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Evaluation of spring tine harrow for soil preparation in savannah ectone of Nigeria

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Abstract
Appropriate type of soil tillage operation is essential for a given soil condition prior to planting. Soil needs to t\be prepared by some form of tillage or chemical "burn-down" to kill the weeds in the seedbed that would crowd out the crop or compete with it for water and nutrients. The major environment concern related to soil preparation is erosion. Soil erosion is a natural process that occurs when the actions of water and /or wind cause topsoil to be removed and carried elsewhere. The effect of soil erosion becomes more pronounced within the savannah ectone zone in Nigeria. This transition zone is formed by the border of forest and savannah belt in Nigeria. Environment of the tillage operation using the spring tine harrow was carried out in a row crop farm. The effect of application of spring tine harrow for tillage operation in a maize farm was investigated on formation of a plowpan, increased susceptibility to compaction and erosion. Soil Conditioning (modification of soil structure to favor agronomic processes such as soil seed contact, root proliferation and water infiltration), weed/pest suppression (direct termination or disruption of weed/pest life cycles) and residue management to minimize negative effects of crop/cover crop residue and promote beneficial effects within the soil condition in savannah ectone of Nigeria. Water infiltration is generally increased immediately after tillage, but the result indicated that tillage tends to break down soil structure by reducing soil aggregation and pore openings. The tillage effect reduces the rate of water movement into the soil. The available soil nutrient and soil organic measurement during the maize tasselling stage indicated that tillage increases nutrient losses due to erosion and oxidation of soil organic matter. Soil organic matter is important as a source of nutrients, in regulation of nutrient availability, and in maintenance of soil physical and biological conditions for optimal crop growth. The result showed that maize grain yields were higher on no-till than on ploughed plots and no-till plots yielded 3 times the ploughed plots (3.9 $tha^{-1}a^{-1-}$ and 1.3 t $ha^{-1}a^{-1}$ respectively).

Key words: soil tillage, spring tine harrow, bulk density, cone index, shear strength

Introduction

Tillage is the working of the soil from its natural physical condition to an acceptance condition that write facilitate crop growth. The main objectives of tillage research in the savannah ectone of Nigeria and elsewhere are to develop appropriate tillage methods that will preserver and sustain soil productivity, maintain ecosystem stability optimize the biophysical environment and allocate soil related constraints to crop production (Lal, 1982).

The story and compacted top soil in the savannah ectone of Nigeria are such that implement like disc harrows makes less than the expected pulverization of the soil at a go during the soil

preparation operation with this challenge in view, appropriates spring loaded tines are expected to give the optimum pulverization and structural alignment of the top soil for agricultural production. This optimum tillage will be able to curtail soil degradation and decline in crop yields.

Materials and Methods

The six treatment evaluated are (i) No-till (NT), (ii) reduced tillage (RT), (iii) conventional tillage (PH), (iv) Rotational (T), (v) ploughed (H) and (vi) Ridges (R). the "No till" plots were not disturbed at all except that they were sprayed with insecticide. The "Reduce tillage" plots were ploughed once, while the "conventional tillage" plots were ploughed once and followed by harrowing with spring tine harrow. The "Rotational and Rigded" plot were initially both ridged with hand-hoes. However, while the "Rotational" plots were maintained in subsequent operation by hand weeding new mounds were made every season for "Mound" plots.

The Rigded" plot was ridged with hand-hoe. The plots were 8mx5m and the treatments were laid out in randomized complete block design with four replications. Fertilizer was applied at the rate of 350kg/ha by broadcasting and mixing with the soil. The seeds were planted at the rate of 17kg/ha by broadcasting after mixing with dry sand for even spread.

Crop variables measured included germination count, plant height at a week interval (for 10 randomly selected plants). Leaf area index and yield per plot.

Soil variables measured were soil bulk density, soil moisture, cone index, and shear strength each at 7 and 14cm depth. These were measured 7,14 21 and 28 days after showing.

The cone index and shear strength were measured using hand shear vane and farnell hand held soil penetrometer respectively. All data were subjected to analysis of variance to test the significance of treatment effects. Significance of mean difference for each variable was tested using the test significance difference (LSD).

Preliminary Results and Discussion

Soil moisture content was not significantly affected by tillage methods. The various effects on soil physical properties are shown in Table 1. the highest soil porosity of 37% at 70mm soil depth was recorded under the Reduced tillage method using the spring tine harrow.

Soil porosity was no longer affected by tillage methods after 30 days of planting at either of the two depths used. The bulk density of the soil was not affected by any of the tillage methods used until 30 days after planting when the head methods gave the lowest density of 1.56 gkm^3 with the Reduced tillage method (plough and spring tine harrow) recording the highest of 1.77 gkm^3 at 7cm depth.

At 14 cm depth, however, the lowest bulk density of 1.25gkm^3 was recorded under mound methods while the highest of 1.99gkm^3 was recorded under the disc plough tillage methods.

Cone index was generally affected by the tillage methods employed especially in the first week of the crop. The least cone index and shear strength at both the 7cm and 14cm depth was observed with the heap method.

The highest cone index value was observed at the "No till" plot also the highest shear strength at the two depths was recorded at the "No till" plot.

The height of the maize plantation was affected by the tillage methods from the early to the final stages of the crop. The crop height in the “No till” plot was comparatively lower with respect to other tillage methods used.

Tillage effect on crop performance parameters are shown in table2. very good germination was observed in “No till’ plots. The leaf area was not affected by the tillage methods used and 30 days after planting when the highest index of 8.0 was observed on the “No till” plots, followed the Reduced tillage method (plough and spring tine harrowing) with index of 6.30.

From the preliminary results and analysis, ”No till” and Reduced tillage” (plough and harrowing with spring tine) were observed to be optimum.

Conclusion

The data obtained so far are those obtained in 2011 further results and recommendations on the effect of the use of spring tine harrows for tillage and the resultant effect on soil physical properties and the crop performance would be presented later in subsequent field trials to commence later in the year.

The evaluation also shows that, apart from “No till” method which gave the highest crop yield, the most optimum result came from the “Reduced Tillage” method, which involves the use of **spring tine harrow** for the soil preparation.

Table 1: Effect of Tillage Methods on Soil Physical Properties

Method	Moisture (%)				Cone index (Mpa)				Porosity (%)				Shear Strength				Dr Density			
	7^{+}	30	7^{+}	30	7		30		7		30		7		30		7		30	
					7	14	7	14	7	14	7	14	7	14	7	14	7	14	7	14
NT	10.23	11.15	15.60	11.50	25.0	27 0	25.50	22.0	2.69	2.90	2.77	2.86	1.07	1.31	1.17	1.33	7.19	17.45	15.78	18.75
RT	8.35	11.25	16.70	12.52	28.10	17.25	28.45	19.65	2.84	3.40	2.80	2.96	1.97	1.77	1.42	1.52	20.42	30.35	21.77	20.97
H	5.70	11.30	12.35	12.32	37.12	26.12	37.2	22.60	2.61	2.72	2.45	2.31	1.12	1.11	1.09	1.02	5.43	8.47	2.10	15.62
T	8.66	10.12	13.72	11.19	27.10	2722	27.14	21.32	1.65	2.31	2.81	2.94	1.06	1.13	1.06	1.39	5.60	11.35	1.56	12.72
R	6.35	11.91	13.04	12.34	31.10	28.12	30.81	4.12	2.44	2.94	2.81	2.91	1.05	1.12	1.09	1.13	5.12	8.51	20.11	9.95
CT	7.91	11.12	14.13	11.12	32.62	23.14	29.82	20.94	2.66	2.94	2.81	2.92	1.12	1.23	1.11	1.25	1.64	15.10	13.22	16.26
MEAN	7.14	11.13	14.07	11.12	32.45	23.25	29.85	20.15	2.21	2.11	2.02	2.05	1.01	1.04	1.07	1.06	1.03	15.12	13.12	16.12
L.S.D 05	N.S	N.S	N.S	N.S	9.21*	N.S	N.S	N.S	N.S	N.S	1.12*	1.13*	N.S	N.S	N.S	N.S	1.04*	9.12*	N.S	8.07

Note:
+Day after
++Soil depth (cm)
*Significant difference
H-mounds
T-Rotational tillage
R-Ridge
N.S- Non Significant at P.o.oS
RT – Reduced (plough and spring harrowing)
CT – Conventional tillage
NT – No till

Table 2. Effects of Tillage Methods on Crop Performance

Tillage method	Germination count (mil/ha) 15	Leaf Area Index		Plant height (cm)				Fresh Yield (t/ha)
		15	30	15	23	30	35	
1.Mound	1.21	4.82	7.23	7.0	12.45	18.77	18.68	2.87
2.Reduced Tillage (Plough and spring tine harrowing)	1.12	5.21	7.42	13.43	11.75	20.12	26.15	4.23
3.Rotational	1.28	5.11	4.12	12.12	12.13	13.14	22.17	3.16
4.Ridges	1.23	4.70	5.20	11.43	10.68	15.54	24.82	3.59
5.Conventional tillage	1.19	3.60	4.24	4.20	5.30	7.07	14.51	1.16
6.No till	5.60	6.20	6.40	12.30	13.11	23.12	26.22	4.12
Mean	2.87	5.34	4.20	11.41	11.25	17.06	23.67	3.56
L.S.D 0.05	0.46	N.S		3.1	5.50	6.24	9.48	1.86

+ Days after planting *Significant difference at P0.05 mil million N.S Non-significant difference at P0.05