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Comparative Analysis of the Effects of Two Fertilizers on the Growth and Yield of Yam *(Dioscorearotundata)* Using Bags as Growing Medium

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Abstract

In most developing areas, the available arable farmlands are under threats of non-agricultural uses. Hence, mobile cropping (potting of crops) is gradually shifting from experiments for research purpose into household crop production including yam for small household. However, there is inadequate information on fertilizer types and application rates, hence, this trial focused on the application rates of two fertilizers on the growth and yield of yam under pot condition in an open space. A trial was conducted in Michael Otedola Teaching and Research Farm, Noforija, Epe in Lagos State using sand-loamy soil to raise yam in bags of 50 kg soil using No Fertilizer Application (NFA), NPK 15 – 15 – 15 fertilizer and Poultry Manure-PM under field conditions. The experiment was complete randomized design (CRD) with 3 replicates; 3 levels each of NPK and PM applications; (NFA-0, 200, 400N kg ha^{-1}; and 0, 10, 20 t h^{-1} NPK, fertilizer) per 50 kg soil, respectively. Yam sets of 200 – 250g were sown at one per 50kg soil in open space to meet field conditions. The vegetative and yield parameters observed include; the vine length –VL (m) and number of leaf – NL, tuber length-TL (cm), tuber girth –TG (cm) and tuber weight – TW (g/50kg soil). The results of the trial showed that there was no significant different in the vegetative parameters. However, the tuber yield ranged from 360.5 - 1224.7 g per 50 kg soil under NFA and PM, respectively. The tuber yield (1073.7) under NPK (400 kg ha^{-1}) was not significantly different from tuber yield (1079.3) obtained under application of PM (10 t ha^{-1}). It can be deduced that for small house hold for yam consumption, the use of PM at the range of10 – 20 t ha^{-1} and NPK at the rate of400 kg ha^{-1} will sustain yam production under an open space in bag or any medium that can hold 50kg of soil. It was recommended that bags or containers that can hold 50kg or more of soil can be used as a medium for white yam production using either Poultry Manure (PM)or NPK fertilizer.

Keywords: *Fertilizer, Growing medium, Yam, Yield*

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Background to the Study

Potting of crop, also known as houseplant; indoor crop or plant growing is known and attributed to residences and offices, mainly for decorative purposes. Studies have shown that some arable crops can be raised or cultivated to complete their life cycles for different purposes (Olugbemi, Odulate and Busari, 2015). This principle of potting crops formed the basis of "mobile or pot crop" production, a phenomenon of using bags or containers filled with soil to raise or propagate plants. Yam is one of the important staple food crops grown in Nigeria for its edible tubers. However, its cultivation is constrained by many factors such as high cost of production, poor yield as a result of low soil nutrient and of recent, farmer-herder menace. Yam has not been found to be one of the common potting crops, though it is a tropical but not epiphytes, or succulents or cacti crops which are common crops for potting (Jules, 2010). Potting crops need the correct moisture, light levels, soil mixture, temperature, and humidity as in the field. A more precise knowledge of the natural vegetation area of a plant is therefore required for maintenance (Ayoola and Makinde, 2007).

According to Nwaoguala and Law-Ogbomo (2018), yam is produced largely in Africa, and Nigeria is responsible for about70% of the world production and these amounts to over 37 million tons (FAO, 2012). However, with this high production potential, yam tuber yield below 13 t ha^{-1} is possible due to constraints associated to poor cultural practices, low level of education and low soil fertility status (Okojie, Okodugha and Itaman, 2019). To ameliorate the condition of the available arable farm for crop production, farmers continuously apply fertilizers of different forms to increase crop yields (Ajayi, Akinrind and Asiedu, 2006). The common ones are the inorganic fertilizers which effective and fast nutrients releasing materials for crops growth and yield yet enhance soil acidity, leaching, nutrients imbalances and degradation of organic matter and soil physical properties (Oladapo, Bolarin, Matanmi, Kareem and Ogunmola, 2009). On the other hand, organic fertilizers such as poultry, pig or compost among others are reservoir of various plant nutrients (Ayoola and Adeniyan). Besides, organic fertilizers improve soil physical properties and reduce soil acidity and sustain crop production through nutrient recycling and soil organic matter building capacity (Ayoola, 2006;Olugbemi, 2016).

For small household production of yam and with trending of potting of arable crops for immediate consumption, most farmers were not furnished with data about the fertilizer rates for this innovation of planting yam in pot. Hence, this study compared the growth and yield of white yam under various application rates of NPK 15 -15 – 15 fertilizer and poultry manure under pot (bag) conditions.

Materials and Methods

Experimental location: The experiment was conducted at Michael Otedola College of Primary Education Teaching and Research Farm (TRF) Noforija; located on 6.6^0N and 4.0^0E. The farm is located on the northern shore of the Lagos lagoon, about 32 kilometres south of Ijebu Ode, Lagos state. The coordinates of the experimental farm for the experiment are as follow: N0637.168', E003.323', N0637.166', E003.325', N0637.164', E003.333' and N0637.169', E003.332 (Olugbemi and Onibon, 2019).

Land preparation for soil samples collection: The land was cleared and soil samples were collected at a depth of 0 – 30 cm, samples collected were bulked into composite, air-dried, crushed and sieved with 0.5mm mesh for soil physical and chemical laboratory analyses. With the use hoe and shovel, soil from the site was collected and bags were filled with 50kg of soil and arranged at 1m by 1m.

Experimental deign and treatments: The experiment was complete randomized design (CRD) with 3 replicates of 3 levels of NPK and PM applications; (NFA-0, 200, 400N kg ha^{-1}; and 0, 10, 20 t h^{-1} NPK, fertilizer) per 50 kg soil, respectively. Yam sets of 200 – 250g were sown at one per 50kg soil during the 2021 yam production season in an open space to meet field conditions.

Data collection and analysis: The vegetative and yield parameters taken at 3 months after sowing (3MAS) include; the vine length (m) and number of leaf, tuber length, and tuber girth (cm) and tuber weight, respectively. All data collected were analyzed using analysis of variance (ANOVA $\alpha_{0.05}$) and mean treatments were subjected to Duncan Multitude Range Test (DMTR).

Results and Discussion

Table 1a: Chemical analysis of soil used for the trial

Parameters	Values
pH (Cl)	6.4
Organic C (g kg^{-1})	1.4
Total N (g kg^{-1})	0.34
Available P (mg g^{-1})	55.1
Exchangeable Bases (cmol kg^{-1})	
K	0.65
Ca	26.5
Na	0.38
Mg	2.82

Table 1a shows that the soil used for the experiment was slightly acidic with pH of 6.4. it was moderately low in organic carbon, low in nitrogen concentration, moderately high in available P, while exchangeable K,Ca, and Na were low with Mg of 2.8 cmol kg^{-1} (Table 1a). While table 1c reveals the physical characteristics of the soil (particle size distribution). This shows that it was sandy loam soil. Considering these parameters, the soil in question was low in fertility and cannot sustain or enhance full potential capacity for yam yield without fertilizer application (Tables 1a and b).

Table 1b: Physical soil (particle size distribution) analysis of the soil used

Parameters	Values (g kg^{-1})
Sand	726.0
Clay	140.0
Silt	134.0
Textural class	Sandy loam

Table 1c reveals that the poultry manure contained high plant nutrient for sustainable crop production such as yam. The application of this type of fertilizer to soil of this nature of low fertility enhanced yam tuber yield positively. Although the application of poultry manure at 20 t ha^{-1} significantly increased yam yields compared to others rates of both fertilizers. However, at the application of 10 t ha^{-1}, there was no significant difference in yam tuber yield compared to 400 kg ha^{-1}NPK 15- 15- 15 application (Table 1c).

Table 1c: Chemical composition of the poultry manure used for the trial

Parameters	Values
pH (Cl)	7.2
Organic C (g kg^{-1})	8.3
Total N (g kg^{-1})	3.7
Available P (mg g^{-1})	42.5
Exchangeable Bases (cmol kg^{-1})	
K	0.6
Ca	11.1
Na	0.5
Mg	3.2

Table 2: Effects of two fertilizer types and rates on the growth performance of yam plant at 3weeks after sowing

Fertilizer types and rates		Number of leaf	Vine length (m)	Stem girth (cm)
NFA	0 kg ha^{-1}	146.7	3.3b	1.7
	200 kg ha^{-1}	266.7	4.8a	2.0
NPK 15-15-15	400 kg ha^{-1}	326.3	4.6ab	2.1
Poultry	10 t ha^{-1}	283.7	4.4ab	1.9
Manure	20 t ha^{-1}	289.8	4.6a	2.0
S E (Df = 14)		±4.1	±1.3	±0.6

NFA= No fertilizer Application

There was no significant difference in the vegetative growth characteristics of the yam at the early three months after sowing as shown (Table 2).

Table 3: The influence of two fertilizer types and rates on the growth performance of yam tuber at harvest

Fertilizer types and rates		Tuber length (cm)	Girth (cm)	No of tuber per vine	Tuber weight 50kg^{-1} soil (g)
NFA	0 kg ha^{-1}	27.3d	24.3d	1.0b	360.5d
	200 kg ha^{-1}	36.0c	36.3a	1.3a	939.9c
NPK 15-15-15	400 kg ha^{-1}	44.7a	33.0b	1.0b	1073.7b
Poultry	10 t ha^{-1}	42.7b	32.3b	1.0b	1079.3b
Manure	20 t ha^{-1}	44.0a	27.0c	1.3a	1224.7a
S E (Df = 14)		± 1.8	±1.3	± 0.09	±85.4

NFA= No fertilizer Application

At harvest, the yam tuber yield increased significantly under (20 t ha^{-1}) poultry manure application followed by 400 kg ha^{-1} NPK 15 – 15- 15 fertilizer application. However, the yield reduced significantly when no fertilizer (NAF) was applied. Besides, the tuber yields under 10 t ha^{-1}of poultry manure application and 200 kg of NPK 15 -15- 15 applications were not significantly different when compared. Moreover, the yam tuber characteristics followed the same pattern as showed in the tuber weights except where the tuber girth and number of tuber per vine that were no significant difference under 400 kg ha^{-1} NPK 15 – 15- 15 fertilizer and 10 t ha^{-1}of poultry manure applications (Table 3).

Discussion

Poultry manure is easily available as alternative source of fertilizer at less cost compared to chemical fertilizers with their inherent adverse effects on both soil and human's health (Olugbemi, Odulate and Busari, 2015). More so, poultry manure is a more concentrated source of crop nutrients, namely: NPK, among other nutrients essential for crop production (Okojie, Osajiele, Osemwota, 2019). However, poultry manure has additional advantages of improving soil physical, chemical and biological dynamics which make it readily sustainable source of crop production on both small and large scales (Agbede, Adekiaya, Ogeh, 2013).

At small scale production such as demonstrated in mobile yamproduction; using empty bags of cement, the use of poultry manure sustains the ecological soundness in such a way that the menace of the wastes with foul odors are converted to useful means for crop production and sensitizes the immediate environment (Agbede, Ojeniyi, Adeyemo, 2008). Likewise, the pollution of construction sites as these bags littering the surrounding are converted to growing medium for raising arable crops such as yam and maize.

Significantly, this trial discovered the potential of poultry manure in the production of yam in bags (mobile farm) in order to control conditions with less stress of weeding, pests, or rodents' control and the menace of herder-farmer clash (Nwaoguala, Law-Ogumo,2018). Besides, the bags are useful as containers for planting medium for raising yam instead of being seen as litters all over as waste and land pollutant.

The mobile farm is similar to the recently introduced classroom on the go or mobile classroom. The essence of the mobile classroom is to take education to the nooks and cranny of the society or the grassroot which will ensure the participation of everyone. Other advantages of this mobile farming or yam production include the ability to control the weather by manipulating the micro climate at will to maintain the suitable growing condition for the crop in question. More so, the soil of choice can easily be imported with or without cost for the purpose. The pests and diseases control are also at cheaper or no cost for production and farmers are liberty to employ biological means that are ecosystem and environmentally friendly. Besides, the produce from this farming system is organic and healthy provided soil and other inputs are not chemical or synthetic materials. Produce is also physiologically sound without any physical or chemical deterioration which make it nutritionally intact before consumption.

Recommendation

From the results of the study, it can be recommended that containers or bags of appreciable volume that can contain 50 kg and above should be used for white yam production. Besides, such soil must free from injurious materials and be able to support application 400kg NPK and 20 t ha^{-1} of poultry for the duration of growing period of 8 to 12 months. For teaching and learning to be effective, the right atmosphere should be provided with adequate and proper monitoring.

Conclusion

In conclusion, the result of this trial showed that the soil or the experiment was slightly acidic, inherently low in fertility but with the use of fertilizer and 400kg NPK and 20 t ha^{-1} of poultry manure yam can be produced under such applications using bag or size not below 50kg capacity for mobile yam farm production. The desire quantity of soil and control of all inputs for crop production are at readily available and under closed monitoring compared to normal field conditions.

The implication of the foregoing in education (teaching and learning) is that with the right input (conducive environment, availability of adequate and relevant instructional materials and the right motivation of teachers coupled with proper monitoring), the desired output, which has to do with high yield in learning (high academic performance/achievement) will be attained when compared to a loosely monitored classroom situation in an unconducive learning environment, which may not produce the desired result.

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