Vol. 15(5), pp. 131-137, May 2021
DOI: 10.5897/AJPS2021.2130
Article Number: AC7AB6866951
ISSN 1996-0824

http://www.academicjournals.org/AJPS

African Journal of Plant Science

Full Length Research Paper

Effects of organic and inorganic fertilizers on sweet potato production in Iwo, Nigeria

V. I. Esan[1*], O. O. Omilani[1] and I. Okedigba[2]

[1]Environmental Management and Crop Production Programme, College of Agriculture, Engineering and Science, Bowen University, P. M. B. 284, Iwo, Osun State, Nigeria.
[2]Statistics Programme, College of Agriculture, Engineering and Science, Bowen University, Iwo, Osun State, Nigeria.

Received 2 January, 2021; Accepted 14 April, 2021

Sweet potato (*Ipomea batatas*) is one of the most important horticultural crops for human consumption and livestock feed. All parts of the plant are found useful to human consumption, animal feed, and industrial uses. Fertilizer applications have been shown to improve vegetative and storage parameters could be enhanced, but inorganic fertilizers are not always readily available, or are too expensive for prevalently subsistent farmers in Nigeria. This study aimed to compare the performance characteristics of four potato varieties using two fertilizers from inorganic and organic sources using morphological characteristics of the plants. The experiment was carried out in the field and laid out as randomized complete block design with three replications. Two treatments that is, inorganic and organic fertilizers with three levels for each treatment were used. The yield and other morphological characteristics were measured. The results showed that Iwo 1 (variety 3) produced the highest number of tubers (16.67 and 16.69; 16.67 and 16.33) with both inorganic and organic fertilizers and levels, respectively. Iwo 1 (variety 3) also produced the biggest tuber weight (4.57 and 4.60 kg; 3.97 and 3.88 kg) with both inorganic and organic fertilizers and levels, respectively. The results showed significantly (P≤0.05) similar levels of performance of organic fertilizers when juxtaposed with inorganic fertilizer applications, suggesting that in the absence of inorganic fertilizers either due to cost and or availability, organic fertilizers which are relatively more available to the farmer could be used to obtain similar yield levels. Given the bulky nature of the fertilizers as suggested by the quantity used in this experiment, further research will need to be done to determine the best rate for organic fertilizer application.

Key words: Fertilizers, improvement, productivity, sweet potato.

INTRODUCTION

According to the CIP (2018), the sweet potato is the 6th most important crop in the world. In 2019, Nigeria was the third highest producer of the crop in the world, producing over four million tonnes (FAOSTAT, 2019). It is an important horticultural crop in Nigeria whose storage roots are used for both animals and human beings and as a source of income. The crop occupies a vital place in the diet regime of people in Nigeria (Ejechi et al., 2020). Sweet potato is an important crop for food security in some of the world's poorest nations (Yared et al., 2014) and the fresh storage roots are also sold in the market for income generation. All the plant parts of sweet potato and

*Corresponding author. E-mail: ishola.vincent@yahoo.com.

its culls are used for food, feed, or for industrial uses (Claessens et al., 2008). Sweet potato adapts to many environmental conditions and is of short life cycle when compared with other tropical tuber crops (Horton, 1988).

The importance of sweet potato is increasing in Nigeria's farming and food systems because it is easy to plant, matures easily and has enormous industrial and economic potentials (Chukwu, 1999). According to the survey conducted in six States in Nigeria by Egeonu and Akoroda (2010), the different forms of sweet potato utilization are boiling and eating with stew/palm oil, slicing and frying, roasting, boiling and eating as snack; boiling and pounding alone or with boiled yam/garri for eating with soup; cooking alone or with another crop to make pottage; slicing and sun-drying for milling into flour; feeding of vines and leaves to livestock; small tuberous roots as livestock feed; made into fufu like cassava; fresh leaves and young shoots consumed as vegetable. In most parts of the Kenya, the storage roots are boiled and eaten, or chipped, dried and milled into flour which is then used to prepare snacks and baby weaning foods (Hagenimana et al., 2001).

Sweet potato supplies vital nutrients such as carbohydrates, proteins, minerals, and vitamins (Stathers et al., 2005). Its storage roots provide 25-30% as carbohydrates and 2.5-7.5% as protein of its dry weight, respectively. It also provides 200-300 mg 100 g^{-1} of potassium (K), 0.8 mg 100 g^{-1} of iron (Fe), 11 mg 100 g^{-1} of calcium (Ca) and 20-30 mg 100 g^{-1} of vitamin C of its dry matter (Çalifikan et al., 2007) as well as copper, zinc and manganese, vitamin B2, B6 and E, while the orange fleshed storage roots provide pro-vitamin A. It can also be used as starch, natural colorants, and fermented products. Wine, ethanol, lactic acid, acetone, and butanol are used as fermented products of sweet potato (Winarno, 1982; Clark, 1988; Duvernaya et al., 2013).

Several researches have been carried out with the use of commercial nitrogen - phosphorus - potassium (NPK) fertilizers and farmyard manure, suggesting that a mix of the two is most efficient (Negassa et al., 2001; Balemi, 2012). However, estimates of typical use of fertilizer (of any kind) by farmers growing sweet potato are largely speculative. Maduakor (1991) noted that actual fertilizer use in Nigeria pales in comparison to the estimated requirements for optimum food production. This position is buttressed by an experiment in Imo State, Nigeria, which showed that despite relatively unfertile soils and high population density, some of the primary root crops (cassava, yam, and cocoyam) were grown with minimal fertilizer in most areas (Goldman, 1996). One of the reasons for this observation is the limited availability of inorganic fertilizer at the time farmers need them; this unavailability is sometimes due to poor transportation systems, and the high cost needed to acquire the fertilizers (Liverpool-Tasie et al., 2016).

Although the tuber yield of the sweet potato plant in marginal soils is relatively high (Uwah et al., 2013), for optimum yield, production of the crop is better on soils which have the required nutrients for proper growth of the plant. NPK (15:15:15) was used for this experiment. The application rate of 300 kg NPK/ha is considered beneficial in the savanna zones of Nigeria (Mukhtar et al., 2010), but as earlier mentioned, farmers will not always have access to the required inorganic fertilizer needs. This was considered in deciding what inorganic fertilizer treatment levels to use for this experiment. Organic fertilizer sources can offer themselves as alternatives to the predicament of farmers in Nigeria because of their relative availability (on-farm sources), and significantly lesser cost. Although they are touted for their many advantages which help to improve soil and soil microorganism health, they are not without their own challenges including bulkiness and non-standardization of the fertilizer content. Regardless, they still present themselves as possible alternatives especially for small scale subsistence farmers who form the bulk of farmers in Nigeria. Given their typically non-standardized nature, it is imperative to compare the performance of the crop under their cultivation with the much more standardized inorganic fertilizer if farmers are to consider them as a substitute for the more popular inorganic fertilizer.

The objective of this study was therefore to evaluate the performance of organic and inorganic fertilizers based on agronomic and morphological characteristics of four potato varieties in Iwo, Nigeria. This information can help farmers the major nutrient requirements (N-P-K) of the sweet potato in regard to growth and productivity using organic and inorganic fertilizers.

MATERIALS AND METHODS

Experimental site and planting materials

This experiment was carried out on sweet potato at Bowen University Teaching and Research Farm Iwo, Osun State, Nigeria. Bowen University is located on latitude 7°62ˈ N and longitude and 4°19ˈ E. The altitude is 210 m above sea level. The soil is well drained, light to moderate textured and sandy loam in nature.Two introduced and two local varieties were used in the present study. The two introduced varieties called Mother's delight and King J were respectively designated as V1 and V2 and the local varieties known as Iwo 1 and Iwo 2 are called V3 and V4, respectively. V1 is the orange fleshed varieties while V2 was cream fleshed sweet potato variety. Mother's delight and King J were obtained from a Commercial Agricultural Center located in Abuja. This Commercial Agricultural Center sells the vine of sweet potato in order to promote the production of orange fleshed sweet potato across the country because it is rich in vitamin C.

Planting and experimental layout

Planting of 30 cm long vine cuttings was carried out on each ridge of 2 m long on 21 July 2016. Each vine cutting was inserted at a slant at a spacing of 30 cm within the rows and 90 cm between rows. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replicates (block). Each block had

Table 1. Effect of fertilizers on vine length (cm).

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150 kg/ha	300 kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	20^{aC}	26.61^{bC}	25.88^{bC}	20.94^{aC}	27.06^{bC}	32.56^{bB}
King J	40.78^{aA}	43.22^{aA}	42.28^{aA}	38^{aA}	37.28^{aA}	45.78^{bA}
Iwo 1	32.44^{aB}	32.11^{aB}	33.33^{aB}	32^{aA}	38.33^{bA}	36.44^{bB}
Iwo 2	24^{aC}	32.22^{bB}	33.06^{bB}	27.42^{aB}	32.56^{bB}	33.67^{bB}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.05 and P<0.001 probability level, respectively. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

Table 2. Effect of fertilizers on petiole length (cm).

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150 kg/ha	300 kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	13.39^{bC}	16.30^{aC}	18.63^{aB}	13.03^{bB}	16.08^{aB}	17.56^{aC}
King J	19.12^{cA}	25.44^{bA}	28.54^{aA}	19^{cA}	23.80^{bA}	28.57^{aA}
Iwo 1	15.93^{bB}	18.21^{aB}	17.00^{abB}	15.59^{bB}	16.22^{bB}	23.93^{aB}
Iwo 2	12.88^{bC}	15.41^{aC}	14.53^{aC}	13.04^{aB}	13.49^{aB}	14.71^{aD}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.01 and P<0.001 probability level, respectively. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

a size of 24 × 2 m and a total of 156 plants were planted in each block.

Fertilizer treatment

Two types of fertilizers were applied. Treatment 1 was NPK and treatment 2 was organic manure. As is standard practice, the fertilizer treatments were applied two and four weeks after planting. Three levels of each treatment including the control were considered while the other two levels were designated as level 1 and level 2. For NPK, 150 and 300 kg/ha were used as level 1 and level 2, respectively. While for the organic fertilizer: one (60 g – equivalent to 18 tonnes/ha) and two handfuls (120 g – equivalent to 36 tonnes/ha) of composted manure purchased from a compost farmer in Iwo were used as level 1 and 2, respectively. The organic manure (compost) was applied per plant.

Data collection

Growth and reproductive parameters were measured. Vine length (cm): The length of two most vigorous vines was taken using a measuring tape. The length was taken from the base of the plant vine to the tip of the vine. The vines were straightened to get accurate reading. Petiole length (cm): This was taken by measuring the stalk of the leaf from the base of the leaf to the point of attachment to the stem. Leaf length was measured from the tip of the leaf to the base or bottom of the leaf. Leaf breadth (cm) was the measurement of the width of the leaf. The widest part of the bottom was measured from side to side. Internode length (cm) was obtained by measuring the distance between the nodes of the vines. Fresh weight of the tubers harvested were taken with a weighing balance.

Statistical analysis

The data collected were subjected to an analysis of variance to determine the differences among the varieties and treatments used. Means separation was performed by Tukey's test.

RESULTS

Data presented in Table 1 show the effect of organic and inorganic fertilizers on vine length. The longest vine was recorded in V2 fertilized with 60 g of manure while the shortest was recorded with V1 without any treatment (control). Effect of fertilizers on petiole length is presented in Table 2. Significant differences between the control and the fertilizer treatments were observed. However, there was no significant difference between 150 kg per ha and 300 kg NPK per ha, but slight difference was observed as 300 kg/ha treatment showed higher average values when compared to the treatment with 150 kg/ha. 60 and 120 g of organic fertilizer showed the same the trend as 120 g treatment showed higher average values when compared to the treatment with 60 g. King J (variety 2) had the longest petiole (25.44 and 28.54 cm; 23.80 and 28.57 cm) with both treatments and levels, respectively.

Data presented in Table 3 show the effect of organic and inorganic fertilizers on internode length. There were no significant differences between the control and the fertilizer treatments. Although slight differences were observed between 150 kg per ha and 300 kg NPK per ha,

Table 3. Effect of organic and inorganic fertilizers on internode length (cm).

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150 kg/ha	300 kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	3.17^{aA}	3.29^{aA}	5.53^{aA}	4.22^{aA}	4.46^{aA}	4.80^{aA}
King J	3.64^{aA}	4.32^{aA}	5.64^{aA}	4.36^{aA}	4.02^{aA}	4.67^{aA}
Iwo 1	3.67^{aA}	4.21^{aA}	4.47^{aAB}	3.22^{aA}	4.49^{aA}	3.48^{aA}
Iwo 2	3.48^{aA}	3.93^{aA}	3.06^{aB}	3.74^{aA}	4.26^{aA}	3.72^{aA}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.05. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

Table 4. Effect of organic and inorganic fertilizer on leaf breadth (mean ± SD cm).

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150kg/ha	300kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	7.57 ± 1.08^{aB}	8.58 ± 1.57^{aB}	9.58 ± 2.31^{aA}	7.10 ± 2.42^{aB}	9.83 ± 1.29^{aA}	8.50 ± 1.77^{aB}
King J	10.16 ± 1.85^{aA}	12.11 ± 2.47^{aA}	11.7 ± 0.91^{aA}	10.1 ± 0.74^{aA}	11.2 ± 0.67^{aA}	11 ± 0.75^{aA}
Iwo 1	10.19 ± 0.77^{aA}	10.27 ± 0.32^{aA}	10.50 ± 0.6^{aA}	9.09 ± 0.9^{bAB}	10.23 ± 0.9^{bA}	13.34 ± 1.7^{aA}
Iwo 2	8.90 ± 2.37^{bB}	10.4 ± 2.15^{abA}	11.39 ± 1.4^{aA}	7.94 ± 0.9^{bB}	9.38 ± 0.3^{baA}	10.23 ± 1.3^{aB}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.001. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

Table 5. Effect of organic and inorganic fertilizers on leaf length (cm).

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150 kg/ha	300 kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	7^{bC}	9^{abB}	11.18^{aB}	7.68^{aB}	10.86^{aB}	10.33^{aB}
King J	12.44^{aA}	14^{aA}	14.28^{aA}	$13.\ 31^{aA}$	13.28^{aA}	13.47^{aA}
Iwo 1	12.38^{aA}	13.89^{aA}	13.44^{aA}	11.88^{aA}	13.20^{aA}	14.34^{aA}
Iwo 2	10^{bB}	10.66^{abB}	12.23^{aAB}	9.27^{aB}	10.61^{aB}	11.29^{aAB}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.001. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

as 300 kg/ha treatment showed higher average values when compared to the treatment with 150 kg/ha. King J (variety 2) had the longest internode (4.32 and 5.64 cm) for treatment 1 across both levels. Mother's delight (variety 1) had the longest internode (4.46 and 4.80 cm) for treatment 2 across both levels.

Table 4 shows the effect of organic and inorganic fertilizer on leaf breadth. There were no significant differences between the control and the fertilizer treatments for varieties 1 and 2 for both treatments 1 and 2. Significant differences were however between the control and fertilizer treatment 2 for variety 3 and between the control and the fertilizer levels for variety 4. King J (variety 2) had the widest leaf breadth (12.11 and 11.70 cm) for treatment 1 across both levels and King J (variety 2) also had the widest leaf breadth (11.2 cm) for treatment 2, level 1 while Iwo 1 (variety 3) had the widest leaf breadth (13.34 cm) for treatment 2, level 2.

Effect of inorganic and organic fertilizers on leaf length is presented in Table 5. The results showed that there were significant differences between the control and the fertilizer treatments. Only slight difference was observed between 150 kg per ha and 300 kg NPK per ha as 300 kg/ha treatment showed higher average values when compared to the treatment with 150 kg/ha. Similar results were recorded between 60 and 120 g of organic fertilizer as 120 g treatment showed higher average values when compared to the treatment with 60 g. King J (variety 2) had the longest leaves (14 and 14.28 cm; 13.28 and 13.47cm) with both treatments and levels, respectively.

Table 6. Effect of organic and inorganic fertilizer on number of tubers.

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150 kg/ha	300 kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	8.33^{bAB}	9.33^{abC}	11.33^{aB}	6^{aD}	12.33^{aB}	8^{aC}
King J	6.67^{bB}	10^{abC}	13^{aB}	9^{aC}	11.67^{aB}	13^{aB}
Iwo 1	10.33^{bA}	16.67^{aA}	16.69^{aA}	15.33^{aA}	16.67^{aA}	16.33^{aA}
Iwo 2	6.33^{cB}	13^{bB}	16.33^{aA}	13^{aB}	12^{aB}	14.67^{aAB}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.05. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

Table 7. Effect of organic and inorganic fertilizer on tuber weight (kg).

Variety	Inorganic fertilizer			Organic fertilizer		
	Control	150 kg/ha	300 kg/ha	Control	18 tonnes/ha	36 tonnes/ha
Mother's delight	0.40^{bB}	1.43^{abB}	3.43^{aA}	0.33^{aB}	1.30^{aB}	0.53^{aB}
King J	2.43^{aA}	2.46^{aB}	3.37^{aA}	1.73^{aB}	2.40^{aAB}	3.03^{aA}
Iwo 1	3^{aA}	4.57^{aA}	4.60^{aA}	2.83^{aA}	3.97^{aA}	3.88^{aA}
Iwo 2	1.37^{bAB}	1.80^{abB}	4.30^{aA}	2.10^{aAB}	2^{aB}	3.13^{aA}

Different small letters in the same row for each treatment and capital letters in the column for varieties show significant difference at P<0.05. Treatment 1 was NPK and L1= 150 kg/ha and L2=300 kg/ha. Treatment 2 was organic fertilizer: L1 =60 g and L2 =120 g. Varieties are V1= Mother's delight; V2= King J; V3=Iwo 1 and V4 = Iwo 2.

The effect of organic and inorganic fertilizer on number of tubers is shown in Table 6. Significant differences between the control and the fertilizer treatments were observed for treatment 1. But, there was no significant difference between 150 kg per ha and 300 kg NPK per ha except for variety 4, although, slight difference was observed as 300 kg/ha treatment showed higher average values when compared to the treatment with 150 kg/ha. Iwo 1 (variety 3) produced the highest number of tubers (16.67 and 16.69; 16.67 and 16.33) with both treatments and levels, respectively.

Data recorded in Table 7 demonstrates the effect of organic and inorganic fertilizer on tuber weight. The tuber weight was taken as the average weight of tubers in a plot. Significant differences between the control and the fertilizer treatments were observed but, there was no significant difference between 150 kg per ha and 300 kg NPK per ha, although, slight difference was observed as 300 kg/ha treatment showed higher average values when compared to the treatment with 150 kg/ha. Iwo 1 (variety 3) produced the biggest tuber weight (4.57 and 4.60 kg; 3.97 and 3.88 kg) with both treatments and levels, respectively.

DISCUSSION

Plant productivity is impinged by many factors especially nutrients availability in the soil and soil biota. The depletion in essential soil nutrients nowadays call for fertilizer application to enhance crop yield so as to fight against food insecurity and alleviate poverty in Africa. The cost of inorganic fertilizers is becoming more and more unaffordable to farmers in smallholder agriculture systems. Making use of the available natural resources for organic fertilizer production is of paramount importance in reducing the cost of soil mineral input and replenishing soil fertility and maximizing crop productivity. Many researchers have reported about the importance of organic fertilizers due to the fact that organic fertilizers improve soil chemical, physical and biological properties, soil fertility, water holding capacity, cation and anion exchange capacity, permeability, porosity and texture (Hafifah et al., 2016; Novianantya et al., 2017). Organic fertilizers have the above advantages over the inorganic fertilizers. Thus, the purpose of this study was to compare the strength and performance of inorganic and organic fertilizers during sweet potato growth and development so as to recommend the cheaper organic fertilizers to farmers for their crop production. The decomposition of organic fertilizers such as manure, compost and bio-fertilizers help to amend the soil through the release of organic material needed by plants for its growth and development and high productivity. But the application of manure during crop development may not significantly improve crop productivity due to its slow release type of nutrients to the soil when compared to the inorganic fertilizers. Rishirnmuhirwa and Roose (1998) showed that the decrease in agronomic performance from organic fertilizers could be explained by the slow process of manure decomposition. Nutrients from organic matter are progressively released through mineralization and their action is much slower.

The application of fertilizers whether inorganic or organic resulted in an increase in petiole length, an increase in internode length, an increase in number of tubers and an increase in weight of sweet potato tubers. The longest petiole was recorded in plants receiving 120 g of organic fertilizer. King J variety however provides the best option for longer petioles. The longest internodes were obtained with King J variety using inorganic fertilizer at 300 kg/ha while Mother's delight variety recorded the longest internodes when using organic fertilizer at 120 g. Our results are similar to those of Amara et al. (2015) and Nduwayezu et al. (2005) who reported that application of farmyard manure and solid organic fertilizers increased the vegetative growth of potato through the soil improvement. Atekan and Surahman (2005) reported that application of *Gliricidia* prunings (*Gliricidia sepium*) into acid mineral soils enhanced soil chemical properties due to the increase in the total base cations (Ca, Mg, and K).

An increase in the measure of fertilizers whether inorganic or organic resulted in mixed results for leaf breadth. This suggests that it may be appropriate to use anywhere between 150 kg/ha and 300 kg/ha of inorganic fertilizer to have wider leaf breadth or between 60 to 120 g of organic fertilizer. The use of organic fertilizer and Iwo 1 variety provide the best option for wider leaf breadth. Similar results were reported by Adeyeye et al. (2016) who indicated that numbers of leaves were significant in all the treatments using organic and inorganic fertilizer.

An increase in the measure of fertilizers whether inorganic or organic resulted in an increase in the number of tubers. Our results are consistent with those of Sidiky et al. (2019) demonstrated that fertilizers improved all the agronomic parameters of sweet potato compared to the control treatment during two years of experiment. Similar results were also reported by Okpara et al. (2004) showed that the species of green manure used improved the yield of successively cultivated sweet potato. Okpara et al. (2004), also in a study on infertile soil in Nigeria, found that green manure with mucuna (*Mucuna pruriens*) provided a root yield similar to the yield obtained mineral NPK fertilizer and a higher yield than those under other green manure species. In the present study, the highest number of tubers were obtained with 300 kg/ha of inorganic fertilizer. Iwo 1 (a local variety) provides the best option for more tubers. This is likely due to its acclimatization to the region. It is quite interesting to note that the number of tubers produced by 150kg/ha of inorganic fertilizer and 60g of organic fertilizer yielded averagely the same number of tubers. Also, for organic fertilizer considering the Iwo 1 variety, 120 g yielded less tubers than 60 g. These are contrary to those of Balemi (2012) who reported that the application of any of the cattle manure at 10, 20 and 30 t ha^{-1} alone improved the total tuber yield only over the absolute control but could not significantly increase the total tuber yield over the standard control indicating that unless it is combined with inorganic fertilizers, farmyard (cattle) manure alone cannot considerably enhance tuber yield. An increase in the measure of inorganic fertilizer resulted in an increase in yield. This suggests that to have greater yield, there is a need to use preferably between 150 to 300 kg/ha of inorganic fertilizer. For organic fertilizer, smaller portion of fertilizer resulted in increased yield. To use organic fertilizer, 60 g is preferable. Iwo 1 variety provides the best option for increased yield. Novianantya et al. (2017) reported that the application of compost and biofertilizer increase the weight of sweet potato tuber and starch content of sweet potato tubers because the application of compost mixture and biofertilizer supplied the essential nutrients to plants during the growth and development stages. Similarly, Sidhu et al. (2007) demonstrated that there was 29% yield increase due to the application of 50 t ha^{-1} in potato over FYM untreated control. According to Pahlevi et al. (2016), potassium is an important macronutrient which contribute to the expansion of tuber during development and which participates in the process of translocation of phyto-assimilates from the source (mature leaves) to the storage section (sweet potato tuber). Djalil and Dasril dan Pardiansyah (2004) also reported that the amendment of soil with organic matter sources of potassium can increase the production of sweet potato tubers.

Conclusion

This study suggests to us that smallholder farmers can successfully use organic fertilizers to produce their sweet potato crops at relatively comparable levels when inorganic fertilizers are either too expensive or unavailable altogether. The application of fertilizers whether inorganic or organic resulted in an increase in petiole length, an increase in internode length, an increase in number of tubers and an increase in weight of sweet potato tubers. Iwo 1 (variety 3) produced the highest number of tubers (16.67 and 16.69; 16.67 and 16.33) with both treatments and levels, respectively. Iwo 1 (variety 3) also produced the biggest tuber weight (4.57 and 4.60 kg; 3.97and 3.88 kg) with both treatments and levels, respectively.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Adeyeye AS, Akanbi WB, Sobola OO, Lamidi WA, Olalekan KK (2016). Comparative Effect of Organic and In-Organic Fertilizer Treatment on the Growth and Tuberyeild of Sweet Potato (*Ipomea Batata* L). International Journal of Sustainable Agricultural Research 3(3):54-57.

Amara DG, Kherraz K, Nagaz K, Senoussi MM (2015). Effect of chicken manure and organic nitrogen levels on yielding and antioxidant content of tuber potato at Algeria Sahara. International Journal of Agriculture Innovations and Research 4(1):17-21.

Atekan D, Surahman A (2005). Peranan Bahan Organik Asal Daun *Gliricidia (Gliricidia Sepium)* Sebagai Amelioran Aluminium Pada Tanah Ultisol. Balai Pengkajian Teknologi Pertanian Papua.

Balemi T (2012). Effect of integrated use of cattle manure and inorganic fertilizers on tuber yield of potato in Ethiopia. Journal of Soil Science and Plant Nutrition 12(2):253-261.

Çalifikan ME, Sögut T, Bodyak E, Ertürk E, Arioglu H (2007). Growth, yield, and quality of sweet potato (*Ipomoea batatas (L.) Lam*.) cultivars in the southeastern Anatolian and east Mediterranean regions of Turkey. Turkey Journal of Agriculture and Forestry 31(4):213-227.

Clark CA (1988). Compendium of sweet potato diseases. American Phytopathological Society, Washington, D.C.

Chukwu GO (1999). Scheduling of irrigation on Sweet potato (*Ipomoea batatas (L) Lam*). African Journal of Boot and Tuber Crops 3(2):1-3.

Claessens L, Stoorvogel JJ, Antle JM (2008). Ex ante assessment of dual purpose sweet potato in the crop-livestock system of western Kenya: a minimum data approach. Agricultural Systems 99(1):13-22.

Djalil M, Dasril dan Pardiansyah J (2004). Pertumbuhan dan hasil tanaman ubi jalar *(Ipomoea Batatas* L.*)* pada pemberian beberapa takaran abu jerami padi. Jurnal Stigma 12(2):192-195.

Duvernaya WH, Chinna MS, Yencho GC (2013). Hydrolysis and fermentation of sweet potatoes for production of fermentable sugars and ethanol. Industrial Crops and Products 42:527-537.

Egeonu IN, Akoroda MO (2010). Sweet potato characterization in Nigeria. Sweet potato Breeders' Annual Meeting, Mukono, Uganda pp. 1-31.

Ejechi ME, Ode IO, Sugh ET (2020). Empirical analyses of production behaviour among small-scale sweet potato farmers in Ebonyi state Nigeria. Nigerian Agricultural Journal 51(1):17-21

Food Agriculture and Organization (FAOSTAT) (2019). Retrieved from http://www.fao.org/faostat/en/#data/QC

Goldman A (1996). Pest and Disease Hazards and Sustainability in African Agriculture. Experimental Agriculture 32(2):199-211.

Hagenimana V, Low J, Anyango M, Kurz K, Gichuki ST, Kabira J (2001). Enhancing vitamin A intake in young children in western Kenya: orange-fleshed sweet potatoes and women farmers can serve as key entry points. Food and Nutrition Bulletin 22(4):376-387.

Hafifah H, Sudiarso S, Maghfoer M D, Prasetya B (2016). The potential of *Tithonia diversifolia* green manure for improving soil quality for cauliflower (*Brassica oleracea var. Brotrytis* L.). Journal of Degraded and Mining Lands Management 3(2):499-506.

Horton DE (1988). Underground crops. Winrock International. Morrilton. Arkansas, USA 132 p.

International Potato Center (CIP) (2018). Sweet potato facts and figures. Retrieved from https://cipotato.org/sweetpotato/sweetpotato-facts-and-figures.

Liverpool-Tasie LSO, Omonona BT, Sanou A, Ogunleye W (2016). Fertilizer Use and Farmer Productivity in Nigeria: Food Security Collaborative Policy Briefs 234952, Michigan State University, Department of Agricultural, Food, and Resource Economics.

Nduwayezu JB, Lulandala LLL, Chamshama SAO (2005). Managing decomposition and mineralization of *Senna singueana* (Del.) Lock. manure to improve N use efficiency and maize yield in Morogoro, Tanzania. Journal of Agronomy 4(4):349-359.

Negassa W, Negisho K, Friesen DK, Ransom J, Yadessa A (2001). Determination of Optimum Farmyard Manure and NP Fertilizers for Maize on Farmers Field. Seventh Eastern and Southern Africa Regional Maize Conference, 11th-15th February, pp. 387-393.

Novianantya AC, Fardany NK, Nuraini Y (2017). Improvement of sweet potato yield using mixtures of ground fish bone and plant residues. Journal of Degraded and Mining Lands Management 4(2):759-765.

Maduakor HO (1991). Efficient fertilizer use for increased crop production: The humid Nigeria experience. Fertilizer Research 29:65-79.

Mukhtar AA, Tanimu B, Arunah UL, Babaji BA (2010). Evaluation of Agronomic Characters of Sweet potato varieties grownat varying levels of organic and inorganic fertilizers. World Journal of Agricultural Science 6(4):370-373.

Okpara DA, Njoku JC, Asiegbu JE (2004). Responses of two sweet potato varieties to four green manure sources and inorganic fertilizer in a humid tropical Ultisol. Biological Agriculture and Horticulture 22:81-90.

Pahlevi RW, Guritno B, Suminarti NE (2016). The effect of proportion combination nitrogen and potassium fertilization on growth, yield and quality of sweet potato (*Ipomea Batatas* (L.) Lamb) cilembu variety in low land. Jurnal Produksi Tanaman 4(1):16-22.

Rishirnmuhirwa T, Roose E (1998). Effets des matières organiques et minérales sur la réhabilitation des sols acides de montagne du Burundi. ORSTOM, Montpellier (FRA). 16è Congrès Mondial de la Science du Sol, 20-26 août 1998, Montpellier (France)

Sidhu AS, Thind SS, Sekhon NK, Hira GS (2007). Effect of Farmyard Manure and P application to potato on available P and Crop Yield of Potato-Sunflower Sequence. Journal of Sustainable Agriculture 3(2):5-15.

Sidiky B, Zoumana K, Brice DKE, Martial KJH (2019). Effect of the Organic and NPK Fertilizers on the Growth and Yield of Sweet Potato (*Ipomoea batatas* (L) Lam) in the Centre of Côte d'Ivoire. Asian Journal of Soil Science and Plant Nutrition 4(3):1-14.

Stathers T, Namanda S, Mwanga ROM, Khisa G, Kapinga R (2005). Manual for sweet potato integrated production and pest management farmer field schools in sub-saharan Africa. International Potato Center, Kampala, Uganda pp. 1-168.

Uwah DF, Undie UL, John NM, Ukoha GO (2013). Growth and yield response of improved sweet potato (*Ipomoea batatas* (L.) Lam) varieties to different rates of potassium fertilizer in Calabar. Journal of Agricultural Science 5(7):61-69.

Winarno EG (1982). Sweet potato processing and by product utilisation in the tropics, In: Villarel RL, Griggs TD, editors, Proceedings of the first international symposium. Asian Vegetable Research and Development Centre Shanhua, Tainaan, Taiwan, China pp. 373-384.

Yared D, Tewodros M, Asfaw K (2014). Development of High Yielding Taro (*Colocacia esculenta* L.) Variety for Mid Altitude Growing Areas of Southern Ethiopia. Journal of Plant Sciences 2(1):50-54.