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Reduced Tillage Effect on Soil Physico-Chemical Properties, Growth and Yield of Maize in Gleysol and Ultisol of Kogi State, Nigeria

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Abstract: Field experiments were carried out to investigate the effect of reduced tillage methods on soil properties and maize performance on Ultisol and Glysol of Kogi State. The sites of the experiments were on ultisol at the Lower Niger River Basin Development Authority, Ejiba anda glysol at AhmaduBello University,Division of Agricultural Colleges, College of Agriculture, Kabba. Treatment consisted of five tillage methods namely; Zero Tillage(ZT), Mannual Tillage (MT), Plough Alone (PA), Plough +Harrow (PH), and Plough +Harrow + Ridge(PHR). The treatments were replicated three times. Soil physical properties such as bulk density, porosity, moisture content, temperature, macro and micro porosity and chemical properties such as soil pH, Organic matter, N, P,K,Ca,Mg, CEC and Base Saturationwere examined before and at the end of the experiment.Maize growth parameters (stem girth, leaf area and plant height) were collected at two weeks interval.Days to 50% tasseling were taken. Yield parameters (seed weight, 1000seed weight,number of seed per cob and seed yield t/ha) were collected at harvest. Leaf tissue analysis was carried out on leaves collected at tasseling to determine leaf nutrient. The results showed that tillage significantly (P<0.05) influence soil physical properties, soil organic matter, nitrogen, phosphorus, stem girth, leaf area, plant height, days to 50% tasselling and maize yield and leaf nutrient content in both soils. Plots treated with manual tillage recorded better performance in soil physical condition. However growth and yield of maize were better in plots treated with conventional tillage i.e. plough+Harrow and Plough+Harrow+Ridge.It is therefore recommended that seed bed preparation for maize production should be done with conventional tillage (Plough+ Harrow or Plough + Harrow+ Ridge). However, to reduce cost of seed bed preparation, Plough+ Harrow should be adopted in the study area.

Keywords: Reduced, Tillage, Plough, Harrow, Ridge, Conventional, Manual

Introduction

Cultivation is an essential component of farming (FAO, 1995). Appropriate soil tillage is considered necessary to enhance crop production. Create greater soil volume for seed germination and emergence, seedbed establishment and root growth (Lal, 1979).Tillage improves aeration, water transmission and enhances root growth and nutrient uptake Ojeniyi, (1992).A proper tillage can alleviate soil related constraints while improper tillage may lead to a range of degradation processes(Sornpoon and Jayasuriya, 2013).Soil tillage promotes changes in soil structure and porosity, which in turn affect soil hydraulic properties and the processes of water infiltration, runoff and storage, soil temperature, and chemical transport (Ahuja et al., 1998). Soil tillage generally decreases soil bulk density and increases soil porosity by loosening the soil.Many factors are responsible for the low grain yield in crop (Abimiku, et al., 2002). Appropriate tillage method is considered one of the factors for increasing the yield of crop per unit area. According to (Lal, 1986), the primary aims of tillage are: to control weeds, manage surface trash, provide aeration, prepare good seed beds, shape or level the soil, improve physical conditions of the soil, incorporate fertilizers, break hard pans and allow better water and air infiltration.

Soil compaction is generally defined as an increase of the natural density of soil at a particular depth (Singh and Malhi, 2006). The density increase translates soil into less pore space, less water available for plant, slower water transport, and decreased root ability to penetrate the compacted zone as it seeks out water and nutrients or can reduce the formation of lateral roots (Singh and Malhi, 2006).Compactions limit yields and inhibit effective site management for many crops (Rooney, 2004). Soil compaction leads to corn yield reduction (Philips and Kirkham, 1962, Ogundare et al., 2015).

There are different tillage systems available for crop production. These include plough, chisel, disc stable mulch, ridge, strip till, and no-till. Ultisols are warm and low in basic cation saturated (acidic) occurring in humid region. Without fertilization, they become worn out with time. They can be productive for Agriculture. Gleysols are soils formed from unconsolidated materials exclusive of recent alluvial deposits showing hydromorphic properties within 50cm of the surface Ojo-Atere et.al (2011). It is important to find out the best and appropriate conventional tillage practice which will minimize soil properties disturbance in maize cultivation.This study was therefore designed to evaluate theeffect of reduced tillage on soil physico-chemical properties, growth and yield of maize under ultisol and gleysol soils.

Site Description

The experiments were located at Lower Niger River Basin, Ejiba and Horticultural Section, College of Agriculture, Kabba in 2014 cropping season. Ejiba is located on latitude 8^{0} 18'N and longitude 50^{0} 39'E and Kabba is on latitude 07^{0}35N and longitude 06 08'E in the Southern Guinea Savanna Agro ecological zone of Nigeria. The soil at Ejiba is an ultisol, while that of Kabba is a gleysol(Higgins, 1957; Babalola, 2010). In the study areas, rainfall is monomodal and span from April to September. The experimental sites had been under cultivation for about ten years. The predominant weeds were Spear grass, Carpet grass, Elephant grass, Southern gamba grass and Giant star grass. Common broadweeds were Siam weed, Milk weed, Stubborn weed, Wild marigold. Locust bean tree and Neem tree are the major tree species.

Experimental Area

Each experiment was conducted on a field of dimension of 54m x 30m which was laid out into three blocks with 6m furrow way between blocks.Each block consisted of 5 plots (6m x 6m) and 6m furrow way between plots.The treatments consisted of five tillage methods (Plough + Harrow + Ridge (PHR), Plough + Harrow (PH), Plough alone (PA), Manual Tillage (MT) and Zero Tillage (ZT) (control). The treatments were arranged using Randomized Complete Block Design (RCBD).Maize seeds, (SWAN-SR-DMR) downing mildew resistance, streak resistance, yellow grain open pollinated variety were sown at a spacing of 90cm between row and 30cm within rows. The fully emerged plants were thinned to two plants per stand to give a plant population of 53,333 plants per hectare.Weeding was carried out manually at 3 and 8 weeks after planting. Stem borer was controlled with the use of chloropyrifos at the rate of 500g/L.

Soil Sampling and analysis

Before the commencement of the experiment, surface soil samples (0-5cm depth) were taken from each plot. The samples were bulked, air-dried and sieved through a 2mm sieve and analysed for pre planting soil samples, particle size, soil organic matter, total N,P,K, Ca,and Mg.Soil samples were collected at 15 days intervals on per plot basis, the samples were analysed for routine chemical analyses. The samples particles size analyzes as described by Carter (1993). Particle size analysis was done using hydrometer method (Bouyonces, 1962). The organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1982).Total N was determined by Micro-Kjeldahl digestion method.Available P was determined by Bray-1 extraction followed by Molybdenum blue colorimetry(Bray and Kurtz, 1945). Exchangeable K, Ca, Mg and Na were extracted by Ethylene Diamine Tetra Acetic Acid (EDTA) titration method

(Jackson, 1962). KCl was used for extraction and the determination of exchangeable acidity (exchangeable hydrogen and aluminum) separately (Mclean, 1965). The potential cation exchange capacity (CEC) was determined by summing up the total exchangeable bases and exchangeable acidity (IITA, 1979). The neutral base saturation was calculated by dividing total exchangeable bases (K, Ca, Mg and Na) by the CEC. And the percentage was determined (NSSC, 1995).Soil pH was determined in 1:2 soils water ratio using digital electronic pH meter.

Determination of Soil physical properties

Soil Physical properties were taken at 30 and 60 days after planting. Five undisturbed samples were collected at 0-15cm depth from each plot using core samplers and were used for the determination of Bulk density, Total porosity and Gravitational moisture contents after oven dried at 105^0C until a constant weight is achieved. Total porosity was calculated from the value of Bulk density and Particle density. Soil temperature was determined at 15.00 hr (3pm) with a soil thermometer inserted to 5cm depth. Five readings were made per plot at each monthly determination.

Determination of growth and yield parameters

Ten plants were randomly selected at the center of each plot for data collection. The number of days to 50% tasselling was determined by counting maize plants that tasseled. Plant height and leaf area per plant were determined at 60 days after planting when the maize plant reaches its growth peak. Plant height was measured with a measuring tape from tagged plants from the ground level to the tip of the tassel. For leaf area determination, the average length and breadth of three leaves at upper, middle and lower part, of these plants were taken. The mean of these measurements were multiplied by the average no of leaves per plant and by a coefficient value of 0.75 (Lazarus, 1965).At crop maturity, stem girth of selected plants were measured by usingvernier caliper at 30 cm from the base of the plants.

Statistical analysis

Data collected from each experiment were subjected to analysis of variance (ANOVA) test and treatment means were compared using Duncan Multiple Range Test (DMRT)at $p = 0.05$ probability level (Steel and Torrie, 1987).

RESULTS AND DISCUSSION

The properties of the soils at the sites of the experiment are shown in Table 1. The soils are sand loam and sand clay loam in Ejiba and Kabba respectively.Soil of Ejiba is more acidic (5.74) when compared with the soil of Kabba (6.3). Both soils are high in bulk density. Organic matter, total N, available phosphorus (P) and exchangeable potassium (K) were low. Exchange Mg though low in soil of Ejiba, it was adequate in soil of Kabba. The nutrients present in the soils are expected to meet the growing need of maize in the study area.

Effect of reduced tillage methods on soil physical properties are presented in Table 2 and 3. Bulk density, total porosity and moisture content were significantly influenced by tillage method applied. However, soil temperature was not affected significantly. Among the tillage methods, Plough plus Harrow (P+H) had highest bulk density both in Ejiba and Kabba. It was closely followed by plough plus harrow plus ridge (P+H+R) in Ejiba while plough alone (PA) followed plough + harrow (P+H) in Kabba.The lowest bulk density was observed in plots treated with manual tillage both in Ejiba and Kabba. Mechanical tilled had higher bulk density in this experiment. The result was in line with the findings of Wiermann and Horn, (2000); Lampurlance and Cantero-martinez (2003). They reported increase of bulk density and compaction on mechanically ploughed soil with intensive traffic, which occurred due to many tillage operations. Zero tillage plots had higher bulk density than manually tilled plots. The observation confirmed the work of Ojeniyi and Adekayode, 1999; Bankole and Ojeniyi (2005) and

Agbede (2006). They reported that bulk density was usually higher on zero tilled plots than manually prepared plots. Porosity was high in plots treated with manual tillage (hoe). This was significantly better than Plough plus Harrow and Plough plus Harrow plus Ridge.

The low bulk density and high porosity produced by manually prepared plots was attributed to loosening effect of the manually tilled plots. Manually prepared plots had higher moisture content followed by zero tillage. There was no significant difference among mechanical tillage system used. However, Plough+ Harrow + ridge had the least moisture content in Ejiba and Kabba with values of 11.24% and 09.96% respectively. Soil temperature was not affected significantly by the treatments. The higher moisture content produced by manually prepared plots could be adduced to the presence of organic residue in the surface layer of the soil (Agbede, 2007).

Effect ofreduced tillage methods on soil chemical properties at crop maturity are presented in Table 4 and 5. Significant difference were observed in soil organic matter, nitrogen, phosphorus while, soil pH and potassium were not significantly affected. In Ejiba (ultisol), $_{P}$H range from 6.0 to 6.2, Soil Organic Matter range from 6.2 to 6.0 and P range from 3.39 to 3.98mg/kg.K ranges from 0.39cmol/kg in Plough and Harrow to 0.41cmol/kg in PHR and ZT. Calcium was between 1.8 cmol/kg and 2.3cmol/kg in ZT and PHR. Magnesium was between 1.3cmol/kg in MT and 1.8cmol/kg in PH. The result for sodium range from 0.13 and 0.07cmol/kg.EA was between 2.44 and 2.24 cmol/kg while CEC was between 6.89 and 5.94cmol/kg.

In Kabba(gleysol), PH has an average of 6.0. Soil organic matter ranges from 7.3 to 7.0 %. Nitrogen is between 0.18 and 0.13%. The values of phosphorous cmol/kg range between 5.28 and 4.29mg/kg. The value of calcium in cmol/kg was between 3.3 and 2.6 while the value for K was between 0.41 and 0.51 and Magnesium was between 1.9 and 1.6 in cmol/kg.Sodium ranges between 0.08 and 0.13.

pH of soil of Ejiba was found to be higher in acidity when compared with pH of soil of Kabba. This could be attributed to continuous use of land at Ejiba without serious soil conservation. Soil organic matter was higher in plot treated with zero tillage in Ejiba and Kabba. This finding was similar to that of Ojeniyi and Adekayode (1999), and Agbede (2007) they reported that zero tilled soil produced higher values of soil organic matter, P, K, Ca and Mg contents compared with manually and mechanically tilled soil. The high soil organic matter in zero tillage could be as a result of foliage of weeds that was destroy by herbicide (glyphosphate) which decay and mineralized into the soil. Effect of tillage on N,P, and K were inconsistent in this experiment.

Effect of reduced tillage methods on growth characters of maize are presented in Table 6 and 7. Tillage methods significantly influence stem girth, leaf area, plant height and days to 50% teaseling in maize. Stem girth, leaf area and plant height were better in plots treated with Plough + Harrow. Though, these were not significant better than plots with plough + Harrow + Ridge (PHR). Plots with zero tillage were significantly inferior in terms of growth characters in this experiment. The plant height, for Plough Alone, Plough + harrow and Plough+Harrow +Ridge for Ejiba (ultisol) were 168.1, 206.1 and 199.5cm, while that of Kabba were 192.6, 200.0 and 191.6cm respectively.Days to 50% tasseling in maize was attained earlier in plots prepared mechanically. This was significantly better than plots prepared manually and zero tilled plots. This may be attributed to good distribution of plant nutrient due to tillage implement used.

Table 8 and 9 show that cobweight; cob length; cob diameter performed better in Plough + Harrow + Ridge in both Ejiba and Kabba though not significantly different from Plough +Harrow.The result showed that cob weight was 39.27 and 47.8 in Plough+Harrow and Plough+Harrow+Ridge. Cob length was 19.88 and 22.0 in Plough+ Harrow and Plough+Harrow+Ridge.Cob diameter was between 22.10 and 9.0 in Ejiba. While in Kabba, cob length was highest in Plough+ Harrow+Ridge at 44.7 and lowest in Zero Tillage at 9.44 .Cob diameter range from 5.88 and 4.99.

Yield of maize were significantly affected by the treatment applied (Table10 and 11). Seed weight per plant, 100 seed weight (g) and number of seeds per cob and seed yield (t/ha) were better in the plough + Harrow plots is both stations. Seed weights per plant in grams were;324.2,535.8,634.9,737.6 and 634.9g which were not too different from the result obtained for Kabba gleysol which are368.0, 592.2, 673.0, 747.0 and 592.2g.Plots with Plough plus harrow plus ridge recorded highest seed yield in Ejiba (3.92) while the greatest seed yield in Kabba was observed in plot treated with plough plus harrow(3.92). Zero tilled plots recorded the least values of seed weight per plant andgrain yield (t/ha). Better seed yield (t/ha) observed in plots treated with conventional tillage methods could be due to better root distribution due to good seed bed preparation in the study area. Plots with mechanically tilled treatment(PA, PH, and PHR) recorded higher yield compared to manual tillage and the control. Higher grain yield in these treatments might be the result of better root proliferation and more uniform distribution of nutrients in soil profile. Among the tillage treatments, grains yield reduced most in plough alone(PA).Leaf nutrients were not significantly affected by the tillage methods imposed (Table 12 and 13). Leaf N ranged from 1.69-1.75 and 1.53-1.64 in Ejiba and Kabba respectively. Leaf P also ranged between 0.41 to 0.43 in Ejiba and 0.44 to 0.48 in Kabba.

Table 1. *Physical and Chemical Properties of Soil before the Experiment*

PROPERTIES	EJIBA	KABBA
Sand (%)	68.6	60.3
Clay (%)	16.4	21.6
Silt (%)	19.0	18.1
Soil texture	Sand loam	Sand clay loam
pH	5.74	6.3
Bulk density(g/cm^3)	1.46	1.31
Total porosity (%)	43.8	40.8
Organic matter (%)	1.83	2.1
Total N (%)	0.14	0.19
Available P (mg/kg)	3.16	3.11
Exchangeable K(cmol/kg)	0.34	0.21
Exchangeable Ca(cmol/kg)	1.68	2.67
Exchangeable mg(cmol/kg)	1.43	3.57

Table 2. *Effect of Reduced tillage methods on soil physical properties in ultisol of Ejiba*

Treatments	Bulk density (g/cm^3)	Total porosity (%)	Moisture content (%)	Soil temperature (C)	Macro porosity (%)	Micro porosity (%)
ZT	1.42^{b}	40.31^{a}	12.15^{ab}	30.4^{a}	29.95^{ab}	$10,36^{a}$
MT	1.40^{b}	43.06^{a}	14.06^{a}	30.2^{a}	32.26^{a}	10.80^{a}
PA	1.48^{ab}	41.77^{a}	11.48^{b}	30.0^{a}	30.97^{ab}	11.39^{a}
PH	1.53^{a}	39.93^{ab}	11.23^{b}	30.9^{a}	29.13^{ab}	10.80^{a}
PHR	1.42^{b}	35.24^{b}	11.24^{b}	30.8^{a}	24.03^{b}	11.21^{a}

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 3. *Effect of Reduced tillage methods on soil physical properties in Kabba gleysol*

Treatments	Bulk density (g/cm^3)	Total porosity (%)	Moisture content (%)	Soil temperature (^{0}C)	Macro porosity (%)	Micro porosity (%)
ZT	1.32^b	43.01^a	11.16^{ab}	32.3^a	30.06^b	12.95^a
MT	1.21^c	45.63^a	13.08a	32.2^a	33.61^a	12.02^a
PA	1.37^b	42.89^{ab}	11.18^{ab}	32.4^a	30.80^b	12.00^a
PH	1.44^a	40.56^b	10.0^b	32.7^a	28.26^c	11.80^a
PHR	1.42^a	40.12^b	09.96^b	32.4^a	28.71.^{c}	11.40^a

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 4. *Effect of ReducedTillage Methods on Soil Chemical Properties at Maturity in Ejiba ultsol*

Treat ments	pH	SOM (%)	N (%)	P (mg/kg)	K (mg/kg)	Ca (cmol/kg)	Mg (cmol/kg)	Na (cmol/kg)	EA (cmol/kg)	CEC (cmol/kg)	B. S (%)
ZT	6.0^a	6.0^a	0.13^b	3.39^b	0.41^a	1.8^b	1.6^a	0.07^b	2.24^b	6.58^a	65.96^a
MT	6.2^a	6.2^a	0,15^b	3.77^{ab}	0.40^a	2.3^a	1.3^b	0.11^a	2.36^a	6.48^a	63.58^b
PA	6.2^a	6.2^a	0.17^{ab}	3.84^{ab}	0.40^a	1.6^b	1.6^a	0.08^b	2.44^a	5.94^b	58.92^c
PH	6.0^a	6.0^a	0.21^a	4.38^a	0.39^a	1.9^b	1.8^a	0.13^a	2.41^a	6.54^a	63.15^b
PHR	6.2^a	6.2^a	0.14^b	3.98^{ab}	0.41^a	2.3^a	1.3^b	0.08^b	2.36^a	6.89^a	65.75^a

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 5. *Effect of Reduced Tillage Methods on Soil Chemical Properties at Maturity in Kabba Gleysol*

Treat Ments	pH	SOM (%)	N (%)	P (mg/kg)	K (mg/kg)	Ca (cmol/kg)	Mg (cmol/kg)	Na (cmol/kg)	EA (cmol/kg)	CEC (cmol/kg)	B. S (%)
ZT	5.9^a	7.3^a	0.15^b	4.29^b	0.51^a	2.6^b	1.9^a	0.08^b	3.16^b	7.64^a	58.4^a
MT	5.8^a	7.1^a	0.16^b	4.65^{ab}	0.50^a	3.2^a	1.6^b	0.13^a	3.45^a	7.58^a	54.36^b
PA	5.9^a	7.0^a	0.18^{ab}	4.75^{ab}	0.50^a	2.7^b	1.9^a	0.09^b	3.41^{ab}	7.09^b	51.90^c
PH	5.9^a	7.2^a	0.24^a	5.28^a	0.49^a	2.8^b	1.9^a	0.15^a	3.58^a	7.80^a	54.10^b
PHR	5.8^a	7.3^a	0.15^b	4.88^{ab}	0.41^a	3.3^a	1.6^b	0.09^b	3.44^a	7.53^a	54.32^b

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT (zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 6. *Effect of Reduced Tillage Methods on Growth Components of Maize in Ejiba Ultisol*

Treatments	Stem girth (cm)	Leaf Area (cm)	Plant Height (cm)	Days to 50% tasselling
ZT	2.64[b]	0.32[b]	112.4[c]	51[b]
MT	3.30 [ab]	0,48[a]	173.3b	49[a]
PA	3.15 [ab]	0.50[a]	168.1[b]	49[a]
PH	3.90[a]	0.52[a]	206.1[a]	48[a]
PHR	3.44[ab]	0.48[a]	199.5[a]	48[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 7. *Effect of Reduced Tillage Methods on Growth Components of Maize in Kabba Gleysol*

Treatments	Stem girth (cm)	Leaf Area (cm)	Plant Height (cm)	Days to 50% tasselling
ZT	2.73[b]	0.36[b]	143.8[c]	50[b]
MT	3.30[a]	0.38[b]	176.2[ab]	50[b]
PA	2.74[b]	0.51[a]	192.6[a]	48[a]
PH	3.57[a]	0.52[a]	200.0[a]	48[a]
PHR	3.51[a]	0.48[a]	191.6[a]	48[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 8. *Effect of Reduced Tillage Methods on Yield Components of Maize in, Ejiba Utisol*

Treatments	Cob weight (g)	Cob length (cm)	Cob diameter (cm)
ZT	8.35[c]	9.0[c]	9.0[c]
MT	19.7[b]	13.3[b]	13.3[b]
PA	17.77[b]	14.8[b]	14.8[b]
PH	39.27[a]	19.88[ab]	19.88[ab]
PHR	47.8[a]	22.10[a]	22.10[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 9. *Effect of Reduced Tillage Methods on Yield Components of Maize in a Kabba, Gleysol*

Treatments	Cob weight (g)	Cob length (cm)	Cob diameter (cm)
ZT	9.44[c]	8.3[c]	4.99[b]
MT	20.44[b]	13.9[b]	5.03[b]
PA	18.4[b]	15.2[b]	5.11[b]
PH	43.45[a]	21.03[a]	5.44[ab]
PHR	44.7[a]	21.98[a]	5.88[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 10. *Effect of Reduced Tillage Methods on Grain Yield of maize in Ejiba Ultisol*

Treatments	Seed weight/plant (g)	100 seed weight (g)	Number of seeds/ cob	Seed yield (t/ha)
ZT	324.2[c]	0.18[b]	325[c]	2.42[c]
MT	535.8[b]	0.22[ab]	386[b]	3.58[b]
PA	634.9[b]	0.22[ab]	357[b]	3.49[b]
PH	737.6[a]	0.23[ab]	541[a]	3.76[a]
PHR	634.9[b]	0.26[a]	386[b]	3.92[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 11. *Effect of Reduced Tillage Methods on Grain Yield of maize in Kabba, Gleysol*

Treatments	Seed weight/plant (g)	100 seed weight (g)	Number of seeds/ cob	Seed yield (t/ha)
ZT	368.0[c]	0.23[a]	366.3[b]	2.22[c]
MT	592.2[b]	0.23[a]	366.3[b]	3.06[b]
PA	673.0[ab]	0.23[a]	469.6[a]	3.88[a]
PH	747.0[a]	0.23[a]	484.3[a]	3.92[a]
PHR	592.2[b]	0.22[a]	469.6[a]	3.58[b]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 12. *Effect of ReducedTillage Methods on leaves nutrients of maize in Ejiba Ultisol*

Treatments	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
ZT	1.69[a]	0.41[a]	1.19[a]	1.37[a]	0.45[a]
MT	1.74[a]	0.43[a]	1.25[a]	1.34[a]	0.47[a]
PA	1.70[a]	0.42[a]	1.29[a]	1.38[a]	0.46[a]
PH	1.75[a]	0.43[a]	1.24[a]	1.33[a]	0.48[a]
PHR	1.74[a]	0.43[a]	1.25[a]	1.34[a]	0.47[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

Table 13: *Effect of Reduced Tillage Methods on leaves nutrients of maize in Kabba Gleysol*

Treatments	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
ZT	1.53[a]	0.47[a]	1.34[a]	1.43[a]	0.49[a]
MT	1.57[a]	0.53[a]	1.32[a]	1.38[a]	0.47[a]
PA	1.62[a]	0.46[a]	1.32[a]	1.42[a]	0.42[a]
PH	1.64[a]	0.44[a]	1.44[a]	1.34[a]	0.43[a]
PHR	1.63[a]	0.48[a]	1.35[a]	1.42[a]	0.40[a]

In a column, figures bearing same letter(s) do not differ significantly at 5% level of probability by DMRT. ZT(zero tillage), MT(manual tillage), PA(plough alone), PH(plough +harrow), PHR(plough +harrow+ ridge).

CONCLUSION AND RECOMMENDATIONS

Field experiments were conducted to investigate the effect of Tillage methods on soil properties, growth and yield of maize in ultisol and gleysol of Kogi State, Nigeria. The treatments consisted of five Tillage methods namely Zero Tillage, Manual Tillage, Plough Alone, Plough + Harrow, Plough+Harrow+Ridge. Mechanical tillage (Plough+ Harrow or Plough + Harrow+ Ridge) improves soil properties, growth and yield of maize better than manual tillage and control. It is therefore recommended that seed bed preparation for maize production should be done with mechanical tillage (Plough+ Harrow or Plough + Harrow+ Ridge).However, to reduce cost of seed bed preparation, Plough+ Harrow should be adopted in the study area.

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