ha^{-1} and 0, 90, 120 and 150 kg NPK ha^{-1} and laid out in a split plot design with organic manure assigned to the main plots; whereas inorganic manure to the sub plots with three replications. Data were collected on growth and yield parameters; plant height, number of leaves plant^{-1}, leaf area plant^{-1}, number of corms plant^{-1}, corm yield plot^{-1} and corm yield hectare^{-1}. Results obtained indicated that growth and yield of cocoyam was lowest in control treatments which showed that the organic manure and inorganic manure used in the study especially poultry manure and 150 kg ha^{-1} of NPK, positively influenced the yield of cocoyam. Poultry manure and150 kg ha^{-1} of NPK positively increased cocoyam plant height, number of leaves plant^{-1}, corm yield plot^{-1} and corm yield hectare^{-1} compared to control treatments. There was no significant effect with respect to leaf area plant^{-1} and number of corms plant^{-1}. Based on the findings of the experiments it could be deduced that poultry manure and NPK rate of 150 kg ha^{-1} promoted higher growth and yield of cocoyam.

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Introduction

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 (Anjan and Kumar, 2013; Ashraf and Mahmoud, 2013; Ademiluyi, 2013). The crop had 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 (Ademiluyi, 2013); Ojinaka *et al.*, 2009). Cocoyam ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria. Currently, Nigeria is the world's leading producer of cocoyam (taro), accounting for up to 3.7 million metric tonnes annually (Ademiluyi, 2013). It has relatively small size starch grains which are easily digestible and therefore acclaimed to be a very good source of carbohydrate for diabetic patients (Ekwe *et al.*, 2009). The corms may be cut up and boiled in curries or fried to make crispy chips, leaves and leaf stalks can also be cooked and eaten like spinach (Ademiluyi, 2013; Nwachuckwu, 2009; Dada and Fayinminnu, 2010). Despite the numerous importance of cocoyam in Nigeria and many other nations the potential for food security are grossly underutilized (Ekwe *et al.*, 2009; Gudugi, 2013). A major militating factor in the production of cocoyam in this part of the world is nutrition especially during the early growth stage of between 4-12weeks (Ademiluyi, 2013). There could be serious yield reduction when nutrition is low during canopy formation and early tuberization (Ademiluyi, 2013; Harrison *et al.,* 2014). Losses in cocoyam due to lack of nutrients and weed infestation could be substantial ((Ademiluyi, 2013; Harrison *et al.*, 2014). However, precise information on the total economic impact of nutrient supply on cocoyam production has not been properly documented because methods for estimating yield loses often differ and do not allow easy comparison of different regions of the country ((Ademiluyi, 2013). Different sources of nutrition have been employed in Nigeria to increase the yield in cocoyam production; these include both the organic and inorganic manure sources (Ademiluyi, 2013; Mera *et al.*, 2009). In Nigeria, farmers seldom rely on the use of organic manures only. The reason for this was attributed to high cost of inorganic manures which seems too expensive to the resource poor peasant farmer. (Ademiluyi, 2013; Okoroafor *et al.*, 2013). However, Ademiluyi (2013) reported higher net economic return from the use of both organic and inorganic manures. The present study was designed to study the performance of cocoyam using organic and inorganic manures on the growth and yield.

Materials and methods

Site Location

A field trial was conducted to study the performance of cocoyam as influenced by organic manure and inorganic manure during the 2014 cropping season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria located on latitude 11°11'N and longitude 7°38'E and about 686m in the Northern Guinea ecological zone.

Treatment and Experimental Design

The field was manually cleared with cutlass and plots measuring 5m x 4m were laid out with 1m boarder between plots. Heaps were made with Nigerian hoe and each heap was 1m from the other. The trial was laid out in a split plot design consisting of control, goat manure, cow dung, poultry manure each at 10 tons ha^{-1} assigned to the main plots; whereas inorganic manure of 0, 90, 120 and 150 kg NPK ha^{-1}assigned to sub plots, replicated three times. The sprouted cocoyam corms were planted one $heap^{-1}$.

Data Collection and Analysis

Data collected included plant height, number of leaves $plant^{-1}$, leaf area $plant^{-1}$, number of corms $plant^{-1}$, corm yield $plot^{-1}$ and corm yield $hectare^{-1}$. The data collected was subjected to statistical analysis using mixed model procedure, software version 8. Means were separated using the least significant difference at 5% level of probability (Rangaswamy, 2010).

Results

Plant height (cm)

Table 1 shows a significant difference at P≤0.05 between means due to organic manure at 4WAS, 8WAS and 12WAS during the 2014 cropping season. The control of no manure applied significantly produced the lowest means of 8.25, 12.33, and 21.12 on plant height; whereas poultry manure significantly produced the highest means of 15.14, 23.24 and 26.25 throughout the sampling periods on plant height. Table 1 also shows a significant difference at P≤0.05 between means due to inorganic manure at 4WAS, 8WAS and 12WAS during the 2014 cropping season. The control of 0 kg ha^{-1} of NPK significantly produced the lowest means of 8.32, 12.41, and 21.32 on plant height; whereas NPK at 150kg ha^{-1} significantly produced the highest means of 15.24, 23.33 and 26.65 throughout the sampling periods on plant height.

Table 1. Growth parameters of cocoyam as influenced by organic and inorganic manures in 2014 cropping season at Samaru, Zaria.

	Plant height (cm) plant^{-1}			Number of leaves plant^{-1}			Leaf area (cm^2) plant^{-1}		
Organic manure	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS	3WAS	6WAS	9WAS
No manure (control)	8.25c	12.33c	21.12c	6.21c	8.36c	15.10b	36.22a	37.42a	39.43a
Goat manure	12.30b	15.36b	23.22b	8.34b	10.32b	16.23b	36.38a	37.48a	39.46a
Cow dung	13.28b	14.55bc	24.15bc	6.32bc	10.43b	18.24ab	36.41a	38.48a	39.47a
Poultry manure	15.14a	23.24a	26.25a	10.24a	12.54a	20.21a	37.47a	38.48a	40.48a
SE±	1.22	2.28	2.32	1.22	1.24	2.36	3.23	3.33	3.36
Inorganic manure (NPK)									
0 kg ha^{-1}	8.32c	12.41c	21.32c	6.36c	8.43c	15.12b	36.34a	37.22a	39.42a
90 kg ha^{-1}	12.34b	15.42b	23.42b	8.47b	10.28b	16.21b	36.41a	37.38a	39.44a
120 kg ha^{-1}	13.48b	14.43bc	24.45bc	6.38bc	10.29b	18.22ab	36.44a	38.36a	39.45a
150 kg ha^{-1}	15.24a	23.33a	26.65a	10.44a	12.34a	20.24a	37.48a	38.47a	40.47a
SE±	0.64	1.31	1.62	0.64	0.68	0.72	2.21	2.32	2.34
OM x IM	*	*	*	*	*	*	NS	NS	NS

Key: - OM = Organic manure, IM = Inorganic manure, NS = Not significant, * = Significant at 5% level of probability.

Number of leaves plant^{-1}

Table 1 shows a significant difference at P≤0.05 between means due to organic manure at 4WAS, 8WAS and 12WAS during the 2014 cropping season. The control significantly produced the lowest means of 6.21, 8.36 and 15.10 on number of leaves plant^{-1}; whereas poultry significantly produced the highest means of 10.24, 12.54 and 20.21 throughout the sampling periods on number of leaves plant^{-1}. Table 1 also shows a significant difference at P≤0.05 between means due to inorganic manure at 4WAS, 8WAS and 12WAS during the 2014 cropping season. The control of no fertilizer applied significantly produced the lowest means of 6.36, 8.43 and 15.12 on number of leaves plant^{-1}; whereas NPK at 150 kg ha^{-1} significantly produced the highest means of 10.44, 12.34 and 20.24 throughout the sampling periods on number of leaves plant^{-1}.

Leaf area (cm^2) plant^{-1}

Table 1 shows a no significant difference at P≥0.05 between means due to organic manure and inorganic manure at 4WAS and 8WAS during the 2013 cropping season on leaf area plant^{-1}.

Number of corms plant^{-1}

Table 2 shows a no significant difference at P≤0.05 between means due to organic manure and inorganic manure at 12WAS, 14WS and 16WAS during the 2014 cropping season on number of corms plant^{-1}.

Corm yield (kg) plot^{-1}

Table 2 shows a significant difference at P≤0.05 between means due to organic manure during the 2014 cropping season on corm yield plot^{-1}. The control of no manure applied significantly produced the lowest mean of 3.53 on corm yield plot^{-1}; whereas poultry manure significantly produced the highest mean of 5.34 during the sampling period on corm yield plot^{-1}. Table 2 shows a significant difference at P≤0.05 between means due to inorganic manure during the 2014 cropping season on corm yield plot^{-1}. The control of no fertilizer applied significantly produced the lowest mean a of 3.48 on corm yield plot^{-1}; whereas NPK at 150 kg ha^{-1} significantly produced the highest mean a of 5.28 during the sampling period on corm yield plot^{-1}.

Table 2. Yield parameters of cocoyam as influenced by organic and inorganic manures in 2014 cropping season at Samaru, Zaria.

Treatment	Number of corms plant^{-1}			Corm yield(kg) plot^{1}	Corm yield (tons) hectare^{-1}
Organic manure	12WAS	14WAS	16WAS	3.53d	3.82b
No manure (control)	4.42a	6.13a	6.55a	3.63c	3.86b
Goat manure	4.53a	6.14a	6.57a	4.67a	3.43ab
Cow dung	4.53a	6.16a	6.64a	5.34b	4.60a
Poultry manure	4.54a	6.18a	6.66a	1.22	1.24
SE±	NS	NS	NS		
Inorganic manure (NPK)					
0 kg ha^{-1}	4.34a	6.14a	6.42a	3.48d	3.66b
90 kg ha^{-1}	4.44a	6.15a	6.55a	3.68c	3.68b
120 kg ha^{-1}	4.45a	6.16a	6.65a	4.43a	3.72ab
150 kg ha^{-1}	4.46a	6.17a	6.73a	5.28b	4.83a
SE±	NS	NS	NS	1.12	1.13
OM x IM	NS	NS	NS	*	*

Key: - OM = Organic manure, IM = Inorganic manure, NS = Not significant, * = Significant at 5% level of probability.

Corm yield (tons) hactare^{-1}

Table 2 shows a significant difference at P≤0.05 between means due to organic manure during the 2014 cropping season on corm yield hectare^{-1}. The control of no organic manure applied significantly produced the lowest mean of 3.82 on corm yield hectare^{-1}; whereas poultry manure significantly produced the highest mean of 4.60 during the sampling period on corm yield hectare^{-1}. Table 2 shows a significant difference at P≤0.05 between means due to inorganic manure during the 2014 cropping season on corm yield hectare^{-1}. The control of no fertilizer applied significantly produced the lowest mean of 3.60 on corm yield hectare^{-1}; whereas NPK at 150 kg ha^{-1} significantly produced the highest mean of 4.83 during the sampling period on corm yield hectare^{-1}.

Discussions

Effects of organic and inorganic manure on growth and yield parameters of cocoyam

As observed from the results, it was evidenced that poultry manure and at 150 ha^{-1} of NPK significantly produced higher means of traits assessed, while the control treatments of no manure or fertilizer applied significantly produced the lowest means of the same traits over the rest of the organic or inorganic manures applied. Similar observations were earlier reported by Ademiluyi (2013) when he evaluated Evaluation of weed management strategies in cocoyam (*Colocasia esculentus* (L.) schott) production in Ado-Ekiti, Ekiti State Nigeria observed that there were effective weed control by the herbicides used and their combinations with hand weeding. The highest cormel number and cormel yield (kg plant $^{-1}$) was recorded in the Diuron + hand weeded plots which compared with those of hand weeded plots twice at 3 and 8weeks after planting. It is concluded that Diuron application with supplementary hand weeding will be effective to give

an all season weed control and produce optimum yield in the study area. Gudugi (2013) assessed the effect of cow dung and variety on the growth and yield of okra (*Abelmoschus esculentus* (L. Moench) consisting of two varieties of okra (NHE 47-4 and LD88-1) and four levels of cow dung (0, 5 10 and 15 tons ha^{-1}). The inorganic fertilizer was applied at rate of 200kg ha^{-1} and observed that cow dung applied at 20 tons ha^{-1} and inorganic fertilizer significantly produced taller plants, more leaves and more fruits. Non application of fertilizer significantly delayed flowering. In 2011, cow dung at 20 tons ha^{-1} and inorganic fertilizer statistically gave similar fruit weight which was significantly higher than other treatments. The highest fruit weight in 2012 was obtained with cow dung at 20 tons ha^{-1}. The varietal difference was not significant in most of the parameters measured

Ashraf and Mahmoud (2013) reported similar event when they studied the effect of nitrogen rate and plant density at different levels on yield, yield components and quality traits of safflower (cv. Giza 1) using four levels of nitrogen (0, 40, 80 and 120 kg N ha^{-1}) and four different densities (80,000, 100,000, 133,000 and 200,000 plants ha^{-1}) and observed that the main effects of nitrogen rate and plant density levels were significant ($P \leq 0.01$) for yield and yield components studied. A rise in nitrogen rate and plant density increased seed and oil yield, whereas plant height, number of branches $plant^{-1}$, number of heads $plant^{-1}$, seed yield $plant^{-1}$ and 1000-seed weight decreased as plant density increased. In general, the highest plant density (200,000 plants ha^{-1}) and the nitrogen level (80 kg ha^{-1}) was the best treatment in this research to attain high safflower seed yield under environmental conditions of Giza Governorate, Egypt. Also, the results revealed that, yield and yield components were significantly affected by plant density in linear responses. Correlation analysis showed a positive and significant correlation between seed yield ha^{-1} and each of number of heads $plant^{-1}$, seed yield $plant^{-1}$, number of branches $plant^{-1}$ and 1000 - seed weight. Stepwise regression analysis showed that number of heads $plant^{-1}$ explained 45.57% and along with seed yield $plant^{-1}$, number of branches $plant^{-1}$ and 1000 - seed weight explained 81.63% of total variations for seed yield (kg ha^{-1}).

Mera *et al.* (2009) reported similar event when they evaluated the response of roselle (*Hibiscus sabdariffa* L.) to farmyard manure and nitrogen-fertilizer in the semi-arid savanna of Nigeria during 1998 and 1999 rainy seasons at the Dry Land Teaching and Research Farm of Usmanu Danfodiyo University, Sokoto, using four rates of farmyard manure (0, 2.5, 5.0 and 7.5 tons ha^{-1}) and four levels of nitrogen fertilizer (0, 25, 50 and 75 kg nitrogen ha^{-1}) and reported that there was significant response to applied manure and nitrogen fertilizer on number of leaves up to 5 tons ha^{-1} manure and 50 kg nitrogen ha^{-1}. There was no significant increase in calyx yield by raising manure rate from 2.5-7.5 tons ha^{-1} or nitrogen rate from 50 to 75 kg ha^{-1}. Thus, 2.5 tons ha^{-1} manure and 50 kg nitrogen ha^{-1} were considered adequate for calyx production in roselle in Sokoto Semi-arid Tropics.

Anjana and Kumar (2013) also studied the effect of integrated manuring on growth and yield of (*Centella asiatica* (L.) Urb) using plantlets in earthen pots containing soil, with integrated manuring [Urea(%) : farm yard manure (%), 75:25; 50:50; 25:75], individual manuring (100 % Urea, 100 % farm yard manure) and control conditions (no manure) and observed that number of leaves $ramet^{-1}$, leaf area and number of flowers $ramet^{-1}$ were significantly higher in integrated manuring than other treatments. Biomass production in integrated manuring (50 % Urea and 50 % farm yard manure) was seven times higher than in control; it was five times higher than in complete organic manuring (100 % farm yard manure) and 1.5 times higher than in inorganic manuring (100 % Urea).

Ekwu *et al.* (2012) confirmed the same situation when they studied the effect of NPK fertilizer and weeding regime on the growth and yield of egg plant (*Solanum melongena* L.) in Abakaliki using NPK and weeding regimes on the growth and yield of eggplant (*Solanum melongena* L.) was evaluated. Results

showed that plant height, stem diameter, number of fruits and weight of fruits increased as the NPK rate increased from 0kgNPK ha^{-1} to 150kg NPK ha^{-1}. Fertilizer rate of 150kg NPK ha^{-1} produced the tallest plants (49.88cm), highest stem diameter (3.14cm), number of fruits (34.33) and weight of fruits (32.43 kg). The highest number of leaves (166.24), number of branches (14.07), stem diameter (3.01cm) and the longest number of days to 50% flowering (34.78days) was obtained on the weed free plots while the unwedded plots which gave the highest weed biomass consistently produced least values in all the vegetative and yield measurements taken.

Okoroafor *et al.* (2013) also reported the same results when they studied the effect of organic manure on the growth and yield performance of maize in Ishiagu, Ebonyi State, Nigeria measuring parameters such as number of leaves, stem girth, plant height and frequency of cob and weight of cob after harvest. The analysis showed that there was significant difference ($P \leq 0.05$) among the treatments applied on the parameters measured. It was discovered that treatment (Poultry dropping) gave the greatest difference among the treatments.

Conclusion

Farmers in Samaru are therefore advised to produce cocoyam using poultry manure and 150 kg ha^{-1} of NPK when the soil moisture is adequate in order to increase its growth and yield.

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