NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 53 Number 1, April 2022 Pg. 316-318
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng
Creative Commons User License CC:BY

Effect of Different Tillage Practices on Selected Soil Properties and Proximate Composition in Sweet potato Production

Mbah, N .T., Onyiba, P.O., Onuba, M.N, Okoh, T., Opara, T.C. and Ajisola, J.K.

National Root Crop Research Institute, Umudike, Abia State
Corresponding Author's email: azodonchedo@gmail.com

Abstract
The effect of different tillage practices on selected soil properties and proximate content of sweet potato (*Ipomoea batatas* (*L.*) were carried out in 2019 cropping season. The tillage treatments (bed, mound, flat, ridge and zero tillage) were arranged in randomized complete block design (RCBD) with 3 replicates. Tilled plots of mounds and beds significantly ($p<0.05$) led to higher value of nitrogen and phosphorous content in sweet potato compared to flat treatment with least value of $0.98gkg^{-1}$ and $8.10cmolkg^{-1}$ respectively. Tilled Plot of Beds recorded the highest value of cation exchange capacity (10.35), followed by plots of ridge (10.34), whereas, plots of No tillage gave the least meant value of 8.70. There was significant ($p < 0.05$) difference in bacteria, fungi and nematode counts. The plots with No tillage and Flat treatment gave the highest value of bacterial counts of 6.8 cfu/g and 5.3 cfu/g soil respectively, whereas Bed treatment recorded the least value. The fungi population was also highest on plots of No Tillage, while plots of mounds recorded the least value of 3.9. cfu/g soil. The nematode population was higher in plots of No tillage and Mounds, while Bed treatment recorded the least value. The results also showed that the sweet potato is significantly rich in protein and carbohydrate content, and low in fat content among Beds, mounds and ridge practices. Therefore, sweet potato requires Tillage as a practice for sustainable agriculture.

Keywords: Sweet potato, Tillage, Soil properties, Proximate content, Microbial population

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is an important staple food crop in many parts of the tropics which can be used for either domestic or industrial purposes. Globally, it is ranked the seventh most important food crop after wheat, rice, maize, Irish potato, barley and cassava (Collins, 2004). Sweet potato is rich in vitamins A, B_5 B_6, C, riboflavin, copper, potassium, pantothenic and folic acid. They are also a good source of dietary fiber, starch, carbohydrate, protein, polyphenols and anthocyanins. The storage roots have great food quality, and an excellent source of anti-oxidants and beta-carotenes. The crop can be produced mostly in Asian countries, followed by Africa (FAO, 2012). In Nigeria, sweet potato is produced exclusively by peasant farmers. The productivity of the crop has been tremendously challenged by inappropriate soil management practices such as tillage, and lack of knowledge on the type and rate of fertilizer needed by the crop. Appropriate tillage systems improve aeration, water intake, root growth and nutrient uptake. Tillage is the post clearing physical manipulation of soil aimed at modifying its structure, and can control weeds. It induces soil nutrients to be released faster (Ojeniyi, 1992). Some farmers use various tillage systems for sweet potato production. Tillage affects soil properties as observed from research results on soils in several parts of Africa where it was seen to affect soil aggregate, temperature, water infiltration, retention, micro-organisms and earthworms. These micro-organisms, earthworms and others are disturbed and most times are killed during tillage practices, especially when using heavy equipment to till the soil. Soil tillage by use of heavy-duty equipment and implements, and even farm animals often result to soil compaction, which hardens the soil and deplete the infiltration characteristics, reduces the fertility of the soil, increase soil bulk density and root penetration resistance, and reduces crop yield. The continuous use of soil in tropical areas without recourse to conservation practices often constrain the soil ecosystems beyond their natural capacity, consequently leading to reduction in soil productivity and sustainability (Jongruaysup *et al.*, 2003). Therefore, the present study tends to fill in that gap by investigating the effect of tillage systems on the selected soil properties and nutritional composition of sweet potato.

Materials and Methods

The research trial was conducted at the research field of NRCRI (National Root Crops Research Institute), Igbariam Sub-station and Federal College of Agriculture (FCA), Ishiagu in 2019 cropping season. The experimental field was cleared of vegetation, and tilled with Hoe. Composite soil samples (0–20cm) were analysed for chemical and microbial characteristics. The experiment was replicated three times in an RCBD, with Five (5) treatments such as T_1(Bed); T_2(Mounds); T_3(Flat); T_4(Ridge); T_5(Zero tillage). The vines of improved sweet potato variety TIS 87/0087 were planted on the seedbed at a spacing of 0.5m x 0.5m. The proximate contents- of sweet potato such as moisture, ash, protein, fat, crude fiber, and carbohydrate were determined (AOAC, 1997). The soil chemical properties; soil texture, soil pH (in 1:2.5 H_2O), total carbon content, total nitrogen, available phosphorus, cation exchange capacity, exchangeable bases (K,Na,Ca and Mg) were determined. Soil bacteria and fungi were estimated with 10-fold serial dilution plate technique, whereas, nematode was estimated with USDA Nematode extraction technique (Bray *et al*., 1945). The data collected were subjected to analysis of variance (ANOVA) and the treatment means were separated using Duncan's multiple range test at 5% probability level.

Results and Discussion

Results

The results of chemical properties of the pre-studied soil are presented as seen in Table 1. Results revealed that the soil is a sandy loam with a pH of 5.4, organic carbon (0.48%), total nitrogen (0.042gkg^{-1}), available phosphorus (8.53cmolkg^{-1}), and Exchangeable bases (0.04 of Na,0.06 of K, 2.20 of Ca, 1..00 of Mg) and acids (0.80). Tables 2 and 3 showed the effect of different tillage practices on soil chemical properties and soil microbial populations. Tillage practices such as Bed and Mounds have similar pH, as well as Flat and No tillage, whereas, their organic carbon content, nitrogen, and available phosphorus were affected by the method adopted in tillage practices. The same trend followed that of microbial population where No tillage and Flat practices affected the increase in bacteria and fungi species. The proximate composition of sweet potato, as shown in Table 4, was also influenced by the different practices. The mound and ridge practices recorded the highest value of moisture content, 71.87 and 71.85 respectively. The protein content ranged from 2.19% to 2.70%, and the fat content ranged from 0.14 to 0.30, carbohydrate ranged from 23.55 to 24.24.

Discussion

In Table 2, the effect of treatment on total nitrogen and available phosphorus revealed that there were significant ($p < 0.05$) differences among the different tillage practices, where No Tillage treatment gave the highest mean value of 1.25 and 8.25 respectively, due to less loss through immobilization, volatilization, denitrification, and leaching. Available Phosphorus and K were higher under No Tillage treatment probably due to higher soil organic carbon level and surface applied K and P fertilizers. The highest increase of organic carbon (0.67% and 0.61%) was observed under No Tillage and bed treatments respectively. This may be due to untilled soil which increased the build-up of soil organic matter, resulting in high organic carbon; which reflects as reduced rate of leaching in the soil profile (Malhi *et al*., 2001). The results in Table 3 revealed that overall amounts of bacteria and fungi significantly increased in No Tillage and Flat systems because of the stimulating effects for microbial growth due to uniformly distributed residues in the arable layer, and increases the rate of supplied oxygen to soil micro sites. In addition, ridge and mound treatments often destroys soil structure, allowing for faster mineralization of soil organic matter, whereas, No Tillage can improve soil aggregation by the proliferation of bacteria population, and fungal hyphae that contributes to macro aggregate formation (Dalia *et al*., 2013).

The proximate composition of sweet potato (*Ipomoea batatas* (*L*.) as seen in Table 4 showed significant difference among the tillage systems. The mound and ridge practices recorded the highest value of moisture content (71.87 and 71.85 respectively). The fresh sweet potato had a moisture content of 77.8% which can be significantly attributed to cultivation practices and genetic composition of sweet potatoes. The carbohydrate contents were significantly affected by different tillage treatments which have the highest value of 24.50 in Bed practice. FAO (2001) reported 28% for fresh sweet potato due to factors like varieties, tillage systems and stage of maturity of the roots. The protein content ranged from 2.19% to 2.70%, and was significantly higher in Bed practice, and least in No Tillage systems. The typical total protein content of sweet potato is as low as 1.5% fresh weight, and as high as 5% dry matter content. The dietary fiber ranged from 0.34% and 0.40% among the different tillage practices. FAO also reported 1.2%. This may be attributed to cultivation practices, and other factors like environment and geographical areas (FAO, 2001).

Conclusion

Tillage practice is very essential for sweet potato production, as it aids in the absorption of essential plant nutrients from the soil. In this study, tilled plots of mounds and beds significantly ($p<0.05$) resulted in higher value of nitrogen, phosphorous and cation exchange capacity compared to other tillage systems. Tillage systems improved the activity of microbial organisms leading to the fertility of the soil for crop production. The results also showed that the sweet potato are significantly rich in protein and carbohydrate content, and low in fat content among Beds, mounds and ridges practices. Therefore, sweet potato requires tillage for optimum productivity and for sustainability.

Table 1: Pre-planting Soil chemical characteristics

Soil Properties	Values
Textural Class	Sandy Loam
pH	5.4
Org. Carbon(%)	0.48
Total Nitrogen(gkg-1)	0.0422
Available phosphorus(cmolkg)	8.53
Exch. Bases	
Na	0.04
K	0.06
Ca	2.20
Mg	1.00
Exch. Acid	0.80
CEC	10.20

Table 2: Effects of different tillage practices on selected soil chemical properties

Treatment	pH	Org. Carbon(%)	T. Nitrogen (gkg-1)	Avail. Phosphorus (cmolkg-1)	K	CEC
Bed	5.0.	0.61	1.12	8.20	0.07	10.35
Mound	5.0	0.56	1.20	8.25	0.05	10.22
Flat	5.4	0.62	0.98	8.30	0.06	8.75
Ridge	5.1	0.59	1.11	8.25	0.04	10.3
No Tillage	5.4	0.67	1.25	8.59	0.09	8.70
LSD	NS	0.12	0.10	0.01	0.01	0.03

NS = not significant

Table 3: **Effects of different tillage practices on soil microbial (Bacteria, Fungi and Nematode) population**

Treatment	Bacteria (Cfu/g soil)	Fungi(Cfu/g soil)	Nematode(Vnc100/g soil)
Bed	3.5	4.6	3.0
Mound	3.7	3.9	3.2
Flat	5.3	5.9	5.0
Ridge	3.9	4.0	4.5
No Tillage	6.8	6.0	10.7
LSD(0.05)	0.41	0.45	0.47

Table 4: Tillage practices on Proximate Composition of sweetpotato

Treatment	Moisture(%)	Protein(%)	Fat(%)	Crude fiber(%)	Ash(%)	Carbohydrate(%)
Bed	70.97	2.70	0.25	0.40	1.17	24.50
Mound	71.85	2.20	0.17	0.36	1.19	24.24
Flat	71.27	2.41	0.26	0.48	1.18	24.41
Ridge	71.87	2.36	0.30	0.54	1.29	23.55
No Tillage	70.95	2.19	0.24	0.34	1.25	23.28
LSD(0.05)	0.45	0.74	0.14	0.90	0.05	0.39

References

AOAC (1997). Official Methods of Analysis of the Association of Official Analytical Chemists International, sixteenth edition. AOAC International, Arlington, VA., vol. 972. Pp.43

Bray, R.H. and Kurtz, L.T. (1945). Determination of total nitrogen, organic carbon and available forms of phosphorus in soils. *Soil Science*, 59: 39-45.

Collins, G.B. (2004). Biotechnology and Agriculture importance for developing countries. In; Sawye W.O (Ed) Biotechnology in the Americas: Prospect for the developing countries. Washington DC *Interciencia Association*. Pp. 79.

Dalia, J., Grazina, K. and Ona, A. (2013). The Effect of Tillage system on soil microbiota in relation to soil structure. *Pol. J. Environ. Stud*., 22(5):1387-1391.

FAO (2012). FAO production statistics. Available on http://www.fao.org/ assessed on 12/08/2013.

FAO (2001). Improving Nutrition through Home Gardening: A Training Package for preparing field workers in Africa, Rome, Italy.

Jongruaysup, S., Trelo-ges, V. and Chuenrung, C.(2003). Minimum tillage for cassava production in Khon Kaen Province, Thailand. S*ongklanakarin J. Sci. Technol*., 25 (2): 191-197.

Malhi, S.S., Grant, C. A., Johnston, A.M. and Gill, K. S. (2001). Nitrogen fertilization management for no-till cereal production in the Canadian Great Plains: a review. *Soil and Tillage Research*, 60 (3–4):101–122.

Ojeniyi, S.O. (1992). Food cropping, soil tillage and tillage research in sub-Saharan Africa. Paper presented at Inaugural Seminar of ISTRO, Nigeria Branch, NCAM, Ilorin, Nigeria.