# TILLAGE AND FERTILIZER EFFECT ON ROOT DISTRIBUTION, WATER UPTAKE AND YIELD OF MAIZE IN INLAND VALLEY SWAMPS IN SOUTHWESTERN NIGERIA

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## ABSTRACT

*Information on the hydraulic properties of a soil is important in understanding soil drainage, solute transport and water supply to plants, for improved agricultural production. Such information is, however, scarce for the wetlands in southwestern Nigeria. This study evaluated the effect of mound-tillage (MT), ridge-tillage (RT), and no-tillage (NT), with fertilizer  (F) and without  fertilizer (Fo)  on root growth, water extraction and yield of maize in three representative inland valley swamps, namely, very poorly drained (AY11L), poorly drained (AY13D), and imperfectly drained (AY22R) in the Ayepe area of Southwestern Nigeria.  Root growth of maize was significantly (P<0.05) increased by the application of fertilizer. The increases were greater in the 30 cm depth of the MT than RT and NT systems. Soil water storage ($\theta_v$), root water extraction ($r_z$) and total transpiration ($R_z$) varied greatly among the tillage and fertilizer combinations, but generally higher in the mound-till with fertilizer than the ridge-till and no-till with fertilizer treatments in the 1989/90 dry season trial and higher in RT with fertilizer than RT without fertilizer in 1990/91 dry season trial. Green maize yield increased greatly in MT (3.89t/ha) compared with RT (2.77 t/ha) and NT (3.13 t/ha) in AY13D (poorly drained). Yields in AY22R (imperfectly drained) averaged 3.88 t/ha in MT, 2.73 t/ha in RT and 2.72 t/ha in NT. The moun -tillage system may be a more suitable soil and water management practice than the ridge-tillage and no-tillage systems for increases in crop production in the wet inland valleys in southwestern Nigeria.*

**Keywords*:*** Wet inland valley swamps, productive soils, tillage systems, crop production.

## INTRODUCTION

Knowledge of the hydraulic properties of a soil is needed for any study of the status or movement of soil water and solutes, and in understanding water supply to plants in the field (Stone et al., 1973). The hydraulic properties required are the water content and conductivity characteristics, and relating soil water contents with matric potential and hydraulic conductivity, respectively. The water content in the root zone of a crop plant varies in both time and space, depending not only on soil factors but also on the ambient meteorological conditions and rooting characteristics of the crop, including density and depth of rooting. Generally, the amount of water available at any time for withdrawal by a plant increases with available soil water and with the volume of soil occupied by the roots.

Plant roots are not uniformly distributed in the soil; the shape and size of the root system differ greatly due to differences in the root environment (Taylor and Klepper, 1978). The root system is better developed in the upper layers of the soil than in the subsoil because of better aeration, nutrient supply and loose structure (Dugas *et al.,* 1990; Klepper, 1990). Consequently, drainage that lowers the matric potential of soil water and a tillage system that loosens the soil, improve aeration, increase the rooting depth and thus enable roots to proliferate and penetrate unexploited zones (Taylor and Klepper, 1978). The works by Osuji (1984), Longsdon *et al.,* (1987) and Rasmussen (1991) showed increased rooting with depth in tilled than in untilled soils, and that corn roots in the latter had larger diameter and were less efficient in water and nutrient uptake. Lal *et al.* (1989) reported that root-length density was significantly higher in the 0-20 cm layer of tilled than untilled treatment, due to

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soil loosening which enhanced root proliferation in the former. Cornish (1987) attributed greater root growth in the top soil layer to the need for nutrient rather than water uptake. He also attributed greater root growth in the top layer of untilled soil to higher bulk density and often greater soil strength at lower depths. Drew and Saker (1978) had attributed that pattern of growth to the concentration of nutrients, either from native fertility or applied fertility in the surface layers.

The pattern of water depletion in the root zone depth depends on the rooting characteristics of the crop (the rate of transpiration and size, distribution and activity of the root system), and soil water matric potentials and hydraulic conductivity. Root density patterns may not necessarily, however, relate to root activity patterns, such as root water extraction. Equally, water extraction patterns may not necessarily be greater in the soil region with greater root-length density. Ehlers et al. (1980) and Willatt and Olson (1982) found water uptake rate functionally related to rooting density and soil water potential, and that relative growth rate decreased with decreasing soil water potential. Rose and Stern (1967) reported that maximum rate of water withdrawal was between the soil surface and 25cm depth, and relatively low rate, below 30cm while Rickman *et al* (1978), Willatt and Taylor (1978), and Sharp and Davies (1985) reported high uptake where root density was lowest. Reicosky *et al.* (1972) reported that in the presence of a water-table, water uptake was not necessarily related to root distribution in the profile and, that a small amount of roots near the capillary fringe absorbed most of the water.

Inland valley swamps are widespread in southwestern Nigeria. They are under the influence of a seasonal or perennially high groundwater table (Ogban and Babalola, 2002, 2003) and are cultivated in the dry season when the watertable will not adversely interfere with root growth and water extraction. The soils are potentially productive because of adequate water supply and long growing season, low lying topography and low erosion hazard. But the soils are little studied and underutilized. There is the need to characterize the soils for increases in agricultural production. This study was conducted to evaluate the effect of tillage and fertilizer on root distribution and water uptake, and yield of maize (*Zea mays*) in inland valley swamps in southwestern Nigeria.

## MATERIALS AND METHODS
### Experimental Site
The study was conducted in three representative inland valley swamps (IVS) on the basis of watertable depth and soil taxonomic classification, namely, AYIIL (very poorly drained, Aquic Endoaquepts), AY13D (poorly drained, Typic Endoaquepts) and AY22R (imperfectly drained, Aeric Typic Endoaquepts) in the 1989/90 and 1990/91 dry season (December – March) in the Ayepe area of southwestern Nigeria. The area is located on latitude $7^o 20^1$ N and longitude $4^o 15^1$ E. Annual rainfall averaged 1400 mm and temperature ranged from $24^oC$ to $29^oC$. Solar radiation averaged 382 g $cm^{-2}$ $day^{-1}$ and total evaporation averaged 92 mm/month. The climate is divided into rainy (April-October) and dry (November-March) seasons. The soils are derived from the Basement Complex parent material and classified as Aquic Endoaquepts (AYIIL), Typic Endoaquepts (AY13D) and Aeric Typic Endoaquept (AY22R) (Ogban, 1999; Ogban and Babalola, 2009). Some physical and chemical properties of the soils are shown in Table 1.

### Field Methods
There were two soil management practices, namely, tillage and fertilizer. Tillage consisted of mound-tillage (MT), ridge-tillage (RT), and no-tillage (NT) methods. The mounds were 45 cm high, 60 cm diameter and 12 rows of 14 mounds each. The ridges were of the same 45 cm high and 60 cm width, and 12 number rows. Both mounds and ridges were constructed with the short-handle hoe. The fertilizer treatment consisted of fertilized (F) and unfertilized, control ($F_o$). Each plot was 10.0 m x 8.4 m and maize (TZESR-Y) seeds were sown at a spacing of 70 cm x 70 cm. The average distance between two adjacent rows of mounds/ridges and two mounds in a row was 70 cm. The experiment was a split plot in randomized complete block (RCB) with three replications, with tillage in main plot and fertilizer in sub-plot, in 1989/90 and 1990/91. The study was repeated in the 1990/91 planting season but with the ridge tillage system. Fertilizer application was based on soil test values of the nutrient elements, NPK (FMANR, 1990). The rates of application were 45 kgN/ha, 2 kgP/ha and 16 kgK/ha in AY11L, 45 kgN/ha, 9 kgP/ha and 39 kgK/ha in AY13D, and 83 kgN/ha, 18 kgP/ha and 31 kgK/ha in AY22R at planting and a further 30 kg urea/ha at tasseling. In both seasons, all treatments were mulched at the rate of 4.2 t/ha. The mulch consisted of plant residues collected at site. Weeds were controlled by slashing.

Soil samples were collected from each fertilizer treatment for laboratory physical and chemical analyses, using routine/conventional procedures (IITA, 1979; Page *et al*., 1982; Klute, 1986). Undisturbed core samples were collected at depth intervals 0-10, 10-20 and 20-30 cm with cylinders 7.2 cm long and 261.48 $cm^3$ internal volume, for the determination of bulk density. Soil water content was determined regularly with the neutron probe at a depth of 20 cm in aluminum access tubes installed between two vigorously growing maize plants in each tillage treatment in

1989/90 and in the ridge-tillage treatment in 1990/91. The hydraulic potential of soil water was measured with vacuum gauge tensiometers. The root zone of the soil profiles in this study are easily affected by water from the   water table or capillarity, so that sorption of soil water by the tensiometer is possible, and may give erroneous readings of hydraulic head.  This aspect of the study was to test the practicability of using the tensiometer in the soils. The tensiometers were installed so that the middle of the cups was at the 20 cm depth. The tensiometers were placed close to the access tube within the crop row in each fertilized and control plots of the mound, ridge and no-tillage systems in AY13D in 1989/90, and in the ridge-tillage system in AY11L, AY13D and AY22R in 1990/91.  Measurements were limited to the 20 cm depth because of shallow watertables. Data on hydraulic head potential were collected at tasseling during four consecutive   weeks in 1989/90, and six consecutive weeks in 1990/91. From the measurements of soil water content and hydraulic head potential, it was possible to calculate the potential gradients and soil water fluxes operating within the 20 cm soil layer and hence the unsaturated hydraulic conductivity values.  The data obtained were applied to the analysis of root extraction or water uptake in the vegetated field as follows:

At any given time, the amount of water content along the depth interval  between the soil surface and 20 cm was assumed to be identical to that measured with the neutron probe at 20 cm, since this measurement covers a sphere of radius about 15 cm. The amount of water stored in the 0 to 20 layer was obtained by integrating the water content (cm$^3$ of water per cm$^3$ of soil) over the soil layer (Bababola, 1981). The extraction of water by plant roots, the temporal change in water storage with time and the cumulative root extraction or total transpiration were determined according to Ogata *et al* (1960), Rose and Stern (1967), Van Bavel *et al*. (1968) and Scott (2000). The water-free pore space was obtained from the equation by Mbagwu (1983).

Duplicate root samples were collected at harvest from each fertilized and control plot of the tillage treatments, with core cylinders at depth increments of 7.2-cm to a 36-cm profile (Bohm, 1972).  Root extractions were carefully washed and preserved in 5% formaldehyde. Root length was measured with the grid intersection method (Tennant, 1975), and total root length was computed from the equation.

$$R = NL_f$$

Where:

$R$ = total length of roots in the sample, cm

$N$ = number of intersections between roots and grid lines

$L_f$ = length factor, which depends on grid spacing, for the 1cm grid spacing used, l cm = 0.786.

Root length was also expressed as root-length density (cm roots/cm$^3$ soil collected in the cylinder). Green maize was harvested at 79 days after planting (DAP) at about 70% water content in both seasons.

Data on bulk density, soil water content, water-free pore space, root length and green yield were subjected to the analysis of variance, using the Genstat V, Release 1.3 operating on IBM PC compact at the International Institute of Tropical Agriculture (IITA), Ibandan, Nigeria. The Least Significant Difference (LSD) was used in separating the means.

## RESULTS AND DISCUSSION

Effect of Tillage on Bulk Density, Water Content and Water-Free Pore Space: Bulk density differed (P<0.01) among the tillage methods, the highest  value of 1.15 g/cm$^3$ occurring in RT and the lowest value of 1.04 g/cm$^3$ in MT, in all three sites and two cropping (1989/90 and 1990/91) (Figure 1). Equally, the tilled plot had significantly (P<0.01) lower bulk
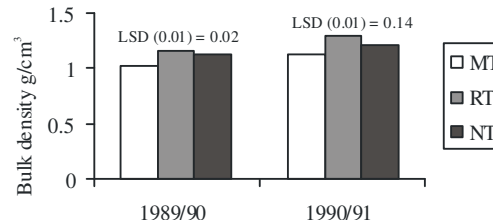


**Figure 1: Effect of mounds (MT), ridges (RT) and no-till (NT) on bulk density in three inland valleys in 1989/90 and 1990/91 dry season**

density, averaging 1.10 g/cm$^3$ than the 1.14  g/cm$^3$ recorded in the untilled, control plot. The lower bulk density value in the mounds indicated that tillage was probably more effective than the ridges. It was also probable that soil slumping or re-settling was faster in the wetter ridges than the drier mounds. The results showed that tillage is needed in the soils, but that mounding (MT) may create a more favourable soil tilth (lower bulk density and soil strength) than ridging (RT).  It could also be due to the finer texture of the surface soil. The low values of bulk density after two seasons of cropping, could be due to the fact that the soils are resilient, that is, they are inherently self-restorative (Kay, 1989; Lal, 1993), a quality often lacking in the adjacent well-drained upland soils when continuously, intensively cropped.  Soil wetness may also have contributed to the observed low values of soil density. This is because water

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molecules may have formed wedges and reduced the cohesive forces between soil particles, thus loosening the soil and lowering soil density.

**Table 1. Physical and chemical properties of the 30 cm top soil in the 1989/90\* and 1990/91\*\*Cropping seasons.**

| Parameters | AY11L | | AY13D | | AY22R | |
|---|---|---|---|---|---|---|
| Sand % | 45.5* | 38.2** | 42.4 | 42.5 | 66.2 | 71.1 |
| Silt % | 31.1 | 28.9 | 30.8 | 28.5 | 7.5 | 8.7 |
| Clay % | 23.5 | 33.0 | 35.7 | 29.0 | 26.3 | 20.3 |
| pH | 6.9 | 6.8 | 6.3 | 6.9 | 6.7 | 7.1 |
| Org C% | 1.1 | 2.03 | 2.78 | 2.14 | 0.37 | 2.01 |
| Total N% | 0.1 | 0.19 | 0.19 | 0.20 | 0.35 | 0.16 |
| Av. P mg/kg | 13.47 | 6.37 | 10.48 | 5.77 | 4.98 | 6.00 |
| Ca cmol/kg | 11.75 | 5.77 | 6.5 | 5.39 | 7.00 | 4.06 |
| Mg cmol/kg | 3.44 | 1.67 | 3.05 | 1.74 | 3.61 | 1.67 |
| Na cmol/kg | 0.50 | 0.80 | 0.52 | 0.70 | 0.64 | 0.71 |
| K cmol/kg | 0.18 | 0.29 | 0.15 | 0.22 | 0.16 | 0.26 |
| Ex. Ac. cmol/kg | 0.20 | 0.11 | 0.20 | 0.09 | 0.20 | 0.09 |
| ECEC cmol/kg | 45.15 | 8.59 | 10.42 | 7.99 | 11.6 | 6.73 |
| BS% | 98.6 | 98.6 | 98.1 | 98.9 | 97.8 | 98.5 |

**Table 2: Effect of mound-till (MT), ridge-till (RT) and no-till (NT) on (a) soil water content and (b) air-filled pore space in three inland valley bottoms in 1990/91 dry season**

| MT | RT | NT |
|---|---|---|
| 0.220 | 0.300 | 0.465 |
| (a) LSD (0.01) = 0.066cm³ /cm³ | | |
| 0.348 | 0.190 | 0.070 |
| (b) LSD (0.01) = 0.066cm³ /cm³ | | |

Seedbed preparation methods significantly (P<0.01) affected soil water retention in all three sites in 1990/91 (Table 2). The mean values were 0.378, 0.355 and 0.253 cm$^3$/cm$^3$, for AY11P, AY13D and AY22R, respectively. The effect was similar among the tillage methods in 1989/90. Soil water content (SWC) was highest in the control and lowest in MT, and also lower in tilled (averaging 0.260 cm$^3$/cm$^3$) than untilled (averaging 0.465 cm$^3$/cm$^3$) soil. The low SWC in the mounds was attributed to their discrete nature and greater evaporating surface, together with actively growing crop plants that aided the removal and thus decreasing the matric potential of soil water from the root zone of the wet soils, compared to the ridges and control (Hulugalle and Palada, 1990; Ogban and Babalola, 1999). The lower SWC in the tilled soil (averaging 0.260 cm$^3$/cm$^3$) supports the regulatory effect of tillage on soil drainage. However, the generally high values of SWC may have been due to the interacting effect of the shallow watertables, the fine textural range, and mulching and indicated that a favourable soil water balance may exist for dry season crop production in the wetland soils, and may explain the long growing season which occurs in the IVS.

Tillage also significantly (P<0.01) affected water-free pore space (WFPS) in 1990/91 (Table 2). The MT soil had an average air-space of 0.348 cm$^3$/cm$^3$, while RT had 0.190 cm$^3$/cm$^3$, and NT had 0.070 cm$^3$/cm$^3$ .Air-space in the tilled soil was 84% greater than untilled soil. The MT was 22% greater than RT, and 97% greater than NT. Equally, RT was 91% greater than NT. Air-space in the tillage systems, tilled and untilled soil, followed the pattern of differences in SWC, although in the reverse direction. In particular, the sustained higher air-space in the mounds reflected their drier nature or lower matric potential, and may be more suitable soil in water management when compared with the ridges, and the no-tillage system, on the wet soils of IVS. The similarity between RT and NT systems in air-space and soil water content pointed to the need for caution in accepting the reports of Lal (1990) and Ohiri and Ezuma (1990) that soil conditions are better improved in the RT than NT system on poorly drained soils. However, except in the NT system, air-space was generally higher than the 0.10 cm$^3$/cm$^3$ , often quoted in the literature as value for optimum root growth, and water and nutrient uptake functions in well-drained upland soils.

**Effect of Tillage and Fertilizer on Root Growth**

Tillage methods and fertilizer application significantly (P<0.05) increased the total root length of maize in the 30 cm soil depth in all three sites in 1989/90 (Figure 2). Fertilizer application
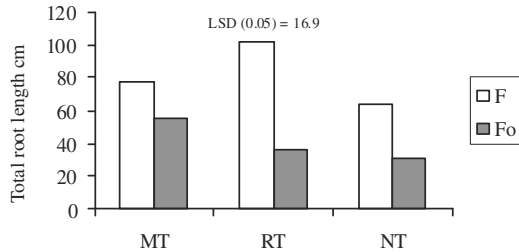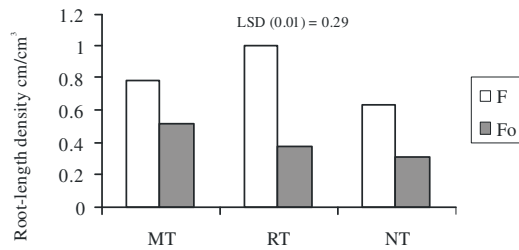
**Figure 2: Effect of mounds (MT), ridges (RT) and no-till (NT), and fertilizer (F) and no fertilizer (Fo) interaction on total root length of maize in three inland valleys in 1989/90 dry season**

significantly (P<0.05) increased root length in 1990/91 (Table 3). In both seasons, total root length was greater in MT than in RT and NT whether fertilizer was applied or not. The application of fertilizer however significantly (P<0.01) enhanced and increased root system development in the tilled than untilled soil.

## Table 3: Effect of fertilizer (F) and no fertilizer on total root length of maize in three inland valley bottoms in 1990/91 dry season

| F | Fo |
|---|---|
| 138.0 | 109.7 |
| LSD (0.05) = 25.7 cm | |

Root-length density pattern (Figure 3) was similar to total root length.



**Figure 3: Effect of mounds (MT), ridges (RT) and no-till (NT), and fertilizer (F) and no fertilizer (Fo) interaction on root length density of maize in three inland valleys in 1989/90 dry season**

Root growth in the 0-15 cm soil layer was similar in the tilled soil, but significantly greater than the control. Root system development in 15 – 30 cm soil depth was similar among the tilled and fertilizer methods. Total root length and root-length density decreased substantially below the 15 cm depth of both fertilized and control plots in 1989/90 and 1990/91.

Root growth was generally sparse and shallow. The observed pattern of root system development was attributed to the generally shallow ground-water tables (WT), averaging 70 cm in the sites. High WTs prevailed in 1989/90 and 1990/91. The high WTs may account for the observed sustained high values of SWC,

unsaturated hydraulic conductivity and soil water flux density, which may have compensated the sparse rooting system. Consequently, extensive rooting was not necessary, as would in soils with deep WTs, where drought-stress could stimulate the proliferation and penetration of roots to compensate the slow rate at which water moves through soil to the roots (Hillel, 1971); in other words, water uptake depended on water movement to roots. The spare rooting system indicated that either all or few roots below the 15 cm soil depth extracted all the water needed to sustain the growth of the crop.

## Effect of Tillage and Fertilizer on Hydraulic Properties and Root
### Water Extraction

The amount of water stored as a depth equivalent ($\theta_v$ cm/cm) in the 20 cm depth varied among the tillage and fertilizer treatment in AY13D in 1989/90 season (Figure 4). Root water extraction ($r_z$ day$^{-1}$) (Figure 5) and cumulative transpiration (R,cm/day) (Figure 6) also varied among the treatments. However, values of the
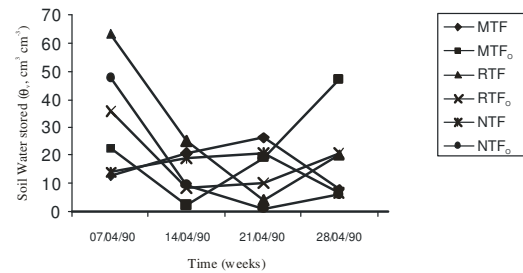


**Figure 4: Effect of mound-till (MT), ridge-till (RT) and no-till (NT) with and without (F0) fertilizer on Soil water stored (qv) in three inland valleys in the 1989/90 trial.**
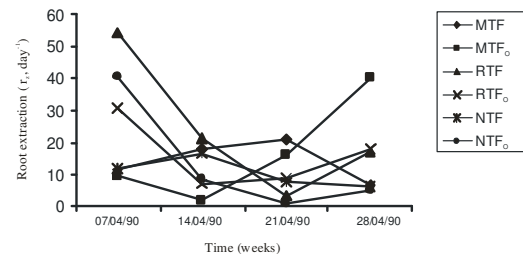


**Figure 5: Effect of mound-till (MT), ridge-till (RT) and no-till (NT) with and without (F0) fertilizer on root extraction (r2) in three inland valleys in the 1989/90 trial.**

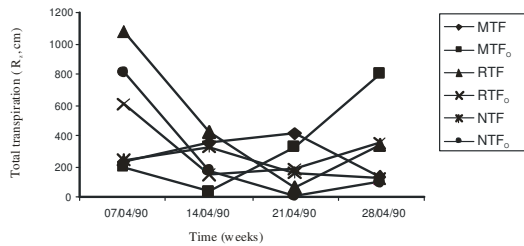Tillage and Fertilizer Effects on Yield of Maize in Inland Valley Swamp.

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**Figure 6: Effect of mound-till (MT), ridge-till (RT) and no-till (NT) with and without (F0) fertilizer on total transpiration (Rz) in three inland valleys in the 1989/90 trial.**

parameters were generally higher in the mound-till than the ridge-till and no-till system, and in the fertilized than control plot in the 1989/90 season. Generally too, values of the parameters were higher initially, decreased till the third week and increased in the fourth week. Data of the hydraulic property (Figure 7) and root water extraction (Figures 8 and 9) also show a general pattern of higher values in the fertilized than control plot of the ridge-till with fertilizer than without fertilizer in 1990/91 trial. The amount of water stored and total transpiration increased to the highest value in the fourth week and declined greatly in the sixth week. This is probably because, as the dry season
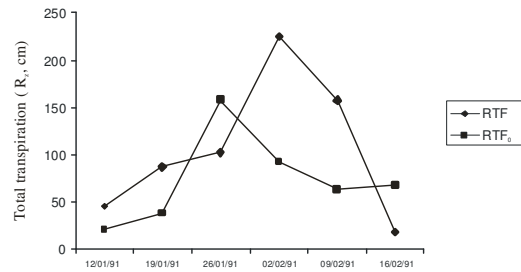


**Figure 7: Effect of ridge-till (RT) with and without (F0) fertilizer on Soil water stored (qv) in three inland valleys in the 1990/91 trial.**



**Figure 8: Effect of ridge-till (RT) with and without (F0) fertilizer on root extraction (rz) in three inland valleys in the 1990/91 trial.**



**Figure 9: Effect of ridge-till (RT) with and without (F0) fertilizer on total transpiration (Rz) in three inland valleys in the 1990/91 trial.**

progressed the groundwater table receded rapidly to lower depths, limiting capillary rise and water infiltration into the rooting depth and therefore the amount of water extracted and transpired (during the peak of the dry season). This is important in terms of farming systems in the wetlands. It indicates that dryland farming in the wetlands must commence as the watertable recedes below the soil surface and soil strength improved so that crop roots could follow the receding groundwater table.

Analysis of plant height and root-length density indicated that there was significant effect of tillage and fertilizer on these plant activities. It is probable that the more vigorous plant activity in the fertilized plot caused soil water deficit, that is, negative matric potential or reduced hydraulic gradient in the surface layer, eliciting increased dH/dz in the root zone, in response to evaporativity during the day. At night, when transpiration becomes negligible, the total soil water potential increased equalizing the water potential gradients which existed in the soil and plant during the previous day. The higher total soil water potential at lower depth caused water to flow towards the soil surface. Soil water storage increased until evaporativity resumed the following day. Changes in soil water storage may be small due to lack of vigorous plant activity.

The values of the parameters were generally high, indicating favourable soil characteristics that enhanced root activity in the soils. The variability in the values of the hydraulic properties and root absorption may indicate that no single factor among ground water supply, evaporativity and experimental treatments could be responsible for the observed differences. Equally, it may also point to the difficulty inherent in conducting this aspect of the study in soils with shallow water tables.
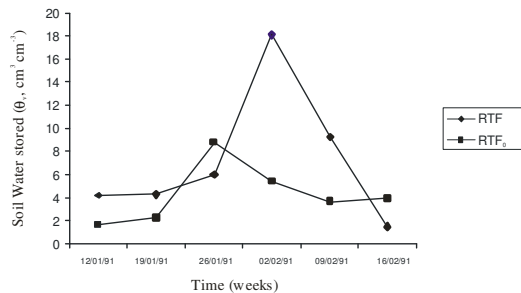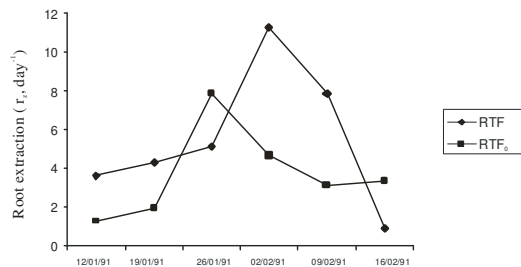
## Effect of Tillage and fertilizer on Green Maize Yield

Tillage methods significantly (P<0.01) affected green cob yield in AY13D and AY22R, while yields in AY11L were similar (Figure 10) in 1989/90. In AY13D and AY22R, the yield from

the MT plot was 1.12 t/ha or 40% and 0.76 t/ha or 24% greater than the yield from the RT and NT, respectively. Yields from RT and NT were similar, pointing to the fairly similar soil physical conditions in the two treatments. Fertilizer application had significant effect on the yield of maize (Table 4).
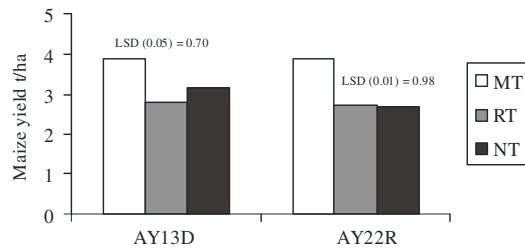


**Figure 10. Effect of mounds (MT), ridges (RT) and no-till (NT) on green yield of maize in AY13D and AY22R inland valleys in 1989/90 dry season.**

## Table 4:  Effect of fertilizer (F) and no fertilizer on green cob yield of maize in three inland valley bottoms in 1989/90 dry season

| F | Fo |
|---|---|
| 3.83 | 1.91 |
| LSD (0.01) = 0.53t/ha | |

In 1990/91, the effect of tillage and fertilizer application was significant ($P<0.01$) between MT and NT in AY22R (Figure 11). The yield from MT was 49% greater than NT. The yield increases from the tillage systems were largely due to fertilizer application, which were 60% more than the control.
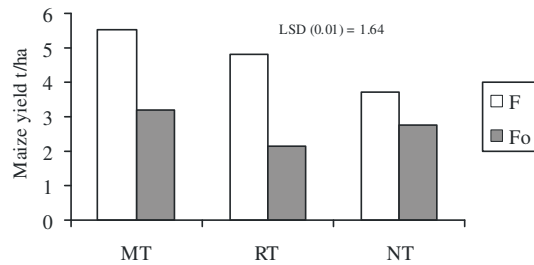


**Figure 11. Effect of mounds (MT), ridges (RT) and no-till (NT), and fertilizer (F) and no fertilizer (Fo) interaction on green yield of maize in AY22R inland valley  in 1990/91 dry season**

The significant yield difference between MT and RT systems was attributed to the improved soil physical conditions (lower bulk density, higher aeration porosity) in the mounds compared with the ridges. The high yields obtained in the NT plot was attributed to improved aeration or low gaseous diffusion resistance, and root activity in the untilled soil. The consistently high yields obtained in the MT plot, with and without fertilizer, compared with yields from the RT plot, indicated that the mounds were the best suited in the hydromorphic soils. This is contrary to reports by Tarawali and Mohamed-Saleem (1987) on the usefulness of the ridge planting systems on poorly drained soils. The significant effect of the applied fertilizer indicates the need for nutrient supplementation (Lal and Taylor, 1989) for increases in crop production on these poorly drained soils. These increases can easily be obtained with mound-tillage, and therefore may be a more suitable soil and water management technology than ridge-tillage in the inland valley swamps.

## CONCLUSION

Soils of the inland valleys in southwestern Nigeria on Basement Complex have excellent growing conditions, because of seasonal or perennially high groundwater table. The soils are cultivated by the low resource farmers, in the dry season when the watertable has receded below the root zone. This study demonstrated that the soils have high stored soil water or plant available water as well as root water uptake. Yields obtained were equally high, especially in fertilized mound-tillage than in ridge-tilled and no-tilled plots. The mound-tilled system with fertilizer may be a more suitable soil and water management practice for increase in crop production in the inland valley wetland soils.

## ACKNOWLEDGEMENTS

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