NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 50 Number 1, April 2019. Pp.17-21
Available online at: http://www.ajol.info/index.php/naj

EFFECT OF STAKING HEIGHTS AND FERTILIZER LEVEL ON THE YIELD OF TRIFOLIATE YAM (*Dioscorea dumentorum*) IN UMUDIKE SOUTHEASTERN NIGERIA

[1]Akinbo, O.K., [2]Okpara, D.A., [1]Chukwu, L.I. and [2]Opara, E.C
[1]National Root Crops Institute, Umudike, P.M.B. 7006, Umuahia, Abia State, Nigeria
[2]Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria
Corresponding Authors' email: oladunniakinbo@yahoo.com

ABSTRACT
Field experiments were conducted at Umudike a rainforest agro ecological zone of South-Eastern Nigeria, during the 2016 and 2017 cropping seasons to study the effect of varying staking height and fertilizer level on the yield of trifoliate yam. In each year, the experiment was laid out as a 5 x 4 factorial in a randomized complete block design (RCBD) with three replicates. The treatments comprised five levels of NPK 15:15:15 fertilizer (0, 150, 300, 450 and 600kg/ha) and four staking heights (0, 1, 2 and 3m). N:P:K 15:15:15 fertilizer up to 300kg/ha significantly ($P<0.05$) increased the tuber yield while staking height of 2m increased the tuber mean yield. Trifoliate yam yield was increased with increasing N:P:K 15:15:15 fertilizer level up to 300kg/ha while staking increased up to 2m and is recommended.

Keywords: Staking height, fertilizer, trifoliate yam and tuber yield

Introduction

Trifoliate yam (*Dioscorea dumentorum)* is an important food security crop in Nigeria and is grown by poor resource farmers who intercrop it with maize, vegetables, cassava, okra and cowpea. It occupies a prominent position in the diet and farming systems in South Eastern agro-ecological zone of Nigeria, especially Abia State. It is a crop with many names, namely: Three leaf yam, Trifoliate yam, Cluster yam and better yamand belongs to the family Dioscoreaceae. Unlike last name, *Dioscorea dumentorum* is not a better yam but sweet yam (Nwankwo *et al*, 2017). But most wild types are bitter. It grows well in moist soil where it requires average of 8-10 months growth period for maximum maturity. Onyekwere *et al.,* (2012) reported that (*Dioscorea dumentorum)* has high protein, minerals and vitamins contents and is superior to other commonly consumed yams. Most of the varieties become hard after harvest and inedible which makes the tubers good for the next planting seasons only. It is one of the most important food security crops in the country especially southeastern Nigeria because of the high tuber yield. The tuber also contain high supply of dietary carbohydrate and high in beta-carotene content than white yam *Dioscorea rotundata.* This type of yam can also be recommended for diabetics (Ezeocha *et al*., 2010). The recommendation of NPK at 400-500 kg/ha applied at 8-12 WAP in bands on both sides of the ridges for single row planting and double rows on each side of the ridge was for white yam (Eke-Okoro *et al.,* 2006). However, no recommendation has been made for trifoliate yam. Okpara *et al*, (2014) have shown that fertilizer needs of yam may depend on the technology used to generate planting materials and plant population density, among other factors. Irizarry *et al* (2015) reported that yams respond to high nutrient levels and fertilizer application under varying agronomic conditions. Consequently, they extract large quantities of nutrients from the soil. For example, a yam yield of 29 t/ha removed 133kg N, 10kg P and 85 kg K from the soil (Sobulo, 1972). Because of the high nutrient needed, yams are planted as the first crops on cleared land or after fallow periods (Ekanayake and Asiedu, 2003). The rate of degradation of soils has been aggravated by continuous cropping and short fallow period due to high population density. This necessitates the need to determine adequate fertilizer rate for *Dioscorea dumentorum* production. Some trials and recommendation said that fertilizer applications are based on soil types and some purpose to be valid for an ecological zone. Similarly, field history, dominant fallow, vegetation and soil properties must be put into consideration according to Carsky *et al.,* 2010. Staking also facilitates weeding, especially with thorny varieties (King and Risimeri 1992). The cost of staking can be high, and staking materials are becoming increasingly scarce in many production areas as land use intensifies. Frequently, where stakes are less available, one stake may be provided for 2–6 stands.

Small sticks, split bamboos or maize stalks can be used as staking material. Staked plants are better exposed to sunlight for enhanced photosynthesis and tuber yield. Staking also reduces the exposure of yam foliage to soil-borne diseases. The objective of this study was to determine the combined effect of staking height and NPK fertilizer (15:15:15) on the growth and yield of trifoliate yam Ona - ohuru in ultisol of South Eastern Nigeria.

Materials and Method

The study was conducted in 2016 and 2017 cropping seasons at the National Root Crops Research Institute (NRCRI), Umudike, South-Eastern Nigeria Umudike is located at Latitude 5^{o} 29^{I} N and Latitude 7^{o} 33^{I} E in the rainforest agro ecological zone of annual rainfall that ranges between 1800mm - 2200mm. It lies at about 122m above the sea level. Soil and meteorological data of Umudike are shown in Table 1. Each year, the experiment was planted on a fresh site that had been under fallow for two years and three years for the 2016 and 2017 experiments respectively. The land used for the experiment was slashed on 21 May, ploughed on 25 May and harrowed on 26 May, 2016. In 2017, the land was slashed on 21 June, ploughed on 25 June and harrowed on 26 June while sowing was done on 9 June for 2016 and 29 June for 2017. A composite soil sample was obtained from representative field locations and used for the determination of physico- chemical properties of the soils in the two seasons. The experiment was a factorial laid out in a randomized complete block design (RCBD) with three replicates. NPK fertilizer 15:15:15 rates were at five levels (0, 150, 300, 450 and 600 kg/ha) while staking heights were at four levels (0, 1, 2 and 3m). These formed 20 treatments combinations. Each plot size measured 4m x 2m ($8m^2$). Sowing was done at a spacing of 1m x 1m which gave a total of 10,000 plants per hectare. Prior to planting, the tubers were treated with insecticide and fungicide to avoid termite attack and rot of the yams. A tuber sett-size of 150g was planted per hole. Inorganic fertilizer NPK 15:15:15 was applied at different rate using the band placement method at various rates in each plot at 8WAP. Manual weeding was carried out at 4, 8 and 12 WAP. Data on the yield and yield components were taken on mean tuber yield, ware tuber yield and seed yam. The plots were kept weed free manually. Pre-emergence herbicide (Diuron) was used immediately after planting in 2016 and 2017and complemented with manual weeding at 12 weeks after planting (WAP). The data obtained were subjected to analysis of variance (ANOVA) and significant differences among treatment mean separated using Least Significant Difference (LSD).

Results and Discussion

The soil of the experimental site was loamy sand and sandy loam acidic with soil pH of 5.1 in 2016 and 5.5 in 2017. The soil was low in N and K but moderate in P. The total rainfall for the period of May to November in 2016 was 1898.4 mm and the total rainfall for the period of June to November in 2017 was 1233.6 mm (Table 1). The effects of NPK fertilizer and staking height on the number of tuber/plant are summarized in Table 2. On the average, staking height at 2m was gave the highest yield than the values at 0, 1 and 3m by 13.87, 18.25 and 20.27 percent respectively. On the other hand, increase in staking height up to 2m increased the number of tubers per plant in 2016. However, for fertilizer application, incremental application of NPK (15:15:15) fertilizer up to 300kg/ha significantly ($p<0.05$) increased in the number of tubers per plant which was on average, higher than values at 0, 150, 450 and 600 N:P:K (15:15:15) fertilizer level by 90, 190, 132 and 160 percent respectively. On the average, the number of tubers increased with incremental application of NPK (15:15:15) fertilizer up to 300kg/ha. Application of 450kg/ ha did not result in increase in number of tubers compared to the application at 600kg/ha. The combined application of 300kg/ha and staking of 2m gave the highest number of tubers per plant while the lowest values occurred with 150kg/ha N:P:K (15:15:15) fertilizer level and 3m staking in 2016. In 2017 however, application of NPK (15:15:15) fertilizer at 150kg/ha increased the number of tubers per plant and beyond and above this fertilizer rate, no further increases in the number of tubers/ plant. Interactions between NPK (15:15:15) fertilizer and staking ($P>0.05$) significantly had no effect on the number of tubers per plant. All cases of NPK (15:15:15) fertilizer application at 150, 300, 450 and 600 kg/ha gave the highest number of tubers except for the 0kg/ha rate with 0m. The lowest number of tubers per plant was produced when no fertilizer was applied and without staking of the yam. Staking at 3m did not result in increase in number of tubers per plant compared to the staking at 1m. Combined staking at 1m and 0kg/ha NPK (15:15:15) fertilizer gave the highest number of tubers per plant while the lowest value occurred with no fertilizer application and no staking.

The effect of NPK fertilizer and staking height on the tuber yield was not consistent in both years (Table 3). In 2016, Application of NPK (15:15:15) fertilizer at 300kg/ha significantly ($P<0.05$) gave the highest tuber yield of 9.46kg/ha by 155.8, 233.1, 201.7 and 224.9 percent. The situation in 2017 was such that application of NPK (15:15:15) fertilizer at 0kg/ha increased the tuber yield more than 150,300, 450 and 600kg/ha by 121.8, 113.1, 6.4 and 11.0 percent respectively. The 2m stake height gave the greatest tuber yield which was, on the average higher than values at 0, 1 and 3m by 47.6, 34.2 and 19.4 percent respectively in 2016. In 2017, 3m stake height gave the highest tuber yield higher than values at 0,1 and 2m by 11.7, 16.1 and 27.3 % respectively. The interaction between stake height and NPK (15:15:15) fertilizer did not significantly ($P>0.05$) affect the tuber yield produced in both planting seasons. In 2016 and 2017, the mean tuber

yield increased significantly (P<0.05) with incremental application of NPK (15:15:15) fertilizer up to 300kg/ha (Table 4). Increment the NPK (15:15:15) fertilizer beyond 300kg/ha and above 0kg/ha resulted in significant tuber yield depression by 50.3, 69.5, 54.9 and 74.0 percent respectively. On the average, mean tuber yield obtained at 300kg/ha (69.5%) NPK (15:15:15) fertilizer level (69.5%) was higher than yield at 0, 150, 450 and 600kg/ha of NPK (15:15:15) fertilizer by 50.3, 69.5, 54.9 and 74.0 percent respectively.

Similar to the results obtained for N:P:K (15:15:15) fertilizer application, increasing in the staking height up to 1m resulted in the increases in the mean tuber yield in the two years mean tuber yield. Height of above 1m did not result in further increment in mean tuber yield. Average mean yield obtained at 1m staking was higher than mean yield value at 0, 2 and 3m by 36.0, 25.1 and 23.6 % respectively. Interaction between staking height and N:P:K (15:15:15) fertilizer level were not significant (P>0.05) differences in the two years combined. The highest mean tuber yield was produced with a combination of 1m and 2m stake height while the lowest mean tuber yield was obtained where no staking was applied or where no N:P:K (15:15:15) fertilizer was applied. According to Ikeorgu (1999), he stated that the fertilizer application is an important option for farmers to adopt in order to improve crop yields in most soils of southeastern Nigeria particularly because of the increased intensity of land use. Also, Okpara *et al.,* (2014) stated that fertilizer is needed for yam and it may also depend on the technology that was used to generate the planting materials and plant population density among other factors. Yam also responds to high nutrient level and fertilizer application under varying agronomic conditions. The findings of this study showed that for optimum mean yield of a trifoliate yam, N:P:K (15:15:15) fertilizer of 300kg/ha are required, while staking height of 2m should be used. This observation agrees with the findings of Onyekwere, *et al,* (2009) on trifoliate yam. The N:P:K are the most common soil plant nutrients needed by plants for their growth and yields, most especially, *Dioscorea dumentorum.* This is why most compound fertilizer requires formulations for these and other crops contain N, P and K. N:P:K 15:15:15 fertilizer increased the number of tubers per plant , tuber yield and mean tuber yield at 300 kg/ha. The initial soil nitrogen of 0.11% obtained in the present study was below the critical value of 0.15%N reported by Chude, *et al,* (2014). Increasing the N:P:K 15:15:15 fertilizer level from 300kg/ha to 450kg/ha depressed mean tuber yield by 54.9%. Staking gave increment mean tuber yield at 2m stake height. The result showed evidence that higher stake of 2m could be utilized to any advantage. Overall, results from this study showed that trifoliate yam (Ona-ohuru) yield responded to fertilizer N:P:K 15:15:15 at 300kg/ha and 2m stake height which had the greatest improvement. It was followed by 1m stake height and fertilizer N:P:K 15:15:15 at 600kg/ha which had a reasonable contribution in soil quality improvement.

Conclusion

From this study, it appeared that high yield of trifoliate yam could be obtained by applying fertilizer N:P:K 15:15:15 at the rate of 300kg/ha and 2m stake. Fertilizer application below or above this and staking below or above this resulted in substantially lower yield under the conditions at Umudike southeastern Nigeria.

References

Carsky, R.J., Saiedu, R. and Cornet, D (2010). Eview of soil fertility management for yam-based systems in west Africa. *African Journal of Roots and Tuber Crops*, 8(2):1-17.

Chude, V.O., Malgwi, I.V., Amapu, I.V and Ano, A.O. (2004). Manual on soil fertility Assessment. Federal fertilizer Department/Natural Programme for Food Security, Abuja, Nigeria. Pp48

Ekanayake, I. J. (2003).Problems and perspectives of Yam-Based cropping systems in Africa. Journal of crop production. .

Eke-Okoro, O.N., C.C. Chinaka, B.C. Okezie and K.I. Nwozu (2006). Root and tuber crops seed multiplication of seed yam multiplication. A Teaching Manual. Kolping Society of Nigeria Headquarters Umuahia, Abia state.30 pp.

Ikeorgu, J. E.G. (1999). Cover crop research activities in Southeastern Nigeria. In: Cover crops of natural resources management in West Africa. Proceeding of workshop organized by IITA and CIEPCA, 26-29 Oct., 1999, Cotonou, Benin.

Nwankwo, I.I.M., Akinbo, O.K. and Okeagu, O.D. (2017). Studies on the flowering ability and variability in tuber yield characteristics of trifoliate yam (*Dioscorea dumentorum). Nigerian Agricultural Journal*, 48 (2):120-128.

Okpara, D. A., Njoku, J. C. and Asiegbu, J. E. (2004). Responses of Two Sweet-potato Varieties to Four Green Manure Sources and Inorganic Fertilizer in a Humid Tropical Ultisol. *Biol. Agric. and Hort*., 22: 81-90.

Onyekwere, I.N., Chukwu, G. O., and Ano A.O. (2009). Characteristics and management of soil of Akamkpa Area in Cross River State, Nigeria for increase Cocoyam yield. *Nigerian Agricultural Journal*, 40 (2):271-278.

Onyekwere, I. N., Ikerogu, J. G., Ano A.O., Udealor, A., Eke-Okoro, O.N., Chukwu, G. O. and M. C. Ogbonna (2012). Studies of the intggrated nutrient management on soil nutrient, bioloded and yield of *Dioscorea dumentorum. Journal of Applied Agricultural Research*, 4 (2): 121-129.

Sobulu, R. A. (1972). Studies on White Yam (*Dioscorearotundata*). I. Growth analysis. *Exp. Agric.* 8: 99-106.

Table 1: Soil properties of the sites for the experimental periods

	2016	2017
Mechanical properties of soil		
Sand (%)	84.2	61.0
Clay (%)	9.4	32.0
Slit(%)	6.4	7.0
Texture Class	LS	SLS
Chemical properties of the soil		
O.M (%)	1.64	2.41
N (%) P (ppm)	0.084	0.11
K (meq / 100g soil)	0.113	0.23
PH (H_20)	5.1	5.5
Monthly rainfall (mm)		
May	278.4	-
June	354.1	298.1
July	268.7	493.9
August	396.2	222.4
September	312.6	400.0
October	273.4	184.2
November	45.0	31.0
Total for the period	1898.4	1233.6

Table 2: Effect of NPK fertilizer and staking height on the number of tuber/plant of trifoliate yam cultivar

			Staking (m)		
NPK level (kg/ha)	**0**	**1**	**2**	**3**	**Mean**
2016					
0	1.51	1.41	1.62	1.07	**1.40**
150	2.57	2.83	3.33	1.10	**2.66**
300	3.60	3.17	5.53	3.93	**4.06**
450	2.07	4.50	2.30	4.17	**3.26**
600	3.93	3.71	3.40	3.50	**3.64**
Mean	**2.74**	**3.12**	**3.24**	**2.19**	
2017					
0	1.75	2.77	2.17	2.43	**2.28**
150	2.33	2.08	2.00	2.27	**2.17**
300	2.04	1.90	1.78	2.08	**1.95**
450	2.00	186	2.00	2.86	**1.93**
600	2.31	1.84	2.15	2.26	**2.14**
Mean	**2.08**	**2.09**	**2.02**	**2.18**	

	2016	**2017**
$LSD_{(0.05)}$ for NPK (F) means =	1.18	NS
$LSD_{(0.05)}$ for Staking (S) means =	NS	NS
$LSD_{(0.05)}$ for F x S means =	NS	NS

Table 3: Effect of NPK fertilizer and staking height on the tuber yield (t/ha) of trifoliate yam cultivar

	Staking (m)				
NPK level (kg/ha)	0	1	2	3	Mean
2016					
0	1.82	2.07	2.16	1.21	**1.81**
150	3.23	5.41	4.89	4.97	**4.63**
300	3.78	4.63	9.42	6.25	**6.03**
450	4.38	8.07	2.81	6.58	**5.46**
600	5.79	7.88	6.14	3.72	**5.88**
Mean	**3.80**	**5.61**	**5.10**	**4.54**	
2017					
0	3.22	4.84	3.65	5.69	**4.35**
150	3.13	4.72	5.13	5.55	**4.63**
300	4.64	4.86	3.77	4.39	**4.61**
450	4.33	3.40	4.87	3.70	**4.07**
600	4.30	4.08	5.35	5.61	**4.83**
Mean	**3.92**	**4.38**	**4.55**	**4.99**	

		2016	**2017**
$LSD_{(0.05)}$ for NPK (F) means	=	2.43	NS
$LSD_{(0.05)}$ for Staking (S) means	=	NS	NS
$LSD_{(0.05)}$ for F x S means	=	NS	NS

Table 4: Effect of NPK fertilizer level and staking heights on the mean tuber yield of trifoliate yam cultivar (2016 and 2017)

NPK Fertilizer (kg/ ha)	**Staking(m)**				
	0	1	2	3	Mean
0	2.52	3.45	2.90	3.45	**3.08**
150	3.18	5.07	5.01	5.26	**4.63**
300	4.12	4.74	6.62	5.32	**5.22**
450	4.35	5.73	3.85	5.14	**4.77**
600	5.04	5.98	5.75	4.66	**5.36**
Mean	**3.86**	**4.99**	**4.83**	**4.77**	

$LSD_{(0.05)}$ for NPK (F) means = 1.30
$LSD_{(0.05)}$ for Staking (S) means = NS
$LSD_{(0.05)}$ for F x S means = NS