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TILLAGE EFFECTS ON SOIL PHYSICAL PROPERTIES AND SUNFLOWER (*Helianthus annuus*) GROWTH AND YIELD IN ILORIN, NIGERIA.

AJAYI A. S.
Dept of Crop Production
University of Ilorin
P. M. B. 1515, Ilorin, Nigeria.

ABSTRACT

Soil physical properties and sunflower (Helianthus annuus) yield under convectional tillage (CT) and zero-tillage (ZT) was monitored for 3 consecutive years in Ilorin, Southern Guinea Savannah zone of Nigeria (SGSZN). While bulk density of CT increased slightly over the years, significant decrease of 12 and 8% were observed in ZT at 0.1 and 0.2m depths respectively. Also, soil moisture release at 50 kPa increased from 7.5 to 14m3m-3 for ZT and 10 to 12.5m3m-3 for CT. Infiltration rate increased by 13% over the 3 years in ZT and decreased by 12% in CT. Sunflower plant height and stem diameter were unaffected by tillage (P = 0.05) significantly higher head diameter and seed yield were observed in CT for 1990 and 1991 (P = 0.05) while in 1992 no significant difference was observed in head diameter and seed yield among the tillage treatments (P = 0.05). It was concluded that sunflower growth under ZT may be beneficial to the fragile soils of the SGSZN.

Key words: *Tillage, Sunflower, yield, Soil moisture release, Infiltration rates.*

INTRODUCTION

The choice of an appropriate method of seedbed preparation depends on soil characteristics, cropping systems, climatic environments and socio - economic conditions (Lal 1979, Hayward *et al* 1980). While ZT techniques have been found beneficial to crop production in the humid tropics (Lal 1979), few studies exist in the Savannah zone of Nigeria that determine the suitability of ZT in crop production (Adeoye 1982; Oni and Adeoti 1986). None of these studies examine the choice of appropriate tillage method for sunflower production. This is largely due to the fact that sunflower cultivation as an oilseed crop is yet to be popular in Nigeria. Furthermore, existing reports on ZT are contradictory with respects to soil improvements and crop yield. For example, while some workers consistently show that ZT improve soil properties and crop yields (Ehlers 1979; Hamblin 1984). Other workers, particularly those in the semi-arid regions reported poor soil moisture relations and low crop yield in ZT (Masseri and Jana 1979; Hayward *et al* 1980). This study was specially aimed at determining soil physical properties and sunflower yield under ZT and CT in the SGSZN.

MATERIALS AND METHODS acetamide + 3(4-bromophenyl)-1-

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MATERIALS AND METHODS

The study was conducted at the University of Ilorin Teaching and Research Farm, Ilorin, Nigeria [80 29'N, 40 35'E; altitude 344m above sea level] in the SGSZN. The mean annual rainfall is about 1200mm and is unimodal with expected planting season from May - September. The soil slope is between 2 - 3% and the soil of the experimental site is skeletal clay, mixed Kaolinite Isohyperthermic Oxic Paleustalf (soil Taxonomy 1975) with a sandy loam top going down to sandy clay subsoil. (PH 6.1, total N, 1g kg-1 , organic C, 15g kg-1 exchangeable; K, 0.71, Ca, 3.4 Cmol kg-1 and soil available P, 11mg kg-1). The experiments were conducted from 1990 to 1992. Two tillage treatments were imposed:

Convectional Tillage: Disc ploughing to a depth of 0.2m followed by harrowing.

Zero Tillage: The existing vegetation in these plots was killed with paraquat (1-1 dimethyl -4, 4- biphyridylium ion)at the rate of 2.5 litres ha-1 one week before planting. The dead vegetation was estimated using a 1m x 1m quadrat and the values were 2.65, 3.2 and 3.65 Mgha-1 in 1990, 1991 and 1992 respectively. The plot size was 4m x 5m and the layout was randomized complete block with four replications. In all treatments, planting of sunflower (variety Isaanka was done manually by mid-July each year at inter-row spacing of 0.5m. (Gallex herbicide 2-chloro-N-(2-ethyl-6-Methyl-Phenyl-N-(2-methyl-1-Methyl) acetamide + 3(4-bromophenyl)-1-methoxy-1-methyl urea was sprayed as pre-emergence herbicide in all plots. Two weeks after emergence the plants were thinned to one plant per hill. Fertilizer was applied at the rate of 90kgNha-1 as urea, 60kgPha-1 as single superphosphate and 60kgha-1 as muriate of potash. Insecticide spraying was not done as the sunflower was minimally affected by insects. Soil bulk density was determined using 0.05m core diameter and 0.05m height. This was done before planting, 6 weeks after planting (WAP) and 12 WAP at 0.1m and 0.2m depths. Gravimetric soil water content from the core samples at the same depth. Core samples were also collected to determine soil water release characteristics. These were determined using tension table for high energy characteristics and lower energy characteristics determined by pressure plate apparatus (Klute 1986). Infiltration rates using double ring infiltrometer (Bertrand 1965) were measured each year at about 5 months after planting (Mid-December). The infiltration data were analyzed according to philip (1957) model. Philip's model is a truncated form of a series shown by equation 1.

$$I = St^{1/2} + At \quad \text{(Eq. 1)}$$

$$i = \frac{dI}{dt} = \frac{1}{2} St^{1/2} + A \quad \text{(Eq. 2)}$$

Where i is the infiltration rate, I represent the cumulative volume of water infiltrated in time t per unit area of the soil surface and i = instantaneous infiltration rate which is the volume flux density. S is the sorptivity and A is the transmissivity. The infiltration data from each plot was analyzed yearly to compute i. Yield parameters estimated include plant height at harvest, stem diameter at 8 WAP, head diameter at harvest and seed yield. Statistical methods of Gomez and Gomez 1976 was used for data analysis using SAS (1985). Software on a computer.

RESULTS AND DISCUSSION

The soils bulk density was high initially before tillage treatments imposition. The values averaged 1.55 Mgm-3 and after tillage treatments imposition the values were 1.39 and 1.51Mgm-3 for CT and ZT respectively. This possibly accounted for no significant difference in bulk density of the two treatments before planting and significant differences valid for 0.1 and 0.2m depth. With increasing years of planting, bulk density of the ZT decreased while that of CT increased resulting in significant differences in the treatments before planting. T x Y and D x Y interactions were significant because bulk density decreased by 12 and 8% at 0.1 and 0.2m depths at the end of 3years in zero tillage while bulk density increased by 3 and 5% in CT in 1992. Yearly, soil moisture content in CT and ZT were not significant before planting possibly due to the prolonged drought following harvest. However this trend changed at 6 and 12 WAP with most of the years CT > ZT in moisture content except in 1992 which was probably due to large amount of rainfall after planting, CT = ZT. Lower soil moisture content was usually observed with increasing depth but in the order observed above. These results contradict higher soil moisture content usually reported for CT in the humid tropics, (Lal 1979, Wilson *et al* 1982) but agreed with workers in the semi-arid regions who attributed lower soil moisture content in ZT to soil hardness (Hayward *et al* 1980). The relatively low amount of vegetation mulch available for ZT plots in these study may account for lower soil moisture content. In 1990, composite water release was better in CT than ZT (Fig 1). This is consistent with the observations of Ehlers 1975 and Hambln 1984. They attributed this initial higher water release to soil loosening by tillage implements. However, as continuous cultivation increased with CT, soil moisture release in ZT was significantly higher (P = 0.05). This may be attributed to macropores destruction by continuous cultivation. The lack of significant difference in soil moisture release at lower potentials (Fig 1) indicate a differential change in the proportion of water transmissions and retention pores. A comparison of the values indicate that soil water release by ZT at 50kPa increased from 7.5 to 14m3m-3 (LSD 0.05 = 1.8) an increase of 46% from 1990 to 1992. Conversely, water released by CT at 50kPa increased from 10 to 12.5m3m-3 (LSD 0.05 = 1.8), an increased of 20%. The differentials may be due to an increase in porosity, particularly in the transmission pores. ZT is known to increase soil porosity (Lal 1979, Hulugalle *et al* 1986). Initial infiltration rates of both tillage treatments were higher despite the observed initial high bulk densities of the two tillage treatments before treatment imposition (fig. 2). However, since the data were collected after planting, improved cultivation and root activity by the sunflower may have improved the soil infiltration rates. Again, initial infiltration rate was 20% higher in CT than ZT in 1990 while infiltration rate of the ZT treatments increased continually from 1991 to 1992. For example initial infiltration rates of ZT increased from 43cmh-1 to 49.4cmh-1 (13% increase) but that of CT increased from a high 50cmh-1 to 44cmh-1 (12% decrease) (Fig. 2). The drop in infiltration rates in CT may be due to soil compaction by the tillage implements resulting in capping of the soil surface. In addition, Ehlers 1975 showed that the cooler environment in ZT encouraged worms activities which create a continuous system of macropres that leads to rapid percolation of roots of the sunflower at the soil surface under ZT is shown in earlier studies by and Lal (1979) reported that ZT create micro-channels that allows rapid infiltration of water into soil resulting in high infiltration rates as ZT is practiced yearly. The plant height and stem diameter did not differ significantly in the tillage treatments (P = 0.05) Tables 3 a & b.

However the head diameter and seed yield (Tables 3 c & d) were significantly higher in CT in 1990 and 1991 (P = 0.05) but were not significantly different from each other in 1992. It is probably due to improve soil physical properties with increasing yearly practice of ZT that accounted for the comparative yield between ZT and CT.

CONCLUSION

Sunflower grown under CT and ZT in the SGSZN reduced soil degradation in both tillage methods. The reduction was more in ZT over the 3 years than CT. The early 2 years of ZT had lower seed yield than CT but seed yield between ZT and CT became insignificant in the third year (P = 0.05). The results show that sunflower can be grown under ZT leading to improved soil properties as ZT practice increased yearly in the SGSZN.

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Table 1. Analysis of variance for probability > F for bulk density at different times after planting.

Sources of Variation	df	Measurement Before Planting	Periods 6WAP	12WAP
Tillage (T)	1	0.9460	0.0001	0.0001
Depth (D)	1	0.6261	0.0134	0.0001
Year (Y)	2	0.0002	0.0119	0.1142
TXD	1	0.0001	0.0001	0.0001
TXY	2	0.0001	0.0001	0.0001
DXY	2	0.0593	0.4124	0.0524
Error	38			

Table 2 Analysis of variance for Soil Moisture Content at 3 different times after Planting.

Sources of Variation	df	Measurement before Planting	Periods 6WAP	12WAP
Tillage	1	0.1000	0.0001	0.0001
Depth	1	0.0032	0.0001	0.0001
Year	2	0.2256	0.0243	0.0001
TXD	1	0.2261	0.0001	0.0001
TXY	2	0.3920	0.0001	0.0001
DXY	2	0.1141	0.1124	0.0110
Error	38			

Table 3. The effects of tillage on some yield parameters of sunflower from 1990 to 1992.

	Year		
(a) Plant Height (m)	1990	1991	1992
Treatments			
CT	1.37	1.42	1.36
ZT	0.95	1.35	1.29
LSD (0.05)	0.24	0.31	0.28
(b) Stem diameter (m)			
CT	1.52	1.61	1.60
ZT	1.50	1.54	1.57
LSD (0.05)	0.11	0.14	0.12
(c) Head diameter			
CT	0.15	0.14	0.12
ZT	0.12	0.11	0.12
LSD (0.05)	0.009	0.004	0.006
(d) Seed yield			
CT	0.89	0.95	1.03
ZT	0.62	0.79	0.81
LSD (0.05)	0.17	0.15	0.14

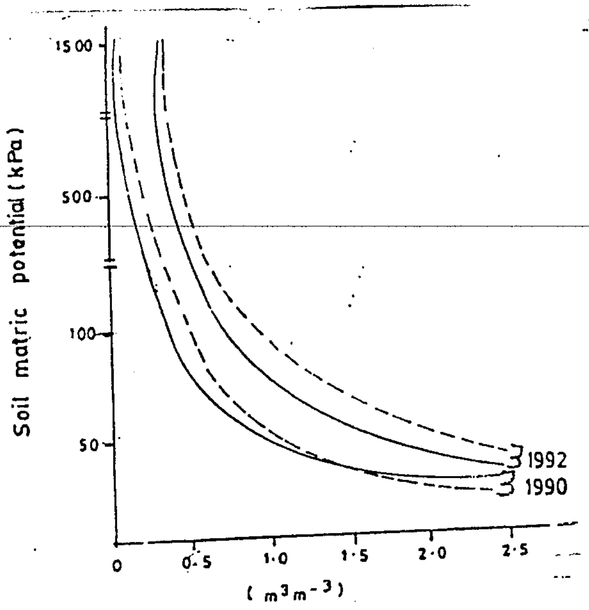

Fig. I Composite water release curves in 1990 and 1992

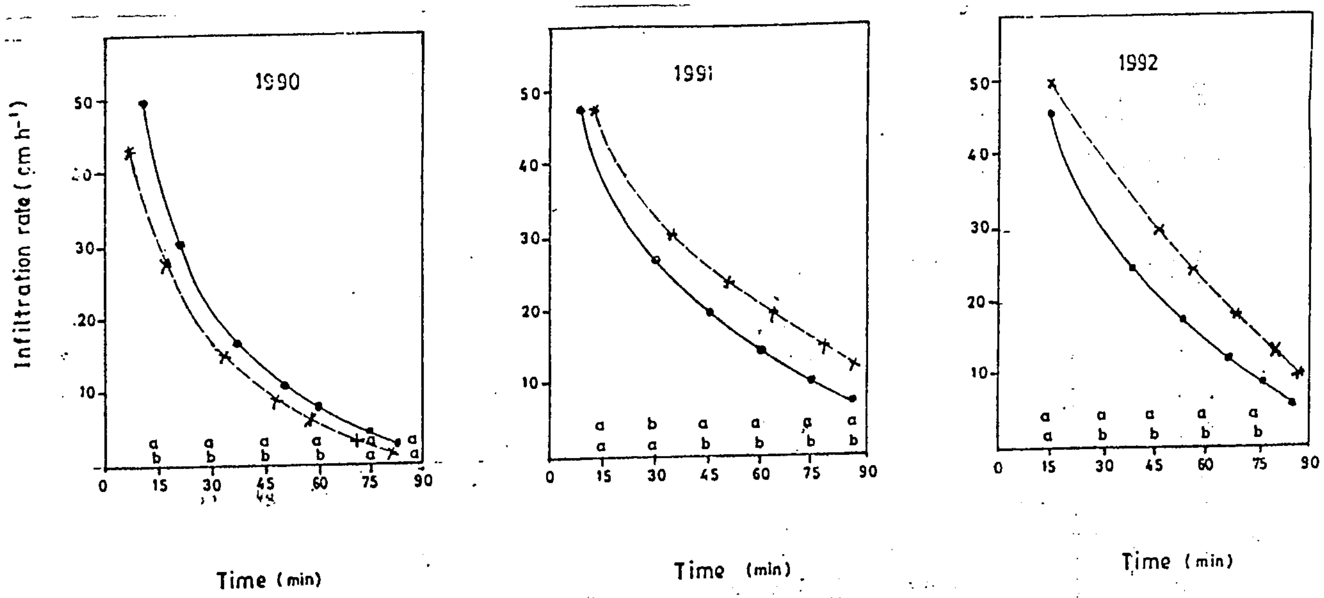

Fig. 2 Mean infiltration rates (cm h^{-1}) of zero tillage (x) and conventional tillage (•) plots planted to sunflower from 1990 - 1992 -
Mean of values followed by the same letter are not significantly different (P = 0 .05).