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Effect of Tillage on Soil Fertility and Sunflower Yield in Southwest Nigeria

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Abstract: The study investigated response of sunflower (*Helianthus annus* L.) to tillage methods and soil properties in the rainforest zone of southwest Nigeria. Soil and plant nutrient omposition and yield of sunflower determined for soils produced by Zero Tillage (ZT), disc Ploughing (PL), Ploughing plus harrowing (PLW), Ploughing plus Ridging (PLR), Ploughing plus two passes of Harrow (PLHH) and two Ploughings (2PL) were compared. Tilled soils had less moisture content but higher organic matter, N,P,K, Ca and Mg contents compared with ZT soil. Seed weight of sunflower was not significantly different among tillage treatments. Soil and plant nutrient contents increased in the order ZT, PL, PLH, PLR, PLHH and 2PL.

Key words: Sunflower, yield, tillage, soil, Nigeria

INTRODUCTION

Sunflower is world's most important edible oil seed. Sunflower was introduced into Nigeria in 1965 and studies are lacking on its soil and tillage requirements in different agro ecologies. In other parts of the world such as arid regions, farmers plant sunflower in different types of seedbed since there is no recommended tillage method (Esechie *et al*., 1996). Esechie *et al.* (1996) studied effect of ridge, furrow and flat planting on population density of sunflower in a desert climate at Oman. Seed and oil yield were not significantly higher in ridge planted sunflower than in furrow or flat. In turkey, Bayhan *et al.* (2002) observed that compaction of soil lowered sunflower yield. This work studied soil physical and chemical properties, nutrient status and yield of sunflower given by zero tillage and different intensities and type of mechanized tillage in humid rainforest zone of southwest Nigeria. The aim was to study the relationship between soil properties and performance of sunflower and recommend whether its cultivation requires tillage.

MATERIALS AND METHODS

Treatments and yield data: Tillage treatments were established at Akure (7° 15[1]N, 5° 15[1]E) in the rainforest zone of Southwest Nigeria. The sandy loam soil is classified as skeletal, Kaolinitic Oxic Paleustalf (Alfisol) or Ferric Luvisol (FAO). Treatments consisted of Zero Tillage (ZT), disc Ploughing (PL), ploughing plus Harrowing (PHL), Ploughing Plus Ridging (PLR), Ploughing plus two passes of Harrow (PLHH) and two passes of Ploughing (2PL).

Sites were manually cleared and treatments replicated three times in 2002 and 2003, a randomized complete block design was used in allocating treatments.

Sunflower seeds were planted at 4 seed per stand at 1.0×0.5m, each plot being 6×5m. Thinning to one plant per stand was done. Head diameter and seed weight were determined using 15 plants per plot at 15 weeks after planting.

Soil properties: At 6, 8 and 15 weeks after planting, gravimetric moisture content, bulk density (by core method) and 15.00 h soil temperature (using soil thermometer) were determined at 5-15cm depth. Three determinations were made per treatment plot and mean values were computed.

At harvest, soil samples were collected to 0. 15m depth. Organic Matter (OM) was determined by wet dichromate method, available P was extracted using Bray-1 method and determined by molybdenum blue colorimetry. Exchangeable K, Ca and Mg were extracted with ammonium acetate and determined using flame photometer and atomic absorption spectrophotometer respectively. Total N was determined by Kjeldahl method and pH determined in 1: 2 soil-$Cacl_2$ medium (IITA, 1979).

Leaf analysis: At 50% flowering, leaf samples were collected for analysis. Samples were dried at 80°C and

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ground. N was determined using Kjedahl approach. After extraction with nitric-perchloric acid (IITA, 1979), P was determined using vanadomolydate colorimetry, K by flame photometer and Ca and Mg by atomic absorption spectrophotometer.

Statistical analysis: Analysis of variance was done on data collected from replicates and mean data were separated using the Duncan multiple range test at 5% level of probability.

RESULTS AND DISCUSSION

Effect of tillage on soil physical properties: Table 1 shows response of soil physical properties to tillage. Day time surface soil temperature was not significantly ($p>0.05$) influenced by tillage methods compared with zero tillage, although zero tillage soil had lower temperature.

Because of its lower temperature, zero tillage soil had relatively high moisture content. This could also be related to its higher bulk density which should have reduced wind turbulence into soil. Soil that was ploughed and ridged tended to have lower mean soil bulk density and moisture status compared with other tilled soils that were ploughed once, twice and ploughed and harrowed once or twice.

Effect of tillage on soil chemical properties: Compared with zero tillage, ploughed and soils given higher number of passes of implement had higher pH, OM, N, P, K, Ca and Mg contents Table 2. Tillage enhanced nutrient availability in soil. Soil pH, OM, N, P, K and Ca tended to increase in the order ZT, PL, PLH, PLR, PLHH and 2PL. This finding can be related to that of Adekiya and Ojeniyi (2002) who found that zero tillage resulted in lowest values of soil OM and Ca compared with manual ridging and mounding. Increased soil OM and nutrient status due to tillage might be due to enhanced soil aeration and oxidation which should have increased breakdown of fresh organic matter and mineralisation of nutrients (Ojeniyi, 1993).

Effect of tillage on sunflower nutrient status: Nutrient availability to sunflower, as indicated by leaf nutrient status Table 3 followed the same trend as soil nutrient status. The leaf N, P, K, Ca and Mg status of sunflower tended to increase in order of ZT, PL, PLH, PLR, PLHH and 2PL. This indicates that nutrient content of soil influenced nutrient uptake by sunflower. Therefore tillage enhanced nutrient availability and uptake at least in the short-term. Adekiya and Ojeniyi[4] in southwest Nigeria also found that tomato grown on untilled soils had lower leaf N, P, K, Ca and Mg status compared with crops grown on mound or ridge.

Table 1: Effect of tillage on soil physical properties under sunflower

	Temperature°C		Moisture Kg^{-1}			
					Bulk density	Mgm^{-3}
Treatment	2002	2003	2002	2003	2002	2003
ZT	25.3^{a}	23.3^{a}	60.8^{b}	131.0^{d}	1.43^{a}	1.43^{a}
PL	25.8^{a}	26.3^{a}	48.5^{b}	84.5^{b}	1.21^{a}	1.38^{a}
PLH	25.5^{a}	25.3^{a}	45.3^{b}	91.6^{ab}	1.34a	1.16^{a}
PLR	27.5^{a}	24.0^{a}	30.4^{a}	90.3^{ab}	1.17^{a}	1.16a
PLHH	27.5^{a}	25.2^{a}	49.7^{a}	102.9^{bc}	1.32^{a}	1.18^{a}
2PL	27.0^{a}	26.5^{a}	62.8^{c}	110.4c	1.20^{a}	1.18^{a}

Values in a column with same superscript are not significantly different (DMRT)

Table 2: Effect of tillage on nutrient composition of soil under sunflower

Treatment	PH	OM %	N %	P Mg kg^{-1}	K	Ca $Cmolfg^{-1}$	Mg
			2002				
ZT	6.50^{a}	1.56^{a}	0.11^{a}	6.7^{a}	0.72^{a}	3.4^{a}	0.54^{a}
PL	6.76^{ab}	2.30^{ab}	0.17^{b}	18.8^{b}	0.95^{ab}	3.7^{a}	0.81^{a}
PLH	6.05^{ab}	2.75^{b}	0.23^{bc}	26.3^{bc}	1.22^{b}	3.9^{a}	0.96b^{c}
PLR	6.89^{b}	2.79^{b}	0.26^{c}	31.5^{a}	1.31^{b}c	4.4^{a}	1.06bc
PLHH	7.05^{b}	2.95^{b}	0.30^{c}	32.6^{c}	1.72^{c}	4.6^{a}	1.15^{c}
2PL	7.11^{b}	4.38^{d}	0.38^{d}	36.2^{c}	1.73^{c}	4.8^{a}	1.11^{c}
			2003				
ZT	6.57^{a}	1.063^{a}	0.12^{a}	3.7^{a}	1.64^{a}	4.3^{a}	1.23^{a}
PL	6.96^{b}	2.69^{ab}	0.17^{ab}	6.1^{a}	1.95^{ab}	4.8^{b}	1.65^{ab}
PLH	7.01^{b}	2.37^{bc}	0.21^{b}	7.2^{a}	2.55^{bc}	5.9^{e}	2.26^{b}
PLR	7.07^{b}	3.37^{bc}	0.30^{c}	13.9^{b}	2.80^{bc}	6.4^{c}	2.18^{b}
PLHH	7.15^{b}	3.32^{c}	0.30^{c}	14.4^{b}	3.03^{c}	6.0^{c}	2.02^{b}
2PL	7.27^{b}	3.91^{c}	0.32^{c}	18.2^{b}	3.34^{c}	7.2^{d}	2.29^{b}

Values in a column with same superscript are not significantly different (DMRT)

Table 3: Effect of tillage on leaf composition of sunflower (%)

Treatment	N	P	K	Ca	Mg
		2002			
ZT	1.74[a]	0.17[a]	1.64[a]	0.49[a]	0.11[a]
PL	4.47[b]	0.028[a]	2.60[b]	0.63[ac]	0.21[b]
PLH	2.53[b]	0.049[ab]	3.53[c]	0.72[c]	0.26[bc]
PLR	2.72[b]	0.046[ab]	.3.71[c]	0.74[c]	0.29[bc]
PLHH	2.65[b]	0.049[ab]	3.88[c]	0.98[d]	0.33[cd]
2PL	2.80[b]	0.064[b]	3.94[c]	0.115[d]	0.42[d]
		2003			
ZT	1.97[a]	0.009[a]	1.99[a]	0.090[a]	0.21[a]
PL	2.55[b]	0.014[ab]	3.04[b]	0.29[b]	0.31[b]
PLH	2.80[b]	0.021a	3.99[c]	1.52[bc]	0.36b[c]
PLR	2.86[b]	0.023[c]	3.18[c]	1.57[bc]	0.36b[c]
PLHH	2.86[b]	0.026[c]	4.37[c]	1.72[c]	0.39c[d]
2PL	2.79[b]	0.038[d]	4.50[c]	1.84[d]	0.43[d]

Values in a column with same superscript are not significant different (DMRT)

Table 4: Effect of tillage on yield of sunflower

	Head diameter(cm)			
				100 seed weight (g)
Treatment	2002	2003	2002	2003
ZT	11.0a	16.8d	5.8a	7.0a
PL	11.4a	14.3bc	5.9b	5.8a
PLH	12.1a	14.6bc	6.0c	6.6a
PLR	13.3a	15.8cd	6.0a	9.8a
PLHH	13.8a	13.8b	6.5a	6.2a
2PL	11.7a	12.2a	5.8a	6.3a

Values in a column with same superscript are not significantly different (DMRT)

Increased nutrient uptake by sunflower adduced to tillage can be related to enhanced availability of nutrient in soil and reduce soil bulk density which should have enhanced root growth. Ojeniyi (1993) also found that surface hoeing (minimum tillage) increased uptake of N, P and K by maize. Also Adekiya and Ojeniyi (2002) recorded negative correlations between soil bulk density and leaf P, K and Ca content of tomato.

Effect of tillage on sunflower yield: Data on yield components of sunflower such as head diameter and seed weight are shown in Table 4. Tillage treatment did not influence seed yield in both years of study and also the head diameter was not influence in 2001. However it was found that ZT had higher diameter in year 2002 and seed weight in 2002. Lack of significant seed weight differences can be attributed to lack of significant difference in soil physical properties such as bulk density and temperature. The slightly higher head diameter recorded for ZT in spite of the lower nutrient status of its soil and nutrient status of its crop can be related to its highest moisture status compared with tilled soils.

These findings indicate that sunflower performance was not limited by nutrient availability in the study area. Although mechanized tillage methods gave higher soil nutrient status and improved nutrient availability of sunflower compared with zero tillage, there was no significant difference in value of seed weight among tillage methods.

CONCLUSION

Sunflower can be grown using any tillage method including zero tillage on Alfisol of the rainforest ecology without significant loss in yield. However tillage improved nutrient availability to sunflower.

Availability of nutrient did not appear to limit sunflower yield.

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