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Tractor Traffic Influence on Soil Properties, Growth and Yield of Maize in Obubra, Nigeria

Odey, Simon Ogbeche
Department of Wood Products Engineering, Cross River University of Technology, Calabar, Nigeria
Correspondence Author:Odey, Simon Ogbeche

Abstract: *A study was conducted at the Research Farm of Department of Agronomy, Cross River University of Technology, Obubra Campus during the 2016 season; with the objectives of ascertaining the influence of tractor traffic on soil properties, growth and yield of maize. The land was manually cleared and ploughed. Four treatments replicated three times were imposed, making a total of 12 plots. The treatments included - No tractor traffic, (A_0), 10 tractor traffic, (B_{10}), 20 of tractor traffic, (C_{20}) and 30 tractor traffic, (D_{30}). Each plot measured 9 m^2. A gross experimental size of 567 m^2 was used. The treatments were laid in a Randomized Complete Block Design (RCBD). A 50 kW tractor was used ininducing compaction on the plots according to the treatments. Soil samples were taken before and after treatments for measurement of physico-chemical properties in the laboratory. Maize (FAMMAX-15) seeds were planted. Data on growth and yield parameters were measured. Analysis was carried out on the data to obtain relationship between tractor traffic, soil properties and growth and yield parameters of maize. Increased tractor traffic led to increase in soil cone index, bulk density and reduction in soil moisture and porosity. Tractor traffic had high positive correlation with bulk density and negative correlation with soil porosity, soil moisture and growth and yield parameters of maize. Bulk density increased with tractor traffic while soil porosity, maize growth and yield reduced with increased tractor traffic. The plots with 30 tractor passes had the lowest grain yield. It was observed that at maturity maize yield on the A_0 plots had a mean value of 2.56 t/ha, B_{10} had 2.11 t/ha, C_{20} had 1.56 t/ha and D_{30} had 1.67 t/ha respectively. Regression model for predicting yield of maize before maturity was formulated. It had coefficient of linearity and standard error of 0.645 and 0.43 respectively.This research has brought to bear the need for controlled tractor traffic on agricultural soils in order to curtail its negative effects on soil and crop yield. Minimum number of tractor traffic below 10 passes on asandy loam field is convenient for effective maize cultivation.*

Keywords: *Compaction,Growth, Maize,Properties,*Tractor *Traffic, Yield*

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I. INTRODUCTION

Maize (Zea mays) is a very important cereal crop, which ranks third in the world after wheat and Rice (David and Adams, 1985). According to FAO (2009), maize is the most widely grown grain crop throughout the Americans with 332 million metric tons grown annually in the United States alone. More than seventy countries (including 15 developed and 58 developing) produce maize spanning several million ha of land. The first four being United States, Brazil, China and Argentina.Followed by Ukraine, India and then Mexico. Indonesia, Philippines, France, Romania, Yugoslavia and USSR are the other maize producing countries. FAO (2009) reported that the area planted to maize in West and Central Africa alone increased from 3.2 million ha in 1961 to 8.9 million ha in 2005. This phenomenal expansion of the land area devoted to maize resulted in increased production from 2.4 million metric tons in 1961 to 10.6 million metric tons in 2005. Maize provides food for humans and feed for livestock. In many parts of West Africa, maize is a staple food and it is sometimes grown on a garden scale where it cannot be grown as a farm crop. It is an important source of carbohydrate and if eaten at the immature state, it provides useful quantities of Vitamin C.Maize can be grown on a wide range of well drained soils, sandy loam to clayey loam and it is important for the soil to have plant nutrients. The soil should be alkaline or almost neutral. Maize does poorly on heavy soils, sand or gravelly soils. Maize has a low ability of extracting water from the soil, so it must have steady water supply during its critical growth period otherwise the performance and crop yield will be poor (Anyanwu et al., 1998).Farm mechanization is a major element in the modern agricultural activities. The extensive use of tractors and associate heavy machinery in farming activities brings about numerous benefits. But the use of farm machinery needs proper management and can adversely affect plant growth due to compaction of agricultural land (Raghavan *et al*., 1990).Soil compaction is the process in which a stress applied to a soil causes densification as air is displaced from the pores between the soil particles (McCarthy, 2007). Normally, compaction is the result of heavy machinery compressing the soils. Heavily compacted soils contain few large pores and have a reduced rate of both water infiltration and drainage from the compacted layer. The change in pore space restricts root growth, and the gas exchange necessary for plant growth and yield. Compaction restricts infiltration of water, increasing runoff and erosion, leading to the loss of valuable nutrients (Botta et al., 2002; 2006; 2008; 2009; and 2010, Manuwa and Odubanjo, 2007). According to Horn and Fleige (2003)and Horn *et al*. (2004), soil compaction refers to the formation of well packed soil, often at the bottom of the cultivated layer. Causes of soil compaction include rain drop impact, natural processes, wheel traffic, tillage operation, pasture grazing and minimal or no crop rotation(DeJong-Hughes et al., 2001, Donkor *et al*., 2002; Rocky, 2011). Some alleviation practices for soil compaction are cultivating cover crops, reduction of secondary tillage and controlled field traffic farming, deep tillage practices and incorporating organic matter into the soil. Soil compaction is the main form of land degradation, affecting more than 11% of land area(Van Lynden, 2000 and Ahmad et al., 2007). Compaction is a worldwide problem in modern agriculture associated with overuse of heavy machinery and intensification of cropping systems (Chen and Weil, 2011). Soane and Ouwerkerk (1994) and Hamza and Anderson (2005) opined that compaction of agricultural soils is a global concern since it has adverse effects on the environment and consequently, agricultural production. They further revealed that it is estimated to be responsible for the degradation of an area of 33 million ha in Europe and is one of the major problems facing modern agriculture in the world today. According to Manor and Clark (2001); Wells et al. (2005); and Alameda and Villar (2009) soil compaction reduces crop growth and yields, by restricting root development as well as water and air movement in the soil.

As recorded by (Mason et al., 1988) the ability of plant roots to penetrate soil is restricted as soil strength increases and ceases entirely at 2.5 MPa. Aase et al. (2001) reported that as cone index approaches 2 MPa and moves above this value, root growth has been shown to be restricted to varying degrees. Hence 2 MPa has been considered as a measure in the determination of soil hard pan layer. Raper et al. (1998) further revealed that a critical limit of penetration resistance restraining root distribution is within 40-50 cm soil depth and that subsoiling can reduce and provide increased rooting depth. Taylor (1983), Monroe and Kladivko (1987), Mason et al. (1988), and Mari and Changying (2008) explained that hydrostatic pressure (turgor) within the elongating region of the root provides the force necessary to push the root cap and meristematic region through the resisting soil. If the hydrostatic pressure is not sufficient to overcome wall resistance and soil impedance, elongation of that particular root tip ceases. Plant roots constitute a major source of soil organic matter when decomposed; and while growing, are capable of both creating and stabilizing useful structural features.Heavier and more powerful tractors and machines have been used on farms throughout the world. The aim is to reduce the human drudgery and labour; and corresponding increase in farm size and individual operator productivity (Mari and Changying, 2007, 2008).Intensity of trafficking (number of passes) plays an important role in soil compaction because deformations can increase with the number of passes (Bakker and Davids, 1995; Reeder and Smith, 1992; Chygarev and Lodyata, 2000; Manuwa and Adesina, 2011). Experimental findings have shown that all soil parameters become less favourable after the passage of a tractor and that a number of passes on the same tramlines of a light tractor, can do as much or even greater damage than a heavier tractor with few passes. The critical number of passes was ten (10), beyond which advantages from the use of a light tractor were lost (Jarajuria and Draghi, 2000 in Mari and Changying, 2008). Shafiq et al. (1994) opined that excessive soil compaction impedes root growth and therefore limits the amount of soil explored by roots which in turn can decrease the plant's ability to take up nutrients and water, from the stand point of production. lants grown in compacted soils have shown a smaller number of lateral roots than plants grown under controlled condition. Plants grown in more compacted soils showed smaller ratios of fresh to dry mass. Soil compaction can have adverse effect upon crops by - increasing the mechanical impedance to the growth of roots; altering the extent and configuration of the pore space and aggravating root diseases (Tardieu, 1994; Hakersson and Reeder (1994); Gregory (1994); Dauda and Samari, 2002; Amauri et al., 2007; Isaac et al., 2002; Lipiec et al., 2003; Duiker, 2004; Borghei et al., 2008; Weber and Biskupski, 2008; Soltanabadi et al., 2008; Grzesiak, 2009; Juliano and Rosolem, 2010; Kulkarni et al, 2010; Becerra et al., 2010; Becerra et al., 2011; Chen and Weil, 2011; Otto et al., 2011; Celik and Raper, 2012; Li et al., 2012).Singh et al., (1992) added that due to the lack of research literature, the maximum value of bulk density which may be considered usable by plant is 2.1 Mg m^{-3} in any type of soil. USDA (1999) revealed ideal bulk densities for crop growth and bulk densities that restrict root growth. Singh *e. al.* (1992)specified that the ideal bulk density for sand and loamy sand is < 1.60 g/cm^3, while > 1.80 g/cm^3 restricts root growth. While for sandy clay and clay loam soils, the ideal bulk density is < 1.40 g/cm^3, and root restricted bulk density is > 1.75 g/cm^3. Whereas for silty clay loam, the ideal bulk density is < 1.40 g/cm^3, while 1.65 g/cm^3 restricts root growth. While for clay soils the ideal bulk density is <1.10 g/cm^3, and root restricting bulk density is >1.47 g/cm^3. On the other hand for Sandy clay and silty clay soils, the ideal bulk density for root growth is < 1.10 g/cm^3, while > 1.58 g/cm^3 restricts root growth. According to Voorhees (1985) a medium textured soil, having a bulk density of 1.2 g/cm^3 is generally favourable for root growth. However, roots growing through a medium textured soil with a bulk density near 1.2 g/cm^3 will probably not have a high degree of branching or secondary root formation. In this case, a moderate amount of compaction can increase root branching and secondary root formation, allowing roots to thoroughly explore the soil for nutrients (Hakersson and Lipiec, 2000). This is especially important for plant uptake or non-mobile nutrients such as phosphorus (Giles, 1981)

1.2Objectives of the Research

The objectives of this research areto study the influence of tractor traffic on soil properties and to establish to what extent this affects growth and yield parameters of a maize crop.

II. MATERIALS AND METHODS

2.1 Experimental Site

The Experiment was located at the Teaching and Research Farm of the Department of Agronomy, Cross River University of Technology, CRUTECH, Obubra Campus located on longitude 08^{o}20$^'$00$^{''}$E and latitude 6^{o}05$^'$00$^{''}$N. The area lies between the Central Senatorial District of Cross River state. Obubra has two distinct climatic seasons a wet season(from March to October) and a dry season (from November to February).

2.2 Experimental Design and Cultural Operation

The experiment was a Randomized Complete Block Design (RCBD) with three blocks (replications). Four (4) treatments and 3 replications were imposed on the land. Each plot size measured 3m x 3m separated from each other by 3 m for the maneuvering of the tractor. A gross experimental size of 27m x 21m was used for the experiment. The Treatmentsused were zero tractor movement (control),(A_0), 10 tractor traffic,(B_{10}), 20 tractor traffic, (C_{20}), 30 tractor traffic, (D_{30}).The vegetation was manually removed from the plots before the tractor traffic treatments were applied. This was followed by layout for pegging. Soil samples were collected before and after treatments using soil cores and auger, and were taken to the laboratory for physico-chemical properties analysis. Ploughing was done according to the experimental design. A Massey Fergusson – MF 435 2WD/4WD tractor of 50 kW and 2,122 kg total tractor weight was used in driving through the field according to the design(see Figure: 1 A and B).

Figure 1: (A) Compaction of plots by tractor and (B) marking of compacted plots prior toplanting

2.4 Cone Index, Moisture Content and Other Soil Properties

Soil cone penetrometer and moisture meter were used to take cone index (CI) and moisture content (MC) of soil on all the plots before and after the treatments. These were taken at three ranges of depths - 0 – 15 cm, 16 – 30 cm and 31 – 45 cm. Soil samples were taken with soil cores and subjected to analysis for physical and chemical properties accordingly.

2.5 Planting and other Operations

The plots were marked and maize (FAMMAX-15) seeds were sown directly at the rate of 2 seeds per stand and at a distance of 70 cm x 30 cm (inter and intra row respectively) according to Anyanwu *et al*. (1998).A 15 – 15 - 15 (N.P.K) fertilizerwas applied at the rate of 30 g/plot. This was done 3 weeks after planting (3 WAP). Manual weeding was carried out at 2 WAP, 4 WAP and 8 WAP using hoe and cutlass before harvesting. Matured maize cobs were harvested, dried and de-cobbed. The maize cobs were shelled, winnowed and weighed according to treatments.

2.7Data Collection

The growth and yield response of maize to tractor traffic-induced soil compaction was measured by collecting data on regular (weeks after planting (WAP)) basis, deduced from (Reeder et al., 1993; Buttery et al., 1998; Dauda and Samari, 2002; Abu-Hamdeh, 2003; Lipiec et al., 2003; Amauri et al., 2007; Borghei et al., 2008; Weber and Biskupski, 2008; Soltanabadi et al., 2008; Botta et al., 2010; Juliano and Rosolem, 2010 and Becerra et al., 2010 and 2011). Among the parameters measured were height of maize, number of leaves, plant width, cob yield and grain yield.

2.8Data Analysis

The data obtained were subjected to statistical analysis according to the procedure for analysis of variance (ANOVA) for experiment laid out in a Randomized Complete Block Design. Correlation and regression analyses were carried out to obtain relevant relationship between parameters.

III. Results And Discussion

3.1 Results

The results of soil analysis show that the soil in the experimental plot was sandy loam, with values of organic matter, Nitrogen and other essential plant nutrients. It also has a moderate acidic $_{P}$H value.Soil particle size distribution before land preparation were 78.2 % sand, 11.5 % silt and 10.3 % clay (see tables 1 and 2).

Table 1: **Mean Values of Soil Particle Size distribution after Treatment Application**

Sample Location	% Sand	% Silt	%Clay	Textural Class
A_0	81.3	10.3	8.4	Sandy Loam
B_{10}	80.0	10.7	9.3	Sandy Loam
C_{20}	78.3	11.2	10.5	Sandy Loam
D_{30}	76.3	12.1	11.6	Sandy Loam

Table 2:Chemical Properties of the Experimental Site

Chemical Properties	Values
P^H in water	5.92
Potassium Chloride (KCl)	5.08
Organic Carbon %	0.54
Organic matter %	0.93
Total Nitrogen %	0.078
Total Phosphorus %	3.50
Exchangeable Cation (Cmol/kg)2.81	
Calcium (Ca)	3.50
Magnesium (mg)	1.52
Potassium (K)	0.25
Sodium (Na)	0.58
CEC	6.35

3.2Soil Moisture Content and Cone Index at Random Locations on the Field Before Treatment were Applied

Figures 2 and 3 showed the distribution of soil compaction (cone index values) and moisture contents in fifteen locations on the agricultural field respectively. These were taken on the 15th of June 2012 prior to commencement of agricultural activities during the year. A lowest cone index of 1.034 MPa was measured at point D within a depth of 0 – 15 cm. While a lowest moisture content of 8.1% was measured at point F within a depth of 0 – 15 cm. The highest penetrometer readings of 1.586 MPa within this depth were measured at point J and N respectively. In general, highest penetrometer readings were recorded at depth of between 30 – 45 cm. Up to 3.999 MPa was obtained within this region. These findings agreed with that of Manor and Clark (2001) and the work of Kumar and Thakur (2005) who revealed that hard pans of 2.0 MPa and above are prevalent in most soils around the globe. The Plot clearly revealed that cone index increases generally from the soil surface into the soil profile. But this was not the case with the soil moisture, as it was found to be irregular irrespective of the depths that were considered. However, at a depth of 30-45 cm high moisture contents were observed at many points.

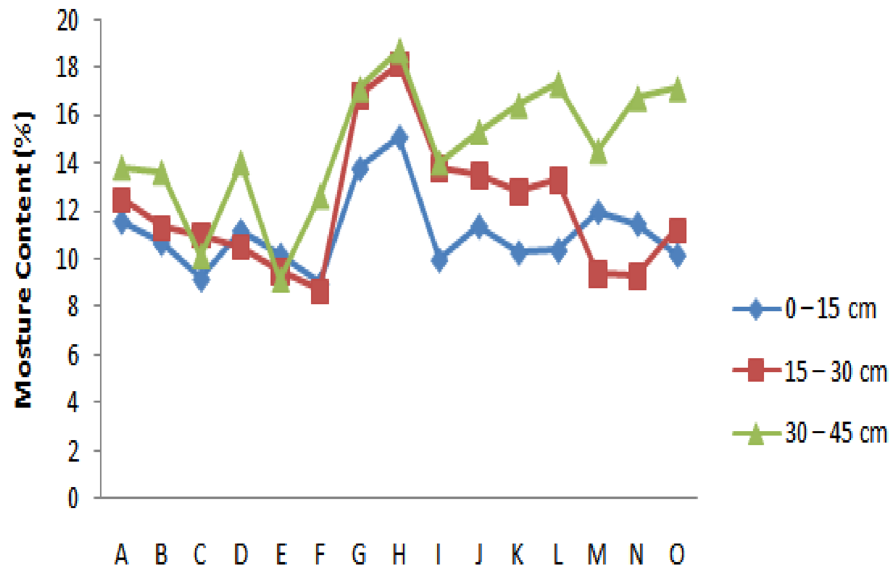

Figure 2: Soil Moisture Content on different Locations on Field Before Treatments

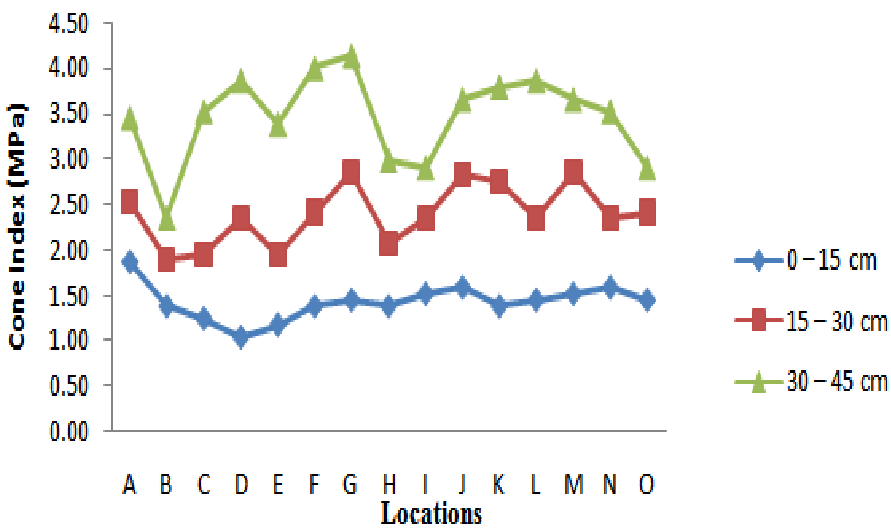

Figure 3: Soil Cone Index on different Locations on Field Before Treatments

Influence of Tractor Traffic on Soil Cone Index During Growth of Maize

Influence of Tractor traffic on soil cone index according to different field treatments are shown on table 3. The penetrometer readings were taken in July, 2016 (just after treatment), September, 2016 (6 Weeks After Planting, WAP) and October 2016 (12 Weeks After Planting).

Table 3: Influence of Tractor Traffic on Soil Cone Index During Growth of Maize in Obubra, Nigeria.

Weeks After Planting (WAP)	Depth (cm)	Ao1 (MPa)	Ao2 (MPa)	Ao3 (MPa)	$B1_{10}$ (MPa)	$B2_{10}$ (MPa)	$B3_{10}$ (MPa)	$C1_{20}$ (MPa)	$C2_{20}$ (Mpa)	$C3_{20}$ (MPa)	$D1_{30}$ (MPa)	$D2_{30}$ (MPa)	$D3_{30}$ (MPa)
Just After Treatment (July, 2016)	0 – 15	0.076	0.074	0.094	0.538	0.800	0.827	0.855	0.855	0.917	1.145	1.117	1.365
	16 – 30	0.896	1.296	1.338	1.476	1.531	1.655	1.234	1.531	1.600	1.531	1.834	2.027
	31 – 45	0.912	1.848	1.738	2.317	3.213	2.910	2.841	2.786	2.744	2.965	3.075	3.337
6 WAP (September, 2016)	0 – 15	0.083	0.080	0.593	1.103	0.924	1.103	0.910	0.979	0.935	1.200	1.062	1.476
	16 – 30	0.717	1.296	1.441	1.724	1.793	1.724	2.013	2.279	2.248	1.510	1.869	2.165
	31 – 45	0.841	0.889	1.600	3.061	3.061	3.061	3.379	3.468	3.470	2.986	3.137	3.316
12 WAP (October, 2016)	0 – 15	1.200	1.255	1.096	1.420	1.407	1.462	1.738	1.613	1.510	2.165	2.193	2.227
	16 – 30	2.000	1.682	1.648	1.765	1.834	1.586	2.165	2.220	2.365	3.006	3.103	3.123
	31 – 45	3.048	2.965	3.075	3.158	3.034	3.158	3.585	3.599	3.861	4.109	4.171	4.302

3.2 Effect of Tractor Traffic on Growth and Yield Parameters of Maize

Figure 4 ($_{A0}$, B_{10}, C_{20} and D_{20}) showed growth of maize plant at 8 weeks after panting (WAP). Plant height was influenced by tractor traffic. No tractor traffic (A_0 Produced the tallest plants, this was followed by B_{10} having 10 runs of tractor traffic and C_{20} having 20 runs of tractor traffic. The least height of maize plant was observed from D_{30}plots that received 30 runs of tractor traffic. For example at 6 WAP one of the A_0 plots had an average of 130.8 cm, B_{10} had 116.9 cm, C_{20} had 106.8 cm and D_{30} had 101.1 cm height respectively. The reduction in plant height in the tractor trafficked plots likely resulted from soil compaction caused by several runs on the plots,possibly causing a reduced rooting depth and low soil moisture content due to increased soil bulk density. The result obtained showed that tractor traffic negatively affected the width of maize crop, as a result of increased bulk density and reduced porosity and soil moisture. Plots with no tractor passes produced the highest width followed by 10 and 20 passes of the tractor plots respectively. The plot with 30 passes of the tractor produced the thinnest crops width. Thus at 6 WAP one of the A_0 plots had 1.35 cm, B_{10} had 1.32 cm, C_{20} had 1.24 cm and D_{30} had 1.23 cm average width respectively The result on the number of leaves produced by maize plant as influenced by tractor traffic showed that tractor traffic affected significantly the number of leaves produced per plot, although not as much as the width and height of plants. Thus it is observed that at 6 WAP one of the A_0 plots had 10.5, B_{10} had 10.1 cm, C_{20} had 9.7 and D_{30} had 9.3 number of leaves respectively. On the average no tractor pass plots (A_0) produced highest number of leaves followed by (B_{10}), $C_{20}$and D_{30}.The result obtained from the maize yield (cobs and grains) indicated that tractor traffic influenced the number of cobs produced per plot. Plots with no tractor pass (A_0) produced the highest number of cobs followed by plots with 10, 20 and 30 passes of tractor wheels respectively. The least number of cobs were obtained from plots with 30 passes of tractor traffic. Also the grain yield was affected by tractor traffic, as the plot with no tractor passes gave the highest grain yield. Plots with 10 tractor passes followed suit while 20 passes of tractor plot came next. The plots with 30 tractor passes had the lowest grain yield. Thus it was observed that at maturity maize yield on the A_0 plots had a mean value of 2.56 t/ha, B_{10} had 2.11 t/ha, C_{20} had 1.56 t/ha and D_{30} had 1.67 t/ha respectively. The reduction in yield (cob and grain) could be as a result of soil compaction caused by tractor traffic which could have caused reduced soil aeration, soil and water losses, increased bulk density, reduction in porosity and inability of the plants to take up nutrients.

Figure 4: Growth of Maize at 8 WAP According to Treatments Operation ($_{A0}$, B_{10}, C_{20} and D_{20})

3.4Correlation Coefficients onEffect of Tractor Traffic on Soil Properties, Growth and Yield of Maize

The results obtained from the Pearson Correlation analysis showed that tractor traffic affected soil bulk density, soil moisture content and soil porosity which in turn affected the growth parameters of maize (plant height, plant width and number of leaves) and maize yield (cob yield and Grain yield). Thus tractor traffic on the plots had high positive correlation with bulk density and high negative correlation with soil moisture, soil porosity, growth parameters (plant height, width and number of leaves) and yield parameters (cob yield, cob weight and grain yield) of maize as shown in Table 4 below. The correlation coefficients were 0.928, -0.780, -0.890, -0.381, -0.500, -0.730, -0.534 and -0.769 respectively. Thus, soil bulk density affected growth and yield parameters negatively as shown. While soil porosity and soil moisture affected positively the growth and yield parameters of maize respectively as shown by their correlation coefficients.Thus, the results in this study on the reduction of growth and yield parameters of maize due to tractor traffic which lead to an increase in soil cone index and bulk density, reduction in soil porosity and moisture, agree with the work of (Dejong-Hugles *et al.* (2001, Manor and Clark, 2001; Soane and Ouwekerk; 1994; Peterson et al., 2004; Wells et al., 2005; Amauri et al., 2007; Borghei et al., 2008;USDA, 2008; Weber and Biskupski, 2008; Soltanabadi et al., 2008; Botta et al., 2010; Juliano and Rosolem, 2010; Becerra et al., 2010 and 2011 and Odey et al. (2014a, 2014b and 2014c), Odey, 2015)).

3.6Regression of Tractor Traffic with Soil Properties, Growth and Yield Parameters of Maize

In the Regression analysis, tractor traffic was regressed with bulk density, porosity soil moisture, growth and yield parameters with grain yield as the dependent variable. A regression model was formulated as shown below.

$Y_m = 29.34 + 0.012T_T - 11.5B_d - 0.75M_s - 0.25P_s + 0.03M_h - 0.34M_w + 0.37M_l$ … (1)

Where,

Y_m = Grain yield

T_T = Tractor traffic

B_D = Soil Bulk density

M_s = Soil moisture

P_s = Soil porosity

M_h = Maize plant height

M_w = Maize stem width

M_l = Number of leaves of maize crop

The above equation (1) had a coefficient of linearity, R^2 of 0.645 and standard (std.) error of 0.43, when the observed and predicted values were graphed. This equation shows that in any particular cropping season, the yield of maize, Y_m can be estimated (predicted) in advance provided the number of machinery traffic on the land is known; more over the knowledge of soil and growth parameters of maize must be measured at particular number of weeks, say 6 WAP.The analysis of variance among parameters showed that the mean difference is significant at the 0.05 level. The multiple comparisons revealed that the parameters responded to the different treatments accordingly with higher number of tractor traffic having significant impact on the soil properties and growth and yield parameters of maize.

	Tractor Traffic	Bulk Density (g/cm^3)	Soil Moisture (%)	Porosity (%)	Plant Height (cm)	Plant Width (cm)	No of Leaves	Cob yield (t/ha)	Weight of cob (t/ha)	Grainyield (t/ha)
Tractor Traffic	1.000	0.928**	-0.780**	-0.890**	-0.655*	-0.381	-0.500	-0.730**	-0.534	-0.769**
Bulk Density (g/cm^3)		1.000	-0.723**	-0.990**	-0.532	-0.159	-0.391	-0.791**	-0.636*	-0.749**
Soil Moisture (%)			1.000	0.719**	0.891**	0.311	0.404	0.586*	0.489	0.529
Porosity (%)				1.000	0.554	0.120	0.401	0.807**	0.674*	0.728**
Plant Height (cm)					1.000	0.477	0.504	0.524	0.442	0.467
Plant Width (cm)						1.000	0.833**	0.383	0.383	0.253
No of Leaves							1.000	0.674*	0.713**	0.387
Cob yield (t/ha)								1.000	0.909**	0.792**
Weightofcob(t/ha)									1.000	0.467
Grainyield(t/ha)										1.000
**. Correlation is significant at the 0.01 level (2-tailed).										
*. Correlation is significant at the 0.05 level (2-tailed).										

IV. CONCLUSION

The successful completion of this research has made it possible to deduce as follows - firstly, severalmovements of tractor wheels on the plots were found to negatively affected soil bulk densityand cone index as these considerably increased depending on the number of tractor passes on the land.While soil porosity and moisture were reduced as a result of the treatments.The growth and yield parameters of maize on the treatments plots were found to be negatively affected by tractor traffic. There was considerable reduction in yield of maize grain due to soil compaction which led to increased bulk density and reduction in porosity and moisture content of the soil.

Results of correlation showed that tractor traffic had high positive correlation with bulk density and negative correlation with soil porosity, soil moisture and growth and yield parameters of maize. Thus bulk density increased with tractor traffic while soil porosity, maize growth and yield reduced with increased tractor traffic. A Regression equation for predicting yield of maize crop was formulated. It had coefficient of determination (linearity) and standard error of 0.645 and 0.43 respectively.Tractor traffic on agricultural lands should be controlled and reduced to the barest minimum (below 10 passes) for better soil properties, growth and yield of crops.Results were generated from this research, but the study was limited bya lack of some basic measuring tools such as leaf area meter for measuring area of maize leaves at intervals, and root analyzing machine for studying the effect of tractor traffic on development of crop roots.

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