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Influence of Tillage Practices on Physicochemical Properties of Cultivated Soil for Cassava

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ABSTRACT

This study determined the influence of tillage practices on physicochemical properties of soil. Eight tillage methods used for the experiment were Ploughing + Harrowing, Ploughing + Harrowing + ridging, Manual Ridging, Flat Manual Clearing, Ploughing + Harrowing + Manual digging + Saw-dust placed at the base, Ploughing + Harrowing + ridging + Saw-dust placed at the base, Manual Ridging + Saw-dust and Manual Digging + Saw-dust placed. The physicochemical properties of the soil examined include pH, Phosphorus, Carbon, Nitrogen, Exchange Acidity, Calcium, Magnesium, Potassium, Sodium, Iron, Copper, Zinc, percentage clay, silt and sand were determined. Three soil samples from three different points within the treatment were obtained for each of the eight tillage practices using auger. The results revealed that the highest value of 6.80 of pH, 7.33 m/kg of Phosphorus, 32.76 g/kg of Carbon, 3.36 g/kg of Nitrogen, 1.00 Exchange Acidity, 3.43 cmol/kg of Calcium, 0.98 cmol/kg of Magnesium, 1.02 cmol/kg of Potassium, 0.40 cmol/kg of Sodium, 543.00 mg/kg of Iron, 13.70 mg/kg of Copper, 0.68 mg/kg of Zinc, 220 g/kg of clay, 234.00 g/kg of silt and 766.00 g/kg of sand occurred in conventional tillage practice while the highest value of 777.00 mg/kg of Manganese was recorded in zero tillage system. There were differences also in the soil texture of for all the tillage practices. This study revealed that tillage practices had significant effect on physicochemical properties of cassava cultivated soil which will be useful in determining the appropriate tillage practice to be adopted for a particular crop.

Key words: Influence, Tillage Practices, Physicochemical, Properties, Soil

INTRODUCTION

Despite the wide range of soil in the world, all of it is not for crop production. Therefore in order to bring these soils into an economical fit condition for crop production, various mechanical operations have to be performed. The key operation of productive agriculture is the preparation of fine seedbed for ideal germination and better start of the seedlings (Ojha and Michael, 2011). It has been reported that world population is expected to be 8.5 and 9.0 billion by 2025 and 2050 respectively. The increase in crop yields to sustain this population shall be by effective cultivation of land that is currently under production, since most of the world arable land is already cultivated (Ohu, 2011).

Tillage is the manipulation of the soil in order to provide conditions necessary for crop growth (Onwualu *et al.*, 2006). Soil manipulation can change fertility status markedly and the changes may be manifested in good or poor performance of crops. In addition, tillage operations loosen, granulate, crush or compact soil structure, changing soil properties such as bulk density, pore size distribution and composition of the soil atmosphere that affect plant growth (Ohiri and Ezumah, 1990). Tillage influences upward movement of moisture to the soil surface, vapour transfer from the surface to the atmosphere, heat transfer to the soil, provides an ideal opportunity to break up nutrients formed in the deep zones of the soil, and disrupts pests and pathogen cycles. Generally, tillage is a process of physical manipulation of the soil to achieve weed control, fitness of tilt, smoothness, aeration, artificial porosity, friability, optimum moisture content to facilitate sowing and covering of the seed (Ohu, 2011). 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 a management input that affects soil physical characteristics (Hamblin, 1985) cited by (Katsvairo *et al.,* 2002). Soil physical properties are important for favourable conditions for crop growth and maintaining soil quality (Rachman *et al.,* 2003). The suitability of a soil for sustaining plant growth and biological activity is a function of physical and chemical properties (Mulumba and Lal, 2008). Soil is a key natural resource and soil quality is the integrated effect of management on most soil properties that determine crop productivity and sustainability (Anikwe and Ubochi, 2007; Franzluebbers, 2002).Tillage practices profoundly affect soil physical properties. It is essential to select a tillage practice that sustains the soil physical properties required for successful growth of agricultural crops (Jabro *et al*., 2009). Seedbed preparation is crucial for crop establishment, growth and ultimately yields (Atkinson *et al.,* 2007). Tillage systems create an ideal seedbed condition for plant emergence, development, and unimpeded root growth (Licht and Al-Kaisi, 2005). Therefore, the objective of this research was to investigate the effect of tillage practices on physicochemical properties of soil.

MATERIALS AND METHODS

Site description

The Field experiment was conducted at Federal University of Technology, Akure between May 2014 and July 2015. Federal University of Technology Akure is in Ondo State, Southwest Nigeria and is situated on latitude 07^o 09'E and 07^o 19'N and longitude 05^o 17'.E and 05^o 07' N. Weather conditions during the growing period were recorded i.e. monthly maximum, minimum and air temperatures in ^{o}C, relative humidity (%), pressure N/m^2.

Data Collection

Table 1 showed the average of the monthly climatic data for Akure between April 2014 and August 2015.

Table 1: Climatic Data for Akure between April 2014 and August 2015

Month	Maximum Temp. (0^{o}C)	Minimum Temp. (0^{o}C)	Air Temp. (0^{o}C)	Rainfall (mm)	Relative Humidity (%)	Pressure N/m^2
May-14	31.8	22.6	27.1	100.6	81	74.8
Jun-14	30.4	22.1	26.1	155.9	86	76.1
Jul-14	28.3	22.1	24.8	184	87	78.5
Aug-14	22.1	21.3	23.5	236.9	90	77.9
Sept. 2014	28.7	21.5	24.7	167.4	86	77.3
Oct. 2014	30.1	22.2	25.8	161.5	84	76.4
Nov. 2014	31.8	21.7	26.5	93.1	83	75.6
Dec. 2014	35.5	20.2	26.7	0	68	76
Jan. 2015	33.5	18.2	25	11.5	80	74.9
Feb 2015.	34.2	23.5	27.7	9.9	81	72.8
Mar-15	33.4	23.4	27.1	168.1	86	72.3
Apr-15	33.1	23.2	27.3	25.6	88	73.5
May-15	31.7	22.2	26.5	179.9	85	74
Jun-15	29.7	21.7	25.2	126.5	84	75.8
Jul-15	28.4	22	24.4	85.9	78	75.7
MEAN	**30.85**	**21.86**	**25.89**	**113.79**	**83.13**	**75.44**
STDEV	**3.16**	**1.28**	**1.2**	**72.04**	**6.25**	**1.72**
MAX	**35.5**	**23.5**	**27.7**	**236.9**	**90**	**78.5**
MIN	**22.1**	**18.2**	**23.5**	**0**	**68**	**72.3**

Soil analysis

Soil samples were taken for analysis before tillage operations and after harvesting in order to determine the physicochemical properties of the soil. This involved taking a composite sample of all the eight treatment plots. The post planting soil samples for analysis were also taken after harvesting. A total of eight soil samples comprising soil samples from the eight tillage treatments were sieved through a 2 mm sieve and analyzed following the laboratory procedures described by Carter (1993). The particle size distribution was determined using 50 g of soil in 0.1M NaOH as dispersing agent using Hydrometer ASTM (1524) methods (Bouyoucos, 1951). The soil pH was determined in water using a glass electrode pH meter in a 1:1 soil-water ratio. Organic carbon was determined by oxidising soil sample with dichromate solution and later titrated with ferrous sulphate solution (Walkley and Black, 1934). The total nitrogen was determined using micro-kjeldahl method and the available phosphorus was determined by the Bray P-1 method (Bray and Kurtz, 1945). The exchangeable cations was extracted by leaching 5 g of soil with 50 ml ammonium acetate at pH 7. The potassium and sodium in the leachate was determined with a flame spectrophotometer while calcium and magnesium was determined with atomic absorption spectrophotometer. The exchangeable acidity was determined by adding barium chloride buffer solution to soil sample and titrated against 0.1M HCl.

Experimental Design and Analysis

Eight tillage methods were used for the experiment namely: Ploughing + Harrowing (A); Ploughing + Harrowing + ridging (B), Manual Ridging (C), Flat Manual Clearing (D), Ploughing + Harrowing + Manual digging to a depth of 30 cm + 10 cm Saw-dust placed at the base (E), Ploughing + Harrowing + ridging +10 cm Saw-dust placed at the base (F), Manual Ridging + 10 cm Saw-dust placed at the base (G) and Manual Digging to a depth of 30 cm + 10 cm Saw-dust placed at the base (H).Statistical mean, standard deviation, minimum and maximum values were determined from the data generated using Statistical Package for Social Science (SPSS) version 21.0 .

RESULTS AND DISCUSSION

Effect of the Physicochemical Properties of the soil before planting and after harvesting

Table 1 showed the result of physicochemical properties of soil before tillage operation and after harvesting. The result revealed thatthere were increase in the pH values for Ploughing + Harrowing, represents Ploughing + Harrowing + Ridging, Manual Heap and Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging whereas they were decrease in the pH values for tillage practices Flat Manual Clearing, Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap, Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging but the pH Ploughing + Harrowing + Ridging + Saw Dust of 10 cm depth placed at the base of the ridging tillage practice remain constant compared to the pH of zero tillage practice. The highest value of pH, Phosphorus, Carbon, Nitrogen, Exchange Acidity, Calcium, Magnesium, Potassium, Sodium, Iron, Manganese, Copper and Zinc occurred in Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, represents Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, Flat Manual Clearing, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, zero tillage, Ploughing + Harrowing + Ridging, Ploughing + Harrowing and Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging respectively. The lowest value of pH, Phosphorus, Carbon, Nitrogen, Exchange Acidity, Calcium, Magnesium, Potassium, Sodium, Iron, Manganese, Copper and Zinc occurred in tillage practices Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging, zero tillage, zero tillage, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging tillage practice, Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging tillage practice, Manual Heap, Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap, Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging,

Table 2: The Physico-Chemical Properties of the soil before planting and after harvesting

S/N	pHin H_2O	Av.P (mg/kg)	T.O.C. (g/kg)	T.N (g/kg)	Exch. Acid		(Cmol/kg)				(mg/kg)				(g/kg)		
					H^+	Al^{3+}	Ca	Mg	K	Na	Fe	Mn	Cu	Zn	Clay	Silt	Sand
O	6.3	2.62	16.75	1.73	0.8	-	2.85	0.71	1.02	0.23	543	573	7.7	0.44	200	134	666
A	6.6	3.38	28.76	2.98	0.8	-	3.07	0.97	0.75	0.33	283	601	13.7	0.45	120	174	706
B	6.5	4.92	26.57	2.62	0.8	-	3.2	0.93	0.56	0.3	231	777	9.1	0.51	180	154	666
C	6.5	2.87	20.02	1.84	0.7	-	3.31	0.91	0.33	0.39	218	723	9.6	0.49	180	154	666
D	6	3.57	27.66	2.52	0.7	-	2.64	0.8	0.51	0.27	222	607	7.4	0.51	200	154	646
E	6.8	7.33	32.76	3.36	0.5	-	3.43	0.43	0.79	0.4	242	594	6	0.54	120	114	766
F	6.3	3.19	23.3	2.14	0.5	-	2.63	0.69	0.67	0.3	218	625	7.2	0.55	140	154	706
G	5.9	1.54	20.38	2.11	1	-	2.55	0.94	0.71	0.21	216	476	5.3	0.53	180	174	646
H	5.8	0.45	29.85	3.02	0.9	-	2.79	0.98	0.5	0.26	206	556	5.2	0.68	220	234	546
MEAN	6.3	3.32	25.12	2.48	0.74	-	2.94	0.82	0.65	0.3	264.33	614.67	7.91	0.52	171.11	160.67	668.22
S. DEV	0.32	1.85	4.99	0.53	0.16	-	0.3	0.17	0.19	0.06	100.8	83.85	2.5	0.07	34.14	31.27	56.13
MAX	6.8	7.33	32.76	3.36	1	-	3.43	0.98	1.02	0.4	543	777	13.7	0.68	220	234	766
MIN	5.8	0.45	16.75	1.73	0.5	-	2.55	0.43	0.33	0.21	206	476	5.2	0.44	120	114	546

Where O represents the pre-planting soil analysis before tillage operation; A represents Ploughing + Harrowing post planting soil analysis, B represents Ploughing + Harrowing + Ridging post planting soil analysis, C represents Manual Heap post planting soil analysis, D represents Flat Manual Clearing post planting soil analysis, E represents Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging post planting soil analysis

Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap, Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging and zero tillage respectively. The variation in physicochemical properties of cassava cultivated soil was due to different tillage practices that the soil was subjected to. Sumithra *et a*l (2013) and Isabirye *et al* (2007) reported that tillage practices had influenced on the physicochemical properties of cassava cultivated soil.

Table 1 also revealed that there were differences in the soil texture of zero tillage practice, Ploughing + Harrowing tillage practice, Ploughing + Harrowing + Ridging tillage practice, Manual Heap tillage practice, Flat Manual Clearing tillage practice, Ploughing + Harrowing + Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging tillage practice, Ploughing + Harrowing + Ridging + Saw Dust of 10 cm depth placed at the base of the ridging tillage practice, Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap tillage practice and Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging tillage practice. This is in agreement with the findings of other researchers Sumithra *et al* (2013) and Isabirye *et a*l (2007) that reported that tillage practices had influenced on the physicochemical properties of cassava cultivated soil.

F represents Ploughing + Harrowing + Ridging + Saw Dust of 10 cm depth placed at the base of the ridging post planting soil analysis, G represents Manual Heap + Saw Dust of 10 cm depth placed at the base of the manual heap post planting soil analysis, H represents Manual Digging to a depth of 30 cm + Saw Dust of 10 cm depth placed at the base of manual digging post planting soil analysis, pH represents the pH, Av.p represents the Phosphorus, T.O.C. represents the total Carbon, T.N. represents the total Nitrogen, Exch. Acid representsExchange Acidity. Ca, Mg, K, Na, Fe, Mn, Cu and Zn represent Calcium, Magnesium, Potassium, Sodium, Iron, Manganese, Copper and Zinc.

CONCLUSION

The experiments showed that the type of tillage adopted influenced the physicochemical properties of the soil as the average value of the physicochemical properties of the soil differed for all the eight tillage practices used in this study. This implied that tillage practices had influence on the physicochemical properties of the soil. This research had provided enough information in order for the farmers to decide the best tillage practices to be adopted for the preparation of the fine seedbed for ideal germination, better start of the seedlings and increase in crop yields to sustain, since most of the world arable land is already cultivated.

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