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PERFORMANCE OF WATER YAM CLONES AS INFLUENCED BY N, P AND K AND STAKING AT SAMARU, NORTHERN GUINEA SAVANNA OF NIGERIA

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ABSTRACT

Performance of water yam (*Dioscorea alata*) clones as influenced by NPK fertilizer rates and staking was tested. The experiment consisted of three NPK fertilizer rates (0-0-0, 50-25-25 and 100-50-50 kg NPK ha^{-1}) and two staking (staking and no-staking). The treatments were arranged using Randomized Complete Block Design (RCBD) with three replications. A yam set weighing 150g was planted at 1 m apart on the crest of a ridge. NPK 15:15:15 Fertilizer was applied in two split doses at planting to supply the first half of N and whole of P and K while the remaining half of N was applied 6 weeks after sowing (WAS) using Urea (46% N). Weeds were controlled using Pendilin as pre-emergence herbicide applied at the rate of 4 litres ha^{-1}and was supplemented with hoe weeding at 6 and 9 WAS. Data collected on tagged plants were analysed using analysis of variance (ANOVA) and means with significant differences were separated using Duncan Multiple Range Test (DMRT) at 5% level of significance. The result showed that increasing NPK fertilizer rate on water yam from the control to 50-25-25 significantly ($P<0.05$) enhanced all the growth and yield parameters assessed in 2011 and 2012 seasons, respectively. However, increase to 100-50-50 kg NPK ha^{-1}significantly reduced the parameters. Staking water yam significantly increases all the growth and yield parameters assessed with the exception of days to 50% sprouting which responded better to no staking. We therefore, recommend the application of NPK fertilizer (15-15-15 grade) at the rate of 50-25-25 kg NPK ha^{-1} and use of staking for the production of water yam in Samaru, northern Guinea savanna agro-ecological zone of Nigeria.

Keywords: Water yam; clones; NPK fertilizer; rates and staking

INTRODUCTION

Yam (*Dioscorea spp*) is an important tuber crop believed to have originated from West African sub-region (Adegbenro *et al*., 2013). The crop is widely cultivated in the tropical regions (Adeniyan and Owolade, 2012). Nigeria is the largest producer of yams in the world (Law-Ogbomo and Remison, 2008). Adegbenro *et al*. (2013) reported that Nigeria is the principal yam producer in the world. The country produces 18.3 million metric tons of tubers from 1.5 million hectares of land (Law-Ogbomo and Remison, 2008). According to FAOSTAT (2013), Nigeria produced 38 million metric tons of yam tubers valued at $7,753,338 in 2012. It is second most important food crops grown in Nigeria behind cassava in 2012.

According to Bamire and Amujoyegbe (2005) cassava and yam are the two most important root and tuber crops grown for food in West and Central Africa. Yam is highly rich in carbohydrates and is a staple food in Africa (Adegbenro *et al*., 2013). In addition to that, yam also occupies a place in many traditional marriage ceremonies and in a special diet for mothers in confinement after child birth (Ikeh *et al*., 2013). According to Ikeh *et al*. (2013), there is no other crop in Nigeria or Africa at large associated with a great amount of social and cultural activities than yam.

Adeniyan and Owolade (2012) stated that yams are utilized in different forms. The crop is usually consumed in forms of chunks, flour, fufu and slices resulting from any of the processes of boiling, drying, fermentation, frying, milling, pounding roasting and steaming (Degras, 1993).

Like all other crops, yam require good fertile soil for its cultivation. Ikeh *et al.* (2013) reported that, yam yield is consistently declining principally due to low productivity associated with poor soil fertility status as well as inappropriate cropping systems and practices. The crop is regarded as a heavy feeder crop and usually the first crop to be planted to a land after long period of fallow (Ikeh *et al*., 2013). Adegbenro *et al*. (2013) stated that soil fertility has been an overriding constrain to yam productivity in Nigeria. Pressure on land as a result of rapid increase in population and high intensity of cultivation without living the land to fallow necessitated the need for fertilizer application to yams (Ndaeyo *et al*., 2001). As such, fertilizer application is considered as a quick way of meeting the immediate nutrient requirements of yam (Law-Ogbomo and Remison, 2008, Adegbenro *et al*., 2013).

Adegbenro *et al*. (2013) reported that nitrogen is one of the most important nutrient elements required by yam and its deficiency can be recognized by stunted growth, narrow and pale green leaves which start at the tips and the margin. Potassium is another element highly needed by yam as well. Its deficiency leads to a depression of yield as well as reducing starch content. NPK fertilizer being a compound fertilizer is known to supply these two important nutrients elements that are very vital to yam production. Although, farmers have been reported to use organic manures in soil fertility amendment before the advent of inorganic fertilizer use, such as NPK (Udoh *et al*., 2005). Some of such common manures are livestock and poultry excrements, crop wastes, green manures and sewage slugs (Ikeh, 2013). Meanwhile, inorganic fertilizers are faster in the release of nutrient in the soil than organic manures.

Staking is an important agronomic practice carried out on yam and all other vine crops. It helps crop by preventing burning from heating of the sun as well as exposes them to sunlight for absorbing solar radiation during photosynthesis.

In Nigeria, yam is grown extensively in the southern and middle belt states. The areas are known to be fertile due to high accumulation of organic matter from leaf litter. However, in the northern Guinea savanna that is characterized by poor vegetation (sparse) and poor soil fertility, the use of inorganic fertilizers becomes necessary in order to obtain an appreciable yield of yam and other crops. This study was therefore undertaken in order to determine the response of white yam clones to different rates of NPK fertilizer and staking for good growth and yield of yam in Samaru, northern Guinea savanna of Nigeria.

MATERIALS AND METHODS

Study Area

Field trials were conducted during the rainy seasons of 2011 and 2012 at the Institute for Agricultural Research farm, Institute for Agricultural Research/Ahmadu Bello University, Zaria, Kaduna State, Latitude 11° 11' N, Longitude 07° 38' E, 686 m above sea level (Kowal and Knabe, 1972).

Treatments and Experimental Design

The treatments consisted of three levels of NPK (15-15-15) fertilizer (0-0-0, 50-25-25 and 100-50-50) kg NPK ha^{-1} and two levels of staking (staking and no-staking). White yam clones were obtained from the National Root Crops Research Institute, Umudike, Abia State. The site was deeply ploughed and harrowed. The experiment was laid out in randomized complete block design (RCBD) with three replications. Yam sets of approximately 150 g weight were planted on the crest of ridge at 1m apart. The gross plot measured 5m x 4m = 20 m^2 with a distance of 1.5 m between ridges. Planting was carried out in the month of June by opening up a hole on the ridge and one yam sett was placed at an angle of 45° with the cut surface facing upward. The plots were mulched with dried grasses. Staking was done in the month of July as per treatments (staking and no-staking) using Gliricidia at one stake per stand. NPK (15-15-15) fertilizer was applied as per treatment (0-0-0, 50-25-25 and 100-50-50) in two split application doses. First half of N and whole of P and K were applied at planting while the other half was applied 6 weeks after sprouting (WAS) using Urea 46% N. Weeds were controlled using pendilin as pre-emergence herbicide applied at the rate of 4 litres ha^{-1}. Supplementary weeding was carried out using hoes at 6 and 9 WAS.

Data Collection and Analysis

Data on growth and yield parameters were collected on vine length, days to 50% sprouting, number of seeds yam, number of ware yam, number of yam tubers/plot and total fresh tubers/plot on selected tagged plants. Harvesting was carried out when the vegetative parts of the plant were fully dried. The data collected were subjected to analysis of variance (ANOVA) and the means with significant differences were separated using Duncan Multiple Range Test (DMRT) at 5% level of significance.

RESULTS

Physicochemical Characteristics

The result of physicochemical analysis of the soil of the experimental site is presented in Table 1. The soil was well drain silt loam and slightly acidic. It contained moderately high amount of available phosphorus and exchangeable cations. The soil fertility is fairly adequate for yam production. This was indicated by the amount of total nitrogen and organic carbon present.

Table1: Physicochemical characteristics of soil at the experimental site

Soil property	Year	
	2011	2012
Physical properties		
Clay (%)	43	45
Silt (%)	47	42
Sand (%)	10	13
Textural class	Silt loam	Silt loam
Chemical properties		
pH in H_2O (1:2.5)	6.80	6.91
pH in 0.01M $CaCl_2$ (1:1.25)	6.11	6.21
Organic carbon (g kg^{-1})	1.07	1.10
Total nitrogen (g kg^{-1})	0.96	1.00
Available phosphorous (mg kg^{-1})	13.4	14.0
Exchangeable cations (cmol kg^{-1})		
Calcium	4.60	4.80
Sodium	2.80	3.00
Potassium	8.30	8.60
Magnesium	2.25	2.30
CEC	6.15	6.31

Growth and Yield Parameters of Water Yam as Influenced by NPK Fertilizer

The effects of NPK fertilizer on the growth parameters of water yam clones in Samaru was presented in Table 2. The results revealed that, increasing NPK fertilizer rate from the control (0-0-0) to (50-25-25) kg NPK ha^{-1} significantly ($P<0.05$) increased vine length and 50% sprouting in both 2011 and 2012 seasons. This resulted to an increase in 22.7 and 21.2% vine length in 2011 and 2012, respectively. Further increase to 100-50-50 significantly reduced the growth parameters. The number of days to 50% sprouting differed significantly from the control. Increasing the fertilizer rate from the control to 50-25-25 was statistically similar but led to 2.7 and 1.7% increase in the parameter assessed in 2011 and 2012, respectively. However, increasing the fertilizer rate to 100-50-50 significantly reduced the parameter assessed.

The numbers of seed yam, water yam, number of yam tubers per plot and total fresh tubers per plot differed significantly. The result is presented in (Table 3). Seed yams (yams of less than 1 kg weight) differed significantly among the different rates of NPK fertilizer. Increasing the rate of NPK from the control (0-0-0) to (50-25-25) significantly increased the number of seed yam. This resulted to 41.8 and 41.6% difference compared to the control in 2011 and 2012, respectively. The number of ware yams (yam tubers above 1 kg weight) differed significantly among the different rates of NPK fertilizer (Table 3). The result showed that increasing the rate of NPK from the control to 50-25-25 significantly ($P<0.05$) increased ware yam tubers better than the control, equivalent to 44.3 and 42.2% in 2011 and 2012 seasons, respectively when compared with the control. Furthermore, increasing the rate to 100-50-50 significantly reduced the yield parameter assessed. Increasing the rates of NPK from the control to 50-25-25 increased the total number of tubers as well as total number of fresh tubers per hectare, respectively. Application of NPK resulted in an increase of 32.8 and 28.8% yield increase in total number of tubers better than the control in 2011 and 2012 respectively. Similarly, increasing the rate of NPK further caused an increase of 38.5 and 38.0% of fresh tubers per hectare in 2011 and 2012 respectively.

The result on the interactions between different rates of NPK fertilizer (0-0-0, 50-25-25 and 100-50-50) kg ha^{-1} and rates of staking (staking and no-staking) on growth parameters of water yam clones was however not significant.

Table 2: Effects of NPK fertilizer and staking on vine length and days to 50% sprouting

Treatment	Vine length		Days to 50% sprouting	
	2011	2012	2011	2012
NPK Fertilizer				
0-0-0	108.0[c]	118.0[c]	21.2[a]	22.5[a]
50-25-25	139.7[a]	149.8[a]	21.8[a]	22.9[a]
100-25-25	120.9[b]	130.6[b]	18.0[b]	19.1[b]
SE	0.38	0.39	0.13	0.14
Staking				
No staking	119.2[b]	129.0[b]	21.4[a]	22.6[a]
Staking	126.5[a]	137.5[a]	19.2[b]	20.3[b]
SE	0.25	0.26	0.10	0.11
Interaction (FxS)	NS	NS	NS	NS

Means followed by different letter(s) are significantly different (P<0.05)

Table 3: Effects of NPK fertilizer and staking on yield and yield parameters

Treatment	No. of seed yam ha^{-1}		No. of water yam ha^{-1}		No. of tubers yam ha^{-1}		No. of fresh tubers ha^{-1}	
	2011	2012	2011	2012	2011	2012	2011	2012
NPK Fertilizer								
0-0-0	13,000[c]	13,800[c]	5,900[c]	6,450c	2,915[b]	3,445[b]	18,750[c]	19,300[c]
50-25-25	22,350[a]	23,650[a]	10,600[a]	11,150[a]	4,335[a]	4,840[a]	30,500[a]	31,150[a]
100-25-25	17,650[b]	18,200[b]	8,400[b]	8,950[b]	3,085[a]	3,590[b]	25,400[b]	25,650[b]
SE	0.21	0.22	0.09	0.10	0.06	0.08	0.03	0.04
Staking								
No staking	16,200[b]	16,750[b]	7,600[b]	8,100[b]	3,110[b]	3,610	23,150[b]	23,700[b]
Staking	19,100[a]	19,650[a]	9,000[a]	9,600[a]	3,780[a]	4,285	26,600[a]	27,150[a]
SE	0.15	0.16	0.06	0.07	0.04	0.05	0.02	0.03
Interaction (FxS)	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different (P<0.05)

Growth and Yield Parameters of Water Yam as Influenced by Staking

The effect of staking on water yam clones significantly (P<0.05) differed among the treatments (staking and no-staking). The result showed that staked water yam significantly produced longer vines (126.5cm – 137.5cm) than no-staked yam (119.2–129.0cm) (Table 2) in 2011 and 2012 seasons, respectively.

Yam clones provided with stakes yielded better than no staked yams. Staking water yam resulted to yield increase of 15.2 and 14.8%, 15.6 and 15.6% for number of seed yam and ware yam tubers in 2011 and 2012 seasons respectively. Furthermore, the effect of staking on yam clones significantly influenced the number of tubers and number of fresh tubers per hectare. Staking water yam resulted to yield increase of 17.7 and 15.8%, 13.0 and 12.7% for number of tubers per hectare and numbers of fresh tubers per hectare in 2011 and 2012 seasons, respectively.

The result on the interactions between different rates of NPK fertilizer (0-0-0, 50-25-25 and 100-50-50) kg ha^{-1} and rates of staking (staking and no-staking) on yield parameters of water yam clones was however not significant.

DISCUSSION

The significant difference obtained with the 50-25-25 fertilizer rate over the control showed the response of yam to fertilization. It is a crop that responds to nitrogen and usually the first crop grown after long period of bush fallow as evidenced by Law-Ogbomo and Remison (2008) and Akanbi *et al*. (2007) The application of inorganic fertilizer in form of NPK as seen by this trial to be contrary to the belief that yam does not require fertilization. The application of fertilizer significantly increased vine length better than the control. This finding proved that yam responds to fertilizer. The result is in agreement with the findings of Akanbi *et al*. (2007) who reported that primary vine length was influenced by the application of fertilizer at the rate of 750 kg ha^{-1} NPK in Ogbomoso, south western Nigeria. Similarly, Law-Ogbomo and Remison (2008) who reported application of fertilizer greatly increased vine length better than the unfertilized plants in Evboneka, humid rain forest zone of Nigeria.

The result of the response of yam to fertilization was manifested in form of increase in tuber yield. The maximum yield obtained in this study (61.0 and 62.3 kg ha^{-1} in 2011 and 2012) respectively showed that, application of 50-25-25 kg ha^{-1} favoured maximum tuber yield. Further increase in the rate of fertilizer resulted to decline in tuber yield. This was consistent with the findings of Law-Ogbomo and Remison (2008) and Adegbenro *et al.* (2013) who reported increase in yield of white guinea yam up to 300 kg NPK ha^{-1} but thereafter declined (400 kg NPK ha^{-1}) in Evboneka, humid rainforest zone of Nigeria. Furthermore, the increased application of these elements might have led to more vegetative growth and maintenance of plant physiological processes at the expense of tuber formation. This was similar to the observation made by Nafi'u *et al*. (2011) as higher application of NPK fertilizer at the rate of 300kg NPK ha^{-1} at 9-11 weeks after transplant (WAT) and even at plant maturity favoured number of branches without leading to an increase in fruit production of egg plant, *Solanum melongena* (L.) in Ibadan southwestern Nigeria.

CONCLUSION

Based on the results obtained in this study, an appreciable yield of yam was recorded in all the years of the experiment. Although, the control experiment recorded substantial yield in all the years of the trial that indicated the natural fertility of the soil was moderate. However, the application of fertilizer at the rate of 50-25-25 kg ha^{-1}NPK (15-15-15) and use of staking significantly increased the yield of yam in all the years of the experiment. These appeared adequate for the cultivation of water yam in Samaru northern Guinea savanna of Nigeria and are hereby recommended.

REFERENCES

Adeniyan, O. N. and Owolade, O. F. (2012). Comparative performance of improved white yam (*Dioscorea rotundata*) genotypes in the rain forest belt of south-west Nigeria. *International Research Journal of Agricultural Sciences and Soil Science*, 2(4): 127-132.

Adegbenro, R. O., Babatunde, K. M., Ojetade, J. O. and Faturoti, O. M. (2013). Effects of combined application of plant residues and NPK fertilizers on the yield of yam (*Dioscorea rotundata* 'cv' Ewura) in the derived savanna of Ogbomoso. *Journal of Agriculture and Veterinary Sciences*, 5(1): 32-39.

Akanbi, W. B., O. A. Olaniran & A. B. Olaniyan (2007). Effect of integrated use of organic and inorganic nutrient sources on growth and tuber characteristics of white yam (*Dioscorea rotundata*) ev ehuru. African Crop Science Conference Proceedings, vol. 8 pp 359-363.

Bemire, A. S. and Amujoyegbe, B. J. (2005). Economic analysis of land improvement techniques in small holder yam-based production systems in the agro-ecological zones of southwestern Nigeria. *Journal Human Ecology*, 18(1): 1-12.

Degras, L. (1993). *The Yam; A Tropical Root Crop*, 2nd eds. London and Basingstoke, XV, The Macmillan press Ltd. 409pp.

FAOSTAT (2013). Food and Agriculture Organization of the United Nation, 2013 Production Year Book, FAO, Rome, Italy.www.FAOSTAT.htm. Retrieved on 22/02/2014.

Ikeh, A. O., Ndaeyo, N. U., Akpan, E. A., Udoh, E. I. and Akata, O. R. (2013). Evaluation of complementary use of organic manure for sustainable white yam production in Uyo, Southeastern Nigeria. *American Journal of Research Communication*, 1(2): 32-48.

Kowal, J. M. and Knabe, O. T. (1972). *An Agroclimatological Atlas of the Northern States of Nigeria with Explanatory Notes*, Zaria, Nigeria, Ahmadu Bello University Press, 111pp.

Law-Ogbomo, K. E. and Remison, S. U. (2008). Growth and yield of white guinea yam (*Dioscorea rotundata* Poir.) influenced by NPK fertilizer on a forest site in Nigeria. *Journal of Tropical Agriculture*, 46(1-2): 21-24.

Nafiu, A. K., Togun, A. O., Abiodun, M. O., and Chude, V. O. (2011). Effects of NPK fertilizer on growth, drymatter production and yield of eggplant in southwestern Nigeria. *Agriculture and Biology Journal of North America*, 2(7): 1117-1125

Ndaeyo, N. U., Umoh, G. S. and Ekpe, E. O. (2001). Farming systems in Southeastern Nigeria: Implications for sustainable agricultural production. *Journal of Sustainable Agriculture*, 17(4): 75-89.

Udoh, D. J., Ndon, B. A., Asuquo, P. E. and Ndaeyo, N. U. (2005). *Crop production Techniques for the Tropics*. Lagos, Nigeria Concept publications limited, 446pp.