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EFFECTS OF DIFFERENT TILLAGE METHODS ON GROWTH AND YIELD OF BIO FORTIFIED SWEET POTATO CULTIVARS IN OBIO AKPA, AKWA IBOM STATE

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ABSTRACT

The field experiment was carried out at Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus to evaluate the effects of tillage methods and varieties on sweet potatoes yield. The experimental design used was Randomised Complete Block. Data were collected on growth and yield parameters which were analysed using analysis of variance. Mean comparison was done with Least Significant Difference at 5% probability. Results showed significant differences in both varieties Nd tillage in both varieties and tillage methods. UMUSPO4 produced significant higher storage root of 21.63 t/ha while UMUSPO3 had 15.59 t/ha yield. Among the tillage methods, ridge method had significant higher storage root yield (20.35 t/ha), followed by mound treatment (19.55 t/ha). The least storage root yield, (2.90 t/ha) was from the zero tillage. Farmers are advised to plant UMUSPO4 in ridge and mounds.

Key words: Tillage, UMUSPO3 and UMUSPO4, Sweet potato.

INTRODUCTION

Sweet potato is an important crop in West Africa. The leaves are used as vegetable, and the root is boiled, fried as chips, baked, roasted or often fermented into food and beverages. It can therefore help to remedy hunger (Kassali, 2011).

The Sweet potato (Ipomoea batatas) was originally domesticated at least 5000 years ago in tropical America (Austin, 1988; Yen, 1982). Nitrogen, Phosphorus and Potassium (NPK) are the most important nutrients in sweet potato production as their application increases yield by the formation of larger-sized tubers (Uwah*et. al*., 2013). NPK is essential in the synthesis and translocation of carbohydrates from the tops to the roots (Byju and Nedunchezhiyan, 2004), activates over 60 enzymes, promotes photosynthesis, controls stomata opening, improves the utilization of nitrogen, promotes the transport of assimilates, and consequently increases crop yields. It plays a critical role in lowering cellular osmotic water potentials, thereby reducing the loss of water from leaf stomata, increasing the ability of root cells to take up water from the soil (Harlin *et. al*, 1999) and maintaining a high tissue water content even under drought conditions (Marschner, 2002). Although it is generally assumed that most tropical soils contain adequate amounts of NPK to sustain crop growth (Afari Sefa *et. al*., 2004) NPK can still become a limiting nutrient under continuous cropping, especially with root and tuber crops. Root and tuber crops, like sweet potato, cassava, and Irish potato, have high demands for NPK because their leaves, vines, stems and tubers usually remove substantial quantities of NPK from the soil. It has been reported in Japan that a 13t/ha of cassava or sweet potato remove about 110kg K2O from the soil (Degras, 2003). Even soils that are naturally rich in NPK can be depleted after successive cropping. Hence it is important to assess the response of sweet potato to NPK fertilizer in these soils. Farmers employ different tillage practices in the production of the crop. While some farmers plant potato after disc ploughing without disc harrowing, other farmers disc plough and disc harrowing before planting. There are some farmers who disc harrow without disc ploughing before planting. Some farmers slash and burn while others use only tillage before planting potato. Many farmers perform tillage operations without being aware of the effect of these operations on soil physical properties and crop responses (Ozpinar and Isik, 2004). Tillage is one of the important processes in agriculture. It is carried out mainly to loosen the upper layer of soil, to mix the soil with fertilizer and organic residues, to control weeds and to create a suitable seedbed for germination and plant growth (Rasmussen, 1999).

According to Srivastava *et al.*, 2006, the objectives of tillage are to develop a desirable soi1 structure or suitable tilt for a seedbed. Tillage is crucial for crop establishment, growth and ultimately yield (Atkinson *et al*., 2007). A good soil management programme protects the soil from water and wind erosion, provides a good weed-free seedbed for planting, destroys hardpans or compacted layers that may limit root development, and allows maintenance or even an increase of organic matter (Wright *et.al*. 2008). One of the most common agricultural practices is soil cultivation which is commonly centered on conventional deep tillage (that is ploughing up to 30cm). Over time, this may result in a decline of soil organic matter and inherent soil fertility in the top soil along with increased risk of soil erosion (Daccache*et al.*, 2012). However, conventional tillage is considered necessary in other to manage crop residues, prepare a suitable seedbed and create favourable soil physical properties for germination and production, while also providing effective weed control (Grant and Epstein, 1973). On the other hand, conservation tillage is a broad term which refers to a wide range of non-inversion tillage practices which have the potential to reduce soil degradation and preserve soil quality (Magagula *et al*., 2010).

The detrimental effects of tillage are as important as its advantages. It loosens and aerates the top layer of soil which can facilitate the planting of the crops, it is a mechanical way of destroying weeds and also help in the mixing of residue from the harvest, organic matter (humus) and nutrients evenly throughout the soil. Some of the disadvantages are: it dries the soil before seeding, erosion of soil, higher rate of fertilizer and chemical run of, decreases the water infiltration rate of soil, destroys soil aggregates, compaction of the soil also known as a tillage pan, crop diseases can be harbored in surface residues and can attracts slugs, cut worms, army worms and other harmful insects to the left over residues, the soil also loses a lots of its nutrients like Carbon, Nitrogen, and its ability to store water. It does not help in the top soil through erosion, it enhanced due to tillage as it remains in loose. (FAO, 2012). Soil tillage is one of the oldest agricultural practices, which has been widely adopted by farmers, and refers to the soil disturbance in order to incorporate previous crop residues and inorganic or organic fertilizers; control weeds; prepare seedbed for seed germination; and create favorable physical conditions (e.g., increase aeration and porosity by loosening the soil) prior to crop establishment. The majority of farmers perceive deep ploughing to be essential, since it has become a key paradigm for increased production and thus the cornerstone of modern agriculture. However, tillage has also drawbacks in terms of soil quality parameters while it may also increase production costs and energy use, therefore contributing to Occupational Health and Safety (OHS) emissions (Hobbs, 2007). Also, excessive tillage causes increased run-off that leads to nutrient depletion and soil erosion. Conservation tillage is a broad term that contains a wide range of non-inverted tillage practices (e.g., reduced tillage and no-tillage) and has the potential to diminish soil erosion and soil degradation as well as to sustain soil quality (Holland, 2004; Carter *et.al.*, 2007; Putte *et al.*, 2010).

Potato (*Ipomea batata)* is an important crop with production area of 19.3 million ha worldwide in 2012 (FAOSTAT). Although there is no standard tillage system for potato production, it is among the crops with the highest soil erosion risks as soil is disturbed frequently during the production period (i.e., seedbed preparation, ridging and harvesting) (Auerswald *et al.*, 2006). Conventional tillage practices (i.e., moldboard plowing) are commonly used for potato production systems because farmers believe that it is require ed to ensure optimal soil structure and high yields (Ivany *et al*., 2007). However, several studies reported that reduced tillage could be applied successfully in potato systems by improving soil quality parameters, minimizing production cost while also sustaining potato yields (Ekeberg and Riley, 1996; Mundy *et.al*., 1999; Carter *et al*., 2009a; Collins *et al*., 2010).

Justification of the study:

There has been a noticeable deterioration in the production and economic yield of sweet potato over the year in Obio Akpa. This problem is attributed to the inability of the peasant farmer to select and know which potato variety and tillage method suitable to use for economic yield production of potato. It is therefore pertinent to evaluate some potato cultivars under different tillage methods and determine the variety and tillage method that is suitable for the growth and economic yield of Sweet potato in Obio Akpa.

The objectives of this research were to:

i. Evaluate the effects of different tillage methods on growth and yield components of sweet potato. ii. Evaluate the performance of sweet potato cultivars as affected by different tillage practices.

MATERIALS AND METHODS

Experimental Site and Cropping History

The research was carried out at the Akwa Ibom State University Teaching and Research Farm, Obio Akpa, Oruk Anam Local government Area. Obio Akpa falls within the tropical rain forest zone of Nigeria and is located at latitude 4°30S and 5° 30N and longitude 7° 30W and 7°30E (SLUS-AK, 1989). The mean annual rainfall is 2000mm to

2600mm. The mean annual temperature is 27°C, the mean annual relative humidity (%) is 88. (SLUS-AK, 1989). Experimental Design and Treatments

The experiment was a 2 x 4 factorial experiment laid out in a randomized completely block design with 4 replications. The treatments were two varieties of sweet potato and four tillage methods. The varieties were Solo Gold (Umupo 4) and Mother's Delight (Umuspo 3) which was designated as V1 and V2 respectively. The tillage methods used were mound, ridge, flat tillage and zero tillage which is designated as Ti (mound), T2 (ridge), T3 (flat), and T4 (zero). The total size of the experimental plot was 13m x Im which is 0.01417ha, and a planting distance of 40x70cm was used with 1m and 0.7m demarcating each replicate and plots respectively.

Data Analysis

Data collected were subjected to analysis of variance. Significant means compared with least significant difference at 5% probability level.

RESULT AND DISCUSSION

Establishment Percentage and number of leaves per plant.Establishment percentage as influenced by sweet potato varieties and tillage practices showed no significant difference (P>0.05) between the two sweet potato varieties and among the tillage practices (Table.1). The interaction effect between sweet potato varieties and tillage practices also indicated no significant difference (P>0.05). Number of leaves per plants as influenced by sweet potato varieties is shown in Table 1. The result did not showany significant difference (P<0.05) between the two sweet potato varieties at 9 weeks after planting (WAP). UMUPO4 had significant higher number of leaves per plant at 9 WAP; 106.20 while UMUSPO3 had 83.55 leaves per plant at 9 WAP. Among the tillage practices, the result also indicatednon-significant difference on number of leaves per plant Higher number of leaves per plant was observed in ridge treatment, followed by mound, while the least was observed in the control treatment (zero tillage). Number of leaves per plant recorded in ridge treatment were 24.72, 58.20, and 90.40 at 3, 6 and 9 WAP respectively, while 19.01, 33.21 and 49.40, respectively was recorded in zero tillage. The interaction effect between sweet potatoes varieties and tillage practices on numbers of leaves per plant was non- significant

Interaction effect between sweet potato variety and tillage method on leaf area at 9 WAP.

The interaction effect between sweet potato varieties and tillage method is presented in Table 4. The largest significant leaf area; 131.01cm^2 was observed at the interaction of Ridge x umuspo4. This was followed by 121.33cm^2 recorded in the treat interaction of mound and UMUSPO4. The least leaf area 37.08cm^2 was observed in the interaction of zero tillage and UMUSPO3.

Number of branches per plant as influenced by sweet potatoes varieties and tillage method is shown in table 2. The result revealed significant difference between the number of branches per plant recorded in UMUPO4 and UMUSPO3 only at 9 WAP (Table 2). UMUPO4 had 18.49 branches per plant while 10.70 branches were recorded in UMUSPO3. Among the tillage method, the result indicated significant difference (P < 0.05) at 6 and 9 WAP (Table 2). The highest number of branches per plant; 7.01 and 20.13 at 6 and 9 WAP were recorded in ridge, followed by 6.69 and 16.36 branches recorded in mounds. The least number of branches per plant; 2.70 and 5.22 respectively were recorded in zero tillage method. The interaction effect between sweet potatoes varieties and tillage method on number of branches per plant showed no significant difference (P> 0.05) (Table 2).

Leaf area of sweet potatoes as influenced by varieties and tillage method.

Leaf area of sweet potatoes as influenced by varieties varied non significantly(P< 0.05) at 3,6 and 9 WAP (Table 3) UMUPO4 had non-significant larger leaf area; 48.90, 85.20 and 100.46cm2 at 3,6 and 9 WAP, respectively while 32.11, 53.51 and 78.14cm2 was recorded in UMUSPO3. The effect of tillage method on leaf area were not significant in all the samples (Table 3). Sweet potatoes planted on ridge and mound had significant larger leaf area at 6 and 9 WAP, when compared to flat. Ridge, mound and flat method produce non significantly larger leaf area when compared to zero tillage method. Ridge method had leaf areas of 80.12 and 109.25cm2 at 6 and 9 WAP, respectively while 42.36 and 49.62cm2 was recorded in zero tillage. The interaction effect between sweet potato variety and tillage method on leaf area indicated significant difference (P<0.05) only at 9 WAP (Table 3).

Vine Length of Sweet Potato as Influenced by Varieties and Tillage Methods

The effect of sweet potato varieties on vine length varied significantly (P<0.05) at 6 and 9 WAS (Table 5). UMUSPO4 had shorter vine; 129.75 and 198.41cm at 6 and 9 WAS, respectively. UMUSPO4 had 80.33 and 122., respectivelyridge tillage have longer vine; 33.72, 122.40, and 210.13cm at 3, 6 and 9 WAS, respectively. The shortest vine; 21.90, 50.30 and 75.10,at 3, 6 and 9WAS respectively were recorded in the zero tillage. The interaction effect between sweet potato varieties and tillage method indicated significant difference (P>0.05) at 3, 6 and 9 WAS (Table 5).

Table 1: Establishment Percentage and Number of Leaves Per Plant as affected by Variety, Tillage methods and Their interaction.

Treatment	Establishment%	Number of leaves per plant	weeks after planting	
		3	6	9
Varieties (V)				
UMUPO4	99.50	24.30	56.14	106.20
UMUSPO3	100.00	22.11	51.40	83.55
LSD(P<0.05)	NS	NS	NS	NS
Tillage(T)				
Mound	100.50	20.61	49.16	93.11
Ridge	100.00	24.72	58.20	90.40
Flat	99.50	19.91	42.18	81.05
Zero	90.00	19.01	33.21	49.40
LSD(P<0.05)	NS	NS	NS	NS
Interaction VxT	NS	NS	NS	NS

Table 2. Number of branches per plant as influence by sweet potato varieties and tillage

Varieties (V) UMUPO4	Treatment	Number of branches per plant week after Sprouting		
		3	6	9
Varieties (V)				
	UMUSPO4	2.06	8.33	18.49
	UMUSPO3	1.10	7.60	10.70
	LSD(P<0.05)	NS	NS	2.16
		2.00	6.69	16.36
	Mound			
	Ridge	1.99	7.01	20.13
	Flat	1.93	4.38	12.04
LSD(P<0.05)	Zero (no tillage)	1.50	2.70	5.22
Interaction VxT	NS	NS	NS	NS

Table 3: Leaf Area of Sweet Potato

Varieties (V)	Leaf area		week after Planting
	3	6	9
Varieties (V)			
UMUPO4	43.90	85.20	105.71
UMUSPO3	32.11	53.51	72.89
LSD(P<0.05)	NS	NS	NS
Tillage (T)			
Mound	42.60	78.44	101.50
Ridge	43.19	80.12	109.25
Flat	42.41	77.93	90.81
Zero	39.77	42.36	49.62
LSD(P<0.05)	NS	NS	NS
Interaction VxT	NS	NS	NS

Table 4: Interaction effect between sweet potato yarieties and tillage practice on leaf area.

Tillage	SweetPotato Varieties		Total	Mean
	UMUPO4	UMUSPO3		
Mound	121.33	81.67	203.00	101.50
Ridge	131.01	87.49	218.50	109.25
Flat	108.30	85.32	193.63	96.81
Zero	62.18	37.08	99.26	49.63
Total	422.84	291.56		
Mean	105.71	72.89		

Table 5: Vine Length of Sweet Potato

Treatment	Vine length	Weeks after Planting	
	3	6	9
Varieties(V)			
UMUPO4	35.40	129.75	198.41
UMUSPO3	32.01	80.33	122.12
LSD(P<0.05)	NS	3.54	5.77
Tillage(T)			
Mound	33.46	120.60	207.55
Ridge	33.72	122.40	210.13
Flat	30.69	96.25	136.44
Zero	21.90	50.30	75.10
LSD(P<0.05)	4.30	3.95	4.81
Interaction VxT	NS	NS	NS

NS is not significant

Yield Components of sweet potato as influenced by varieties and tillage number of storage roots per plant

Number of Storage roots per plant as affected by sweet potato varieties showed no significant difference (P>0.05) (Table 6). UMUPO4 had 3.41 storage roots per plant while UMUSPO3 had 2.92. The effect of tillage method on number of storage roots per plant had no significant difference. Ridge treatment produced 2.92 storage roots per plant, while mound produced 2.50 storage roots. Flat tillage produced 1.78 storage roots per plants. The least number of storage roots per plant; 0.51 was observed in zero tillage. The interaction effect between sweet potato varieties and tillage methods on number of storage roots showed no significant difference (P<0.05) (Table 6).

Number of Marketable and Non-Marketable Storage Roots

Number of marketable storage root per plant as influenced by sweet potato varieties varied significantly (P<0.05) with UMUPO4 producing significant higher number of marketable storage root (2.50) (Table 6) while UMUSPO3 had 0.75 marketable storage root per plant. Number of marketable storage root per plant as influenced by tillage methods is presented in table 6. The interaction effect between sweet potato varieties and tillage methods on number of marketable roots was not significant. Number of non-marketable storage root as influenced by sweet potato varieties with UMUSPO3 producing significant higher number of non-marketable roots while UMUPO4 produced 0.91 unmarketable. Number of non-marketable storage root as affected by tillage method is shown in Table 6. Ridge had higher number of non-marketable storage roots (1.61), followed by 1.30 recorded in mound. Flat and zero tillage methods had 0.87 and 0.51 storage roots, respectively. The interaction effect between sweet potato varieties and tillage methods was (Table 6).

Length of Storage Roots

Length of storage roots as affected by sweet potato varieties varied significantly between the two sweet potato varieties (Table 6). UMUPO4 had 13.60cm Length while UMUSPO3 was 12.41cm long.Among the tillage methods ridge and mounds method produced significant longer storage roots; 16.41 and 16.20cm, respectively while flat produced storage root Length of 12.60cm. The shortest; 6.16cm was recorded in zero tillage. The interaction between sweet potato varieties and tillage methods indicated no significant difference (Table 6).

Table 6: Yield of Sweet Potato as Influenced by Varieties and Tillage Methods Yield Components of Sweet Potato as Influenced by Varieties and Tillage Method.

Treatment	Number of Storage roots/plants	Number of Marketable storage	Number of non-marketable storage	Length of storage roots	Circulation of storage root
Varieties					
UMUPO4	3.41	2.50	0.91	18.60	21.14
UMUSPO3	2.92	0.75	2.17	12.41	14.80
LSD (P<0.05)	NS	1.32	NS	1.69	2.06
Tillage(T)					
Mound	2.50	1.20	1.30	16.20	20.17
Ridge	2.92	1.31	1.61	16.41	20.18
Flat	1.78	0.91	0.87	12.60	16.01
Zero	0.51	0.00	0.51	6.16	8.50
LSD (P<0.05)	0.88	0.41	0.39	2.11	2.50
Interaction VxT	NS	NS	NS	NS	NS

DISCUSSION

This field study revealed remarkable differences on growth and yield of both sweet potato varieties UMUSP4 had significant longer vines, longer leaf area, number of branches per plant. The variations in both growth and yield parameters could be attributed to inherent characteristics of different sweet potato varieties. This observation agrees with Ndunchezhiyan*et al*., (2012) that wide variations occurred among sweet potato cultivars. Tillage method had significant effect in all the growth parameters of sweet patoto. Significant yield was recorded in ridge, followed by mounds, while the least was in zero tillage shows that soil manipulation has significant role in sweet patoto growth and yield. This observation agrees with Atkmfon*et al.,* (2007) that a good soil tillage promote good crop establishment, growth and yield. From the result of the study; UMUSPO4 produced significant storage root yield compared to UMUSPO3. ii. Sweet potato planted in ridge performed best in growth and yield parameters, followed by mound, while the least was from zero tillage.

RECOMMENDATION

The result of the study revealed that UMUPO4 was high yielding variety of sweet potato. Therefore, farmers within Obio Akpa and its environs should plant UMUPO4 in ridges for high storage root yield.

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