Soil Physical Properties of Cassava and Potatoes Performance in Differently Tilled Soil

Agriculture

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Abstract

The soil physical properties and performance parameters of Cassava (Manihot esculanta) and sweet Potato (Ipomea batatas) were evaluated on ridge, heap, zero-till and untilled flat soils in order to determine soil physical properties dictating the crops performance and most suitable tillage method. Separate experiment was performed on the crops on sandyclay loam alfisol at the Federal University of Technology, Akure, Southwest Nigeria. Tilled soils (heap and ridge) had lower and similar bulk density, lower moisture content and higher temperature. The tilled soils also had higher values of growth parameters and tube yield. Correlation coefficients between soil bulk density and Cassava yield was -0.96, while it was -0.98 in respect of Potato. Soil bulk density dictated crops performance. Heap and ridge significantly increased performance of the crops. Relative to untilled soil, heap and ridge increased Potato yield by 159 and 222% respectively, the value for Cassava were 19 and 32%.

Introduction

Tillage is an important agronomic and cultural operation in crop production which is known to degrade soil physical, chemical and biological conditions on long term basis. Hence there is need for continuous study on response to tuber crops to reduce and minimum tillage methods. Tuber crops such as Cassava and Sweet Potato are traditionally grown on heaps (mounds) and ridges in tropical countries. However studies carried out in Nigeria, Trinidai and Liberia gave controversial and inconclusive results on response of Cassava to soil preparation methods (Lal and Dinkins, 1979: Opara-Nad and Lal, 1987). Also research information is scarce on response of sweet Potato to tillage methods.

In the review of tillage requirement of food crop in Africa, Ojeniyi and Agbola (1995) concluded that there was no blue print of a universally applicable sustainable tillage technique. The choice of an appropriate method of seed bed preparation depends on soil characteristics, cropping systems and microclimate for applicability it is necessary that any tillage study should characterize the soil physical. Hence this work carried out on afisols of in the rainforest zone of southwest. Nigeria evaluated selected soil physical properties and performance parameters of Cassava and sweet Potato on heap, ridge, zero till and untilled flat soils. The aims were to recommend suitable tillage practice on the test soil and identify soil physical property dictating of the tuber crops.

Materials and Merthods

Experiment was conducted at Emmanuel Alayande College of Education, Teaching and Research Farm, Lanlate in cropping season of 2012 and 2013. Lanlate soil is described as skeletal Kaolinitic oxic palenstalf. The soil was carefully selected based on well drained loamy soils recommended for tuber crops.

The tillage and seed bed types investigated were (a) ridge (b) heap (c) flat planting after manual clearing and (d) herbicide based zero tillage after clearing. The four treatments were replicated thrice and allocated using a Randomized Complete Block Design (RCBD).

Sweet Potato trial -2012

Sweet Potato (TIS 87/ 0087) vines were cut into 15-20cm length with four needs, and planted measuring 10m^2 each. Planting was dove in March 2012. Five plants were select out of 18 plants in each plot for determination of vine length, vine growth, number of benches and leaves and tuber weight 11 weeks after planting.

Cassava trial - 2013

The experiment was repeated on Cassava in March 2013 at a different site at the same location in 2012. Cassava stakes content 20-25cm cuttings were planted at 1m X 1m. Each of the 12 plots contained nine (9) plants. Four plants were selected for determination of plant height, number of leaves, stem growth, leaf area and tuber weight (months after planting). The growth parameters were determined at 2 weeks internal for 3month starting from 2weeks after planting. The mean values are presented. Leaf area was determined using a simple non-destrnctive field technique (Hammer, 1980).

Length area Y = 6.11 X L

Length = length of mid – rib of central lobe

Soil physical properties

Before tillage treatments were established in 2011 and at harvest of each crop, selected soil physical properties were evaluated. The moisture content was determined gravimetrically, bulk density by core method and soil temperature was determined by using soil thermometer inserted to 5cm depth. Determination was replicated thrice in each plot and mean values calculated.

Result and Discussion

The test soil is sandy clay loam with a bulk density of 1.45g/cm^3. (Table 1)

Tables 2 and 3 indicate that cultivated soils (heap and ridge) had lower and similar bulk density, lower moisture content and higher temperature. Relative to untilled (zero till, flat) soils in the first (Potato) and second (Cassava) trial the untilled soils also had similar values of bulk density, moisture contain and temperature.

With reference to Potato (Table 4) heap and ridge had higher values of performance parameters such as vine length, girth, number of branches and leaves and tuber yield relation untilled zero till and flat soils. The latter had similar and lower. Relative to untilled flat soil, heap and ridge increases Potato yield by 159 and 222 to respectively.

In Cassava production (Table 5), also the cultivate soils had higher and similar values of performance parameters such as plant length, stem girth and tuber weight compared zero-till and flat untilled soils which also had similar values Relative to untilled soil, heap and ridge increased Cassava yield by 19 and 32% respectively. Therefore Potato response more to tillage

The above findings indicate that the tuber crops require tillage such as ridging and mounding for performance. This is more so in case of Potato. Although the tilled soils had lower moisture content and higher temperature, their relatively low bulk density values enhanced growth and yield of Potato and Cassava. It is thus indicated that bulk density and hence soil compacting hinders tuber formation, possibly nutrients and water uptake by the crops. It is also suggested that the initial soil bulk density of 1.45g/cm^3 was higher for the tuber crops and thus soil required tillage. Hence compared with soil moisture and temperature soil bulk density dictated performance of Cassava and Sweet Potato on the sandy clay loam alfisol in southwest Nigeria.

Ohiri and Ezumah (1990) had found that zero tillage ultisols located on Umudike of southeast in Nigeria resulted in low Cassava yield owing to high soil bulk density of 1.6g/cm^3 and high mechanical impedance. Soil total porosity was relatively high in tillage seedbed (50.8%) relative to untilled soil (48.4%) in this work under Potato which is a consequence of soil loosening and formation of macrospores. Fergusen and Gumbs (1976) recorded a reduction of 27% in Yam tuber yield by increasing soil bulk density from 1.1 to 1.3g/cm^3 and 32% by increasing from 1.1 to 1.6g/cm$_3$. Kang and Wilson (1981) found that large mounds significantly increased Yam yield by 34% relative to flat soil which was adduce to soil impedance and lack of effective soil depth in untilled flat soil. e\reduction in yield of yam in untilled soil was adduced to reduce gaseous diffusion at the soil-atmos here interface (Fergusen and Gunbas, 1976). Ojeniyi *et al* (2009) indicated that crops require a loose, deep soil to allow permeability of air and water to tubers; and that higher soil bulk density would adversely affect tuber initiation and growth and nutrients uptake.

In this work negative correlation of -0.96 and –o.98 were recorded between yields of Cassava and Potato and soil bulk density respectively. Prerecord studies by Adeleke *et al* (2011), Adekiya *et al* (2011), Adekiya and Ojeniyi (2011) and Ojeniyi *et al* (2009) also found that soil bulk density dictation yield of tuber crops such as yam and cocoyam. The response of the tuber crops to tillage in the present study is consistent with initially higher bulk density of the test soil (1.60g/ cm^3). Adekiya and Ojeniyi (2011) indicated that a degree of tillage is essential for improved cocoyam performance when soil bulk density is 1.55g/cm^3 and above. Adeleye *et al* (2011) also concluded that yam production on alfisols in southwest Nigeria requires tillage for tuber development.

Conclusion

This study carried out in the rainforest zone of southwest Nigeria on a sandy alfisol found that tuber crops such as Cassava and sweet Potato required soil preparation inform of ridge and heap for significant increase in growth and yield soil bulk density dictated the crops performance higher soil bulk density led to reduction in crops yield, Sweet Potato responded more to tillage than Cassava.

Table 1: Pre-planting soil physical properties 2012

Property	
Bulk density g/cm^3	1.45
Sand %	50
Silt %	25
Clay %	25
Texture	sandy clay loam

Table 2 soil physical properties under Potato

Treatment	Bulk density g/cm^3	Moisture %	Temperature
Heap	1.30^b	52.2C	31.6a
Ridge	1.32b	50.4c	31.2a
Zero till	1.41a	59.0c	29.9b
Flat	1.39a	54.3b	29.3b

Table 3 soil physical properties under Cassava

Treatment	Bulk density g/cm^3	Moisture%	Temperature
Heap	1.26b	17.1a	31.16
Ridge	1.13c	18.7a	30.4ab
Zero till	1.36a	23.6a	29.8a
Flat	1.35a	24.1b	30.0ab

Table 4: Performance parameters of sweet Potato in differently tilled soil

Treatment	Vine length (cm)	Vine girth (cm)	No of branches	No of leaves	Tuber weight (gm)
Heap	237a	1.26b	35a	394a	841a
Ridge	206ab	1.11b	26b	299b	676a
Zero till	179c	0.95b	15b	189c	214b
Flat	191b	0.97bc	19bc	185c	261b

Table 5: Performance parameters of Cassava in differently tilled soils

Treatment	Plant height (cm)	No of leaves	Stem girth (cm)	Leaf area/plant (cm^2)	Tuber weight (gm)
Heap	63b	4.5a	1.24b	121a	978a
Ridge	57ab	3.9a	1.10ab	112a	1083a
Zero till	34.7a	3.6a	0.86a	117a	868b
Flat	46ab	3.9a	1.00ab	113a	823b

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