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Correlation analysis on the growth and yield traits of orange-fleshed sweetpotato (*Ipomea batatas* (L).) varieties under varying planting density

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Abstract

Understanding interrelationships among various agronomic traits is vital to plan an effective production program in sweetpotato. Field experiments were conducted at the National Root Crops Research Institute, Umudike in 2015 and at the Research farm of Michael Okpara University of Agriculture Umudike, Umuahia, Abia State in 2016 to determine the correlation effect on the growth and yield traits of orange-fleshed sweetpotato under varying densities (25,000; 33,333 and 50,000 plants/ha). The field trial was a 2 x 3 factorial laid out in randomized complete block design (RCBD) with six replications. Data were collected on the growth and yield characters of the orange-flesh sweetpotato. Total root yield of sweetpotato in the two cropping seasons showed positive and high significantly correlation with marketable toot yield ($r = 0.978^{**}$ and 0.984^{**}), unmarketable root yield ($r = 0.719^{**}$ and 0.698^{**}), total number of roots ($r = 0.865^{**}$ and 0.851^{**}), number of marketable roots ($r = 0.833^{**}$ and 0.844^{**}), number of unmarketable roots ($r = 0.804^{**}$ and 0.812^{**}), respectively. In the first cropping season, the yield and yield components were negatively correlated with the number of leaves and number of vines, while they had a positive correlation with the vine length except for the unmarketable root yield. In the second cropping season, yield and yield components were positively correlated with the number of leaves, number of vines showed positive relationship with the number of yield components but had a negative relationship with the yield components; vine length had a positive and highly significantly correlation with the yield and yield components. It could be concluded that any positive increase in characters as vine length and yield components of the orange-flesh sweetpotato had corresponding increase in total root yield of the crops.

Keywords: orange flesh-sweetpotato, correlation, growth, yields, traits.

Introduction

Sweetpotato (*Ipomoea batatas* (L.) Lam) is a member of the morning glory family, *Convulvulaceae*, producing edible roots and leaves. It originated from Latin America with China being the top producer, growing 85 million tons annually with Uganda being the major producer in the Sub-Saharan Africa (International Potato Center-CIP, 2012). The crop has great potential to alleviate hunger, malnutrition and poverty in developing countries, since it is source of food, feed and processed products (CIP, 2012; Afuape *et al.,* 2014). In the last two decades, sweetpotato production in Nigeria has increased from 143,000 tonnes in 1990 to over three million tonnes in 2013 (Faostat, 2014). The crop is presently cultivated in all agro-ecologies of Nigeria. The orange-fleshed sweetpotato (OFSP) varieties with high β-carotene content have been fortified with vitamin A to reduce its deficiency especially in children (Mwanja *et al.,* 2017) and also play a key public health role in interventions aiming to reduce the prevalence of the Vitamin A deficiencies that occur across much of Sub-Saharan Africa. Low *et al*. (2007a) observed that orange-fleshed sweetpotato (OFSP) offer high levels of this important micronutrient and is both drought resistant and easily cultivated. The production constraints of sweetpotato include low resistance to sweetpotato virus disease, susceptibility to sweetpotato weevil, lack of tolerance of some important cultivars to random drought and poor soil fertility.

Plant density has been reported by several researchers as an index of yield in sweetpotato, (Nano and Itodo, 2006) maize, (Omoshere and Chukwu, 2006) and sesame (Kalu and Adeyemo, 1998). According to Yahaya *et al.* (2015) developing appropriate genetic and or crop management strategies towards increasing the yield of any crop require the knowledge of important traits that influence it and the relationships among those traits, this is because increasing total yield is easier by improving its components (Grafius, 1959) and also many economically important traits of plants are often related to each other in several ways (Afuape, *et al.,* 2014).

Yahaya *et al.* (2015) notated significant and positive correlations between number of leaves per plant, number of roots per plant, average root weight and root yield of sweetpotato genotypes.

In a study of some growth attributes and their interrelationships with yield, leaf size and number of roots per plant; it was reported that the growth attributes were observed to be closely connected with yield in sweetpotato (Maity and Chatterjee, 1977). Other authors have also reported findings on relationships among important yield components and yield (Islam *et al.,* 2002; Tsegaye *et al.,* 2006; Alcoy, 2007 and Afuape *et al.,* 2011); however, there was no adequate information on the character associations as well as percentage contributions of the various growth and yield related components to root yield in the study area. Thus, understanding the nature and magnitude of genetic diversity and interrelationships among sweetpotato genotypes for maximum yield is vital for its effective improvement (Solankey, 2014). Therefore, the study was carried out to assess the extent of the relationship of the various growth and yield components so as to form a basis of selection for further improvement.

MATERIALS AND METHODS

Field trials were conducted at the western and eastern farms of National Root Crop Research Institute (NRCRI) Umudike, Umuahia Abia State during 2015 and 2016 planting seasons respectively, to determine the association of growth and yield of orange-fleshed sweetpotato varieties under varying planting densities in South Eastern Nigeria. The study sites at western and eastern farms of Umudike were thus, located on longitude 007^{0} 31ʿ E and latitude 05^{0} 28ʿ N at an elevation of 109 m above sea level and longitude 007^{0} 33ʿ E and latitude 05^{0} 29ʿ N at an elevation of 136 m above sea level respectively, in the tropical rain forest zone of Nigeria.

The soil in the experimental sites is predominantly sandy loam, belonging to the broad group typic paleudult, isohyperthermic udic argiustolls (Ano, 1990 and Eswaran *et al.*, 1995).

The textures of the top soil (30 cm) of the two experimental sites were sandy loam (Table 1). The experiment was laid out in a 2 x 3 factorial in a randomized complete block design (RCBD) with six replications. Treatments consist of two varieties of orange-fleshed sweetpotato (Tio-joe and Melinda varieties) at three planting densities (50,000 plants/ha, 33,333 plants/ha, 25,000 plants/ha), giving a total of 6 treatment combinations. The planting materials used in 2015 and 2016 cropping seasons were vines of newly released Orange Fleshed Sweetpotato varieties (Tio-joe and Melinda), they were obtained from National Root Crops Research Institute Umudike, Abia State. Tio-joe orange-fleshed sweetpotato variety is characterized by light green vines and pinkish root, while Melinda orange-fleshed sweetpotato variety characterized by purplish green vines and light-yellow roots. The sweetpotato vine cuttings of 20 – 25 cm were planted on the crest of the ridges with the varying planting density in the two cropping seasons (2015 and 2016) of the experiment. Weeding was carried out at 4 weeks after planting (WAP) and 8 WAP in each planting season. NPK 15:15:15 was applied at the rate of 450 kg/ha at 4 WAP in both planting season after the first weeding. For each character under study, data were recorded on four randomly taken plants from the middle three rows of each plot. The mean of four plants was used for statistical analysis. During the course of the study, the following growth traits were taken at 8 WAP; number of branches, vine length and vine girth of the sweetpotato and the marketable (comprised of tuberous roots > 150g which are not infested or disease attacked), and unmarketable roots (comprised of roots < 150g) of the sweetpotato were taken at 14 WAP and net yield.

Statistical Analysis

Pearson correlation coefficient was used to estimate the relationships between the yield and the crops related traits using Discovery Edition – 3rd software (Genstat, 2007).

Result and Discussion

The Pearson correlation coefficient (r) showed significant (P = 0.05) to highly significant (P = 0.01) level among the traits in both cropping seasons (Tables 2 and 3). In 2015 and 2016, the total root yield of the two orange-fleshed sweetpotato had a positive and highly significant correlation (P = 0.01 level) with marketable root yield (r = 0.978^{**} and 0.984^{**}), unmarketable root yield (r = 0.719^{**} and 0.698^{**}), total number root (r = 0.865^{**} and 0.851^{**}), number of marketable roots (r = 0.833^{**} and 0.844^{**}), number of unmarketable roots (r = 0.804^{**} and $0.812^{**)}$, respectively. In 2016, the association of total root yield with vine length at 8 WAP was also positively and highly significant ($0.532^{**)}$, while in 2015 the relationship with vine length at 8 WAP (r = 0.03) and number of leaves at 8WAP (r = 0.106) were not significant. In both seasons, the total weight of the roots had a negative relationship with the number of leaves at 8 WAP. Positive and highly significant correlations were found between total number of roots and number of marketable roots (r = 0.983^{**} and 0.988^{**}), number of unmarketable roots (r = 0.958^{**} and 0.961^{**}) in both seasons respectively. The relationship between total number of roots and vine length at 8 WAP in 2015 was not significant (r = 0.21) while in 2016 it had a positive and highly significant relationship (r = 0.514^{**}). The marketable roots yield relationship with vine length at 8WAP was not significant (r = 0.09) in 2015, while in 2016 it was positive and highly significant (0.557^{**}). Similarly, marketable root yield had positive and highly significant correlations with total number of roots (r = 0.917^{**} and 0.898^{**}), number of marketable roots (r = 0.899^{**} and 0.899^{**}) and number of unmarketable roots (r = 0.841^{**} and 0.841^{**}) in both seasons respectively. The yield and yield components of the orange flesh sweetpotato in the first cropping season were negatively correlated with the growth parameters, in the second cropping season, vine length had a positive and highly significantly correlation with the yield and yield components exception of the unmarketable root yield in which it had a negative relationship. The positive and highly significant correlations between total root yield, marketable, unmarketable root yields, total number of roots, number of marketable and unmarketable roots suggested that an increase in the performance of one implies an increase in performance of the others. These agreed with the findings of Solankey *et al.* (2015) and Hossain *et al.* (2000) who reported that root yield in sweetpotato was positively and significantly ($p>0.001$) correlated to root diameter, average root weight and number of roots per plant.

Also, Yahaya *et al.* (2015) reported that number of roots per plant was positively correlated to the average root weight and root yield of sweetpotato. On the other hand, the negative relationship between total root yield with number of leaves per plant and number of vines per plant in the first cropping season was contrary to the findings of Khayatnezhad *et al.* (2011) and Burhan (2007) in which significant and positive correlations were found between root yield and main stems per plant of Irish potato; root yield and number of leaves (Yahaya *et al.*, 2015).

Conclusion and Recommendation

The correlation matrix of the varieties in the two-cropping season showed that any positive increase in such characters as vine length, number of marketable and unmarketable roots, total number of roots, marketable and unmarketable root yield will result to a corresponding increase in total root yield of the two varieties. Based on the result from the correlation analysis, selecting of any of the two varieties with higher number of marketable roots/m^2 and weight of marketable root t/ha will suffice the boast in total root yield of the orange-fleshed sweetpotato.

Table 1: Physio-chemical analysis of the experimental sites in 2015 and 2016 planting seasons

	2015	**2016**
Physical characteristics		
Sand (%)	67.2	75.8
Silt (%)	9.0	10.8
Clay (%)	23.8	13.4
Textural class	Sandy-loam	Sandy loam
Chemical properties		
pH (H_20)	5.2	5.8
Organic matter (%)	0.87	1.93
Organic carbon (%)	0.504	1.12
Total nitrogen (%)	0.182	0.097
Avail. P (mg kg^{-1})	67.8	33.4
Exchangeable K (cmol kg^{-1})	0.079	0.221
Exchangeable Ca (cmol kg^{-1})	2.80	3.20
Exchangeable Mg (cmol kg^{-1})	1.60	1.20

Exchangeable acidity (cmol kg $^{-1}$)	2.16	0.96
Effective cation exchange capacity (cmol kg $^{-1}$)	6.82	5.72
Base saturation (%)	68.35	83.21

Table 2: Matrix of correlation coefficients showing association among some growth and yield related components to root yield of the two orange-fleshed sweetpotato in 2015 cropping season

Plant trait	1	2	3	4	5	6	7	8	9
1).No. of leaves per plant at 8 WAP	1.00								
2).No. of vines per plant at 8 WAP	0.699**	1.00							
3).Vine length (cm) at 8 WAP	0.10	-0.02	1.00						
4).No. of marketable roots per m^2	-0.12	-0.22	0.22	1.00					
5).No. of unmarketable roots per m^2	-0.12	-0.15	0.26	0.907**	1.00				
6).Total no. of roots per m^2	-0.14	-0.22	0.21	0.983**	0.958**	1.00			
7). Marketable root yield (t/ha)	-0.17	-0.21	0.09	0.899**	0.841**	0.917**	1.00		
8). Unmarketable root yield (t/ha)	-0.03	-0.04	-0.17	0.32	0.399	0.386	0.558**	1.00	
9). Total root yield (t/ha)	-0.15	-0.19	0.03	0.833**	0.804**	0.865**	0.978**	0.719**	1.00

*** Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).**

Table 3: Matrix of correlation coefficients showing association among some growth and yield related components to root yield of the two orange-fleshed sweetpotato in 2016 cropping season

Plant trait	1	2	3	4	5	6	7	8	9
1).No. of leaves per plant at 8 WAP	1								
2).No. of vines per plant at 8 WAP	0.705**	1							
3).Vine length (cm) at 8 WAP	-0.011	-0.142	1						
4).No. of marketable roots per m^2	0.150	0.081	0.525**	1					
5).No. of unmarketable roots per m^2	0.252	0.150	0.464**	0.907**	1				
6).Total no. of roots per m^2	0.190	0.108	0.514**	0.988**	0.961**	1			
7). Marketable root yield (t/ha)	0.104	-0.006	0.557**	0.899**	0.841**	0.898**	1		
8).Unmarketable root yield (t/ha)	0.071	-0.073	0.235	0.315	0.398*	0.352*	0.558**	1	
9).Total root yield (t/ha)	0.106	-0.021	0.532**	0.844**	0.812**	0.851**	0.984**	0.698**	1

*** Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed)**

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