Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension
Volume 2, Number 2, June 2001 pp. 26 - 36

ISBN 1119-7455

CONSERVATION AND CONVENTIONAL TILLAGE EFFECTS ON SOIL PROPERTIES AND SOYBEAN PRODUCTION

A. P. Onwualu
Department of Agricultural Engineering
University of Nigeria, Nsukka, Nigeria
E-mail: ponwualu@yahoo.com

I. E. Ahaneku
Department of Land and Water Management Engineering
National Centre for Agricultural Mechanization, Ilorin
E-mail:ncam @ cyberspace.net.ng

ABSTRACT

Four conservation tillage practices and two conventional tillage practices were evaluated for two years to determine their effects on soil properties (moisture content, bulk density, porosity, shear strength, cone index), weed control, germination, growth and yield of soybean (Glycine max (L) Merril). The soil was sandy loam and classified as Typic Haplustalf of Eruwa and Odo Owa series. The conservation tillage practices were: no tillage (NT), chisel ploughing (CHP), use of a cultivator (CU) and disc ploughing once (DP). The conventional tillage practices were disc ploughing followed by harrowing (DPH) and disc ploughing followed by harrowing and ridging (DPHR). The treatments were laid out in a Randomized Complete Block Design with three replications. Results show that tillage practices significantly affected soil properties, weed control, germination, growth and yield of soybean. Soil strength and moisture content were significantly higher under the conservation tillage practices, whereas porosity was significantly lower. There was better crop establishment and growth under the conservation tillage practices due to the better moisture conservation under such systems. Weed control was more effective under conventional tillage practices. Over the two-year period and compared to NT, the percentage increase in yield with other tillage practices were 9.3% for CHP, 10.1% for CU, 13.7% for DP, 17.9% for DPH and 16.12% for DPHR. In overall performance, when the effect on soil properties and crop performance were considered together, the conservation tillage practices of DP, CHP and CU are recommended for the area, depending on equipment availability. The results are applicable to other regions with the same soil type.

Key words: Tillage, conservation tillage, soybean production, conventional tillage.

INTRODUCTION

In Nigeria and other countries of the humid tropics, many experiments have shown that comparable crop yield can be obtained with machinery intensive conventional tillage practices and conservation tillage, especially for cereals (Lal, 1979; 1983; Anazodo, *et al.*, 1983; 1991; Ojeniyi, 1986; Obi and Nnabude, 1988; Benites and Ofori, 1993; Babalola and Opara-Nadi, 1993; Oni, 1997; Eje *et al.*, 2001; Yiljep and Yusuf, 2000). The added advantage of the conservation tillage practices is Superiority in soil, water and energy conservation. This ensures sustainable use of soil resources in the long term (Lal, 1993). This advantage is very important, especially in a developing country such as Nigeria where the cost of restoration of a degraded soil is beyond the reach of most farmers (Onwualu and Ahaneku, 1996).

In Ilorin area of the southern Guinea Savannah zone of Nigeria, conventional tillage involves the use of a disc plough followed in a separate operation by a disc harrow and sometimes a ridger for areas prone to flooding. Conservation tillage practices involve reduction in the number of separate operations and the use of those tillage implements that do not invert the soil but leave organic matter on or near the soil surface. These include zero tillage, chisel ploughing, use of cultivator, disc ploughing in a once over operation supported by

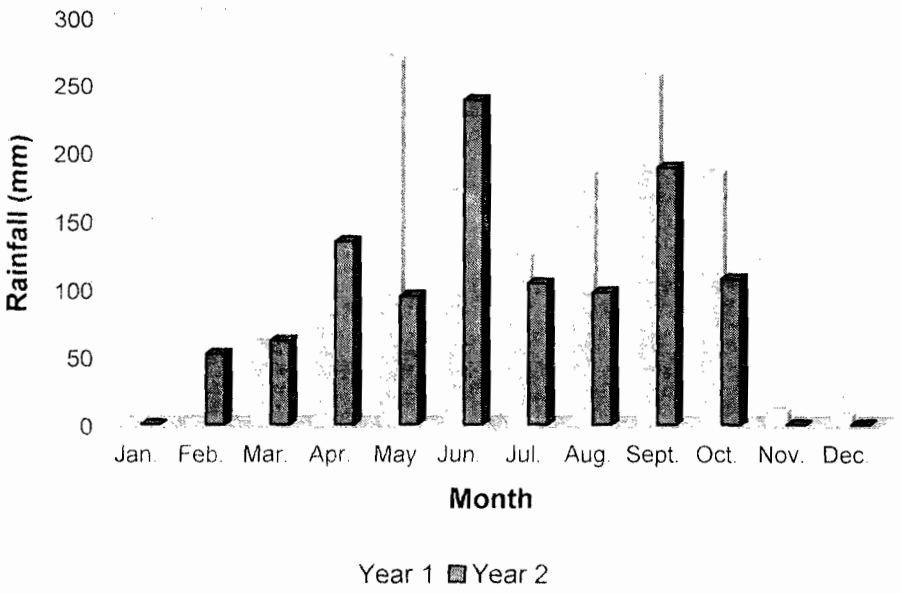

Fig. 1: Rainfall distribution of the experimental site during the two years.

herbicides for weed control. The effects of these tillage systems on soil properties and crop production have not been extensively evaluated, especially with respect to relating the temporal variability of the soil properties to crop growth parameters in this zone, (Lal, 1997; Olaoye, 2002). Evaluations for maize and cowpea production were reported by Jasanya *et al*. (1997) and Ahaneku *et al*. (1999).

Soybean is fast becoming an important crop in the zone following successful promotion and popularization of its utilization by the International Institute of Tropical Agriculture (IITA), Ibadan and other research centers (Mustsaers, 1991). Work on tillage for the crop has not been as widespread as for other cereals. In one of the published reports, Nangju (1979) found that comparable yields could be obtained with ridging, conventional, strip and zero tillage but that at times zero tillage gave yield higher than that of ridging. This and other studies noted the site and crop specific nature of tillage experiments (Lal, 1979; Anazodo *et al*., 1983; Oni, 1997). This underscores the need to evaluate the response of soybean to different tillage methods in the area under study.

The objective of this study was to evaluate the effect of different conservation and conventional tillage practices on soil physical properties, weed control, germination, growth and yield of soybean (Glycine max (L) Merrill) in Ilorin (sandy loam soil).

MATERIALS AND METHODS

Experimental Site

The experiment was conducted for two years (Year 1 and Year 2) at the production farm of the National Centre for Agricultural Mechanization (NCAM), Ilorin, Kwara State, Nigeria. The town is in the Middle Belt of Nigeria which is part of the southern Guinea Savannah zone. Ilorin is on longitude 4°30'E and Latitude 8°26. The weather is characteristic of a transition zone between the dry north and the wet humid south of the country. It receives on the average 1000 mm of rainfall annually between April and October with a dry spell in August. The monthly rainfall distribution pattern during the two years of the experiment is shown in Fig.1. The dry season occurs between November and March, with the drier harmattan in December/January. Daily temperatures can be as high as 37°C just before the rainy season and as low as 21°C during the harmattan.

The soil of the experimental site is classified as Typic Haplustalf of Eruwa and Odo-Owa (Kwara state) series, developed from the parent material consisting of micaceous schists and gneiss of basement complex origin which are rich in Ferro-magnesian minerals. The top 0-20cm soil was sandy loam (73% sand, 5% silt and 22% clay) of moderate acidity (pH=5.1). It contained low organic C (0.69%) and total N (0.03%) but high level of available P (26.1 kg^{-1}). The exchangeable cati-

ons included (in Cmol.kg^{-1} soil), Ca (5.26), Mg (3.20), K (0.35), Na (0.20), Mn (2.48).

Tillage Treatments

Six tillage treatments were evaluated as follows:

(1) Disc ploughing followed in a separate operation by disc harrowing (DPH);
(2) Disc ploughing followed in separate operations by harrowing and ridging (DPHR);
(3) Chisel ploughing alone (CHP)
(4) Use of a cultivator alone (CU)
(5) Disc ploughing alone (DP); and
(6) No- tillage (NT).

The first two treatments (DPH, DPHR) are the most common conventional tillage methods while the other four (CHP, CU, DP, NT) are the conservation tillage practices in use in the area. These treatments were randomly assigned to 80 m^2 experimental plots using randomized complete block design with three blocks or replications. The disc plough used for DP, DPH, and DPHR had three discs with an effective width of 0.9 m. The disc harrow consisted of two gangs of discs made of nine discs per gang with an effective width of 2.1 m. The cultivator had two gangs of spring loaded tines with ten tines in front and five behind. The arrangement of the gangs was such that the effective spacing between gangs was 0.24 m. The chisel plough had three gangs of tines with one tine in front, two in the middle and three at the rear. The rows of tines were arranged such that the effective spacing was 0.3 m. The ridger had four discs arranged such that two ridges were made in one pass of the equipment with effective width of 1.8 m. All tillage implements were pulled by a 45 kW tractor.

For all the conservation tillage plots, organic residues from previous years' cropping were left on the soil surface as mulch. A pre-emergence herbicide (Galex) was also used at four litres per hectare on such plots.

Crop Establishment and Observation

After the tillage operations and pre-emergence herbicide treatment, Sam-Soy II variety of soyabean was planted in the third week of July each year. The seeds were dressed with Apron Plus for protection before planting. Two seeds were planted per hole at a spacing of 60 x 20 cm. Germination of the crop was monitored by counting the number of crops that emerged five and nine days after planting (DAP). For this purpose, the two centre rows on each plot were used. The percent germination was obtained. Crop growth was monitored by measuring the height of the plants 26, 41, 51 and 69 days after planting (DAP). At maturity, the crop was harvested, threshed and the seeds were weighed. Weeding was done for all plots three weeks after planting. The weed removed from a square metre on each plot was air-dried and weighed.

Soil Properties Measurement

The soil properties monitored during the growth of the crop were moisture content, total porosity, dry density, shear strength and cone index. These were measured in the last week of each of the months of July, August and September of each year, and at 7, 14 and 21 cm soil depth zones. Standard procedures were used for these measurements. Moisture content was determined by the gravimetric method. Bulk density was obtained by the core technique. Total porosity (n) was obtain from the relationship between bulk density (() and particle density. (Gs) as follows:

$$n\% = \left[1 - \frac{\gamma}{Gs}\right] x100$$

Dry density (($_d$) was obtained from the relationship between bulk density and moisture content

$$\gamma_d = \frac{\gamma}{1 + mc}$$

Shear strength was obtained using the Pilcon hand vane tester with 33 mm vanes. Cone index was measured using Farnell hand held soil penetrometer fitted with a 30^0 cone. For each plot (80 m^2), two determinations were made for each soil property and the mean used for analysis.

Data Analysis

The means of the observations for soil properties and crop performance parameters were subjected to analysis of variance. Means were separated using Duncan's New Multiple Range Test (Obi, 1986)

RESULTS AND DISCUSSION

Effects of Tillage on Soil Porosity

Soil total porosity was significantly affected by tillage treatments as shown in Table 1. Generally speaking the plots under the conservation tillage treatments of NT, CHP, CU and conventional tillage treatments of DPH and DPHR gave porosity values not significantly differ-

Table 1: Effect of tillage method on mean** soil porosity (%) at different soil depths

Month	Tillage Method	Year 1 Soil depth (cm)			Year 2 Soil depth (cm)			Mean Soil depth (cm)		
		7	14	21	7	14	21	7	14	21
July	NT+	47a	36a	29a	50a	39ab	34ab	49	38	32
	CHP	48a	40a	28a	52ab	37a	33ab	50	39	31
	CU	47a	36a	28a	52ab	37a	32ab	50	37	30
	DP	58b	47b	33a	60c	45b	38b	59	46	36
	DPH	51a 51a	40a	31a	56bc	44b	38b	54	42	35
	DPHR	50.3	54b	36a	57bc	43b	36ab	54	49	36
	Mean		42.2	30.8	54 5	40.8	35.2	52.7	41.8	33.3
		45a								
Aug	NT	46ab	35a	30a	48a	39ab	30a	47	37	30
	CHP	46ab	39a	26a	51ab	35a	31a	49	37	29
	CU	53c	39a	27a	48a	36a	29a	48	38	28
	DP	50bc	45b	30a	53b	42b	32a	53	44	31
	DPH	50bc	40a	30a	50a	40b	35a	50	40	33
	DPHR	48.3	45b	29a	51ab	40b	34a	51	42	32
	Mean		40.3	28.6	50.3	38.7	31.8	49.7	39.7	30.5
		44a								
Sept	NT	45ab	36a	27a	45a	37a	28a	45	37	28
	CHP	46ab	36a	24a	49a	34a	29a	47	35	27
	CU	50b	34a	25a	48a	22a	30a	47	33	29
	DP	49b	45b	29ab	50b	39b	31a	50	42	30
	DPH	47ab	40b	33b	48a	40b	30a	49	40	37
	DPHR	46.8	41b	32b	47a	41b	29a	47	41	31
	Mean		38.7	28.7	47.8	37.2	29.5	47.5	38	29.5

* Sampling was done in the last week of each month.
\+ NT = No tillage. CHP = Chisel ploughing, CU = Cultivator, DP = Disc ploughing.
DPH = Disc ploughing + harrow, DPHR = Disc ploughing + harrowing + ridging.
** Values are means of 3 replications with 2 sub-samples per plot.
In each column and each month, means followed by the same letter are not significantly different at $P<0.05$ using Duncan's New Multiple Range Test.

ent from each other. Plots under disc ploughing alone (DP) gave porosity significantly higher than the other treatments.

Table 1 shows that porosity decreased with time after tillage. The soil porosity was highest in July, immediately after ploughing, decreasing in August, with the lowest values in September. The mean values, taken over all tillage treatments were 50.3%, 48.3% and 46.8% for July, August, September respectively for 7 cm soil depth in Year 1. Similar results are shown in Table 1 for the other depths for the two years. This is due to reconsolidation and settlement occasioned by raindrop impacts. Porosity also decreased with soil depth. This can be attributed to natural increase in packing density of the soil with depth, thus reducing pore space as depth increases.

Effects of Tillage on Soil Dry Density

Tillage significantly affected soil bulk density as shown in Table 2, although not in a consistent manner. The conservation tillage practices (NT, CHP, CU) generally exhibited higher soil density compared to the conventional tillage practices. Among the conservation tillage practices, there was no significant difference in density. The order of magnitude was not consistent from month to month. Among the conventional tillage practices, (DPH and DPHR), there was no significant difference between bulk density exhibited by DPH and DPHR.

For the three months monitored, soil density increased with depth (see the means calculated across treatments in Table 2). The differences in soil density between the tillage practices decreased with increase in depth. In fact, at the maximum depth monitored (21 cm), soil density tended to be about the same for all tillage practices. This is because the depth of ploughing was 20 cm, below which there should be no treatment effects.Thus the effect of tillage is more in the 0-15 cm layer.

Effect of Tillage Practices on Shear Strength

There was no significant difference between shear strength obtained from the conservation tillage Practices (NT, CHP, CU,) as shown in Table 3. Among the conventional tillage practices (DPH, DPHR), there was also no significant difference. The conservation tillage practices of NT, CHP, CU and DP gave significantly higher soil shear strength than the conventional tillage practices (DPH, DPHR). This condition can be attributed to the pulverizing action of the disc plough and the harrow used for the conventional tillage practices.

Table 3 also shows that shear strength increased with increase in depth, as can be seen from

Table 2: Effect of tillage method on mean** dry density (Mg/m3) at different soil depths

Month	Tillage Method	Year 1 Soil depth (cm)			Year 2 Soil depth (cm)			Mean Soil depth (cm)		
		7	14	21	7	14	21	7	14	21
July *	NT+	1.33b	1.59b	1.67ab	1.25c	1.51c	1.70a	1.29	1.55	1.69
	CHP	1.20ab	1.39a	1.80b	1.26c	1.40bc	1.65a	1.23	1.40	1.73
	CU	1.23ab	1.56b	1.76ab	1.18bc	1.39ab	1.65a	1.21	1.48	1.71
	DP	1.02a	1.30a	1.60a	1.07a	1.29a	1.49a	1.05	1.30	1.55
	DPH	1.11a	1.43ab	1.66ab	1.13ab	1.48b	1.58a	1.12	1.46	1.62
	DPHR	1.10a	1.30a	1.57a	1.14ab	1.38ab	1.52a	1.12	1.34	1.55
	Mean	1.17	1.43	1.68	1.78	1.41	1.60	1.17	1.42	1.64
Aug	NT	1.35b	1.54b	1.70a	1.30b	1.49b	1.68b	1.33	1.52	1.69
	CHP	1.28b	1.41a	1.68a	1.32b	1.40a	1.59a	1.30	1.41	1.64
	CU	1.26b	1.50b	1.69a	1.29b	1.50b	1.60ab	1.28	1.5	1.66
	DP	1.09a	1.42a	1.74a	1.10a	1.39a	1.58a	1.10	1.41	1.55
	DPH	1.22b	1.50b	1.65a	1.13a	1.30a	1.45a	1.18	1.40	1.66
	DPHR	1.20b	1.44a	1.70a	1.24b	1.50b	1.61ab	1.22	1.47	1.36
	Mean	1.23	1.47	1.69	1.23	1.43	1.59	1.24	1.45	
Sept	NT	1.37b	1.57b	1.73a	1.35b	1.56b	1.71b	1.36	1.57	1.72
	CHP	1.31b	1.58b	1.76a	1.40b	1.45a	1.68b	1.36	1.52	1.72
	CU	1.37b	1.56b	1.73a	1.36b	1.48a	1.66b	1.37	1.52	1.69
	DP	1.18a	1.48ab	1.69a	1.19a	1.35a	1.48a	1.19	1.42	1.62
	DPH	1.25a	1.34a	1.64a	1.25a	1.49a	1.60b	1.25	1.42	1.64
	DPHR	1.28a	1.46ab	1.69a	1.20a	1.50b	1.59ab	1.24	1.53	1.40
	Mean	1.29	1.49	1.71	1.29	1.47	1.62	1.30	1.50	

* Sampling was done in the last week of each month.
+ NT =No tillage, CHP = Chisel ploughing, CU = Cultivator, DP = Disc ploughing, DPH = Disc ploughing + harrow, DPHR = Disc ploughing + harrowing + ridging.
** Values are means of 3 replications with 2 sub-samples per plot.
In each column and each month, means followed by the same letter are not significantly different at P<0.05 using Duncan's New Multiple Range Test.

the means calculated across the treatments. This is attributed to the natural increase in density of the soil as depth increased. As was observed with bulk density, as the maximum depth of ploughing was approached (20 cm), the shear strength was about the same for all tillage practices even though significant differences were obtained at 7 and 14 cm depths. The implication of these results is that for shallow rooted crops, there may really be no difference between the tillage practices in terms of resistance to root growth and proliferation.

Tillage Effects on Cone Index

Table 4 shows that cone index was significantly affected by tillage practices. As was the case with shear strength and soil bulk density, the conservation tillage practices (NT, CHP, CU, DP) gave higher cone index than the conventional tillage practices (DPH, DPHR). Within each group, there was no significant treatment difference. Cone index also increased with depth, which was expected, since soil packing increases with depth.

Effects of Tillage on Soil Moisture Content

Soil moisture content was significantly (P 0.05) affected by tillage treatment as shown in Table 5. In general, the conservation tillage practices of no tillage (NT), chisel ploughing (CHP), cultivator (CU) and disc ploughing (DP) exhibited soil moisture content significantly higher than those of the conventional tillage practices of disc ploughing followed by harrowing (DPH) and disc ploughing followed by harrowing and ridging (DPHR). The higher moisture retention in plots under the conservation tillage practices is attributed to the reduced soil manipulation, and organic matter left on or near the soil surface. On the other hand, the conventional tillage practices involved more soil pulverization and destruction of organic matter, leaving soil exposed. All these combine to give more evaporation, infiltration and hence less moisture retention.

Within the conservation tillage practices, there was no significant treatment effect. Similarly, between the two conventional tillage practices (DPH and DPHR), there was no significant treatment effect. The result shows that for this area, the conservation tillage practices are superior to conventional tillage practices in soil moisture conservation. This agrees with results obtained elsewhere in Nigeria (Lal, 1979; Ojeniyi, 1986; Anazodo, *et al.*, 1991).

Tillage Effects on Weed Control

As shown by the results in Fig.2, more weed growth was

Table 3: Effect of tillage method on mean** soil strength (kPa) at different depths.

Month	Tillage Method	Year 1			Year 2			Mean		
		Soil depth (cm)			Soil depth (cm)			Soil depth (cm)		
		7	14	21	7	14	21	7	14	21
July*	NT+	17.3c	22.3b	22.9b	15.4b	16.5b	17.6a	16.3	19.4	20.3
	CHP	12.2b	19.b	16.9ab	11.7b	14.2b	14.5a	11.9	17.0	15.7
	CU	12.5b	20.6b	21.2b	10.5b	13.1b	15.1a	11.5	16.9	18.2
	DP	8.8b	6.9a	10.5a	6.6a	7.5a	12.5a	7.7	7.2	11.5
	DPH	3.3a	5.2a	15.9ab	4.5a	6.5a	11.9a	3.9	5.9	13.9
	DPHR	4.1a	4.2a	14.6a	3.8a	8.2a	12.8a	4.0	6.4	13.7
	Mean	9.7	10.2	17.0	8.8	11.0	14.1	9.2	12.1	15.6
Aug	NT	14.6b	16.7b	23.0c	16.6b	16.9c	17.5b	15.6	16.8	20.3
	CHP	11.8b	19.9b	17.0b	12.8b	13.1c	14.9ab	12.3	16.5	16.0
	CU	11.6b	18.6b	18.3bc	11.6b	12.8bc	13.5ab	11.6	15.7	15.9
	DP	7.9a	8.4a	12.7a	7.8a	9.6ab	12.9ab	7.9	9.0	12.8
	DPH	5.8a	7.9a	13.6a	6.5a	7.9a	10.5a	6.2	7.9	12.1
	DPHR	6.6a	5.8a	10.8a	6.8a	8.6a	12.6ab	6.7	7.2	11.7
	Mean	14.1	12.9	16.0	10.4	11.5	13.7	10.1	12.2	14.8
Sept	NT	12.0bc	20.8c	23.6a	14.2c	15.3b	16.6b	13.1	18.1	20.1
	CHP	12.4bc	20.8c	21.7a	12.1b	12.8b	14.3ab	12.3	16.8	18.0
	CU	14.3c	15.9ab	21.9a	13.8c	14.6b	15.6b	14.1	15.3	18.8
	DP	11.0ab	16.3b	23.0a	8.5ab	9.3a	11.3a	9.8	12.8	17.2
	DPH	12.2bc	15.7ab	21.5a	7.2a	8.6a	10.3a	9.7	12.2	15.9
	DPHR	8.7a	11.1a	16.9a	7.1a	8.3a	12.5ab	12.8	9.7	14.7
	Mean	11.8	16.8	21.4	10.5	11.5	13.4	12.0	14.2	17.5

* Sampling was done in the last week of each month.
NT =No tillage, CHP = Chisel ploughing, CU = Cultivator. DP = Disc ploughing.
DPH = Disc ploughing + harrow, DPHR = Disc ploughing + harrowing + ridging.
** Values are means of 3 replications with 2 sub-samples per plot.
In each column and each month, means followed by the same letter are not significantly different at P<0.05 using Duncan's New Multiple Range Test.

Table 4: Effect of tillage method on mean** cone index (MPa) at different depths

Month	Tillage Method	Year 1			Year 2			Mean		
		Soil depth (cm)			Soil depth (cm)			Soil depth (cm)		
		7	14	21	7	14	21	7	14	21
July*	NT+	0.25c	0.41ab	1.03b	0.27b	0.91b	1.29c	0.26	0.66	1.16
	CHP	0.21bc	0.50b	0.99a	0.22b	1.01b	1.25b	0.22	0.76	1.12
	CU	0.14ab	0.81c	1.50b	0.23b	0.95b	1.30b	0.19	0.88	1.40
	DP	0.11ab	0.36a	0.65a	0.20b	0.84b	1.09b	0.16	0.60	0.87
	DPH	0.08a	0.26a	0.62a	0.21b	0.73ab	0.20b	0.15	0.50	0.91
	DPHR	0.05a	0.43ab	0.84	0.10a	0.55a	0.78a	0.08	0.49	0.81
	Mean	0.14	0.46	0.94	0.21	0.83	0.99	0.18	0.65	1.05
Aug	NT	0.20b	0.31c	0.56b	0.31b	0.52a	1.09a	0.26	0.42	0.83
	CHP	0.18b	0.26bc	0.39ab	0.28b	0.82b	1.21ab	0.23	0.54	0.80
	CU	0.19b	0.29c	0.42ab	0.25b	0.91b	1.28b	0.22	0.60	0.85
	DP	0.09a	0.12a	0.25a	0.18b	0.72b	1.11ab	0.14	0.42	0.68
	DPH	0.03a	0.17ab	0.41ab	0.17ab	0.69ab	1.02a	0.10	0.43	0.72
	DPHR	0.04a	0.11a	0.38ab	0.12a	0.75b	0.98a	0.08	0.43	0.68
	Mean	0.12	0.21	0.40	0.22	0.74	1.12	0.17	0.47	0.76
Sept	NT	0.30b	0.50b	0.75b	0.24b	0.48b	0.87b	0.27	0.49	0.81
	CHP	0.23a	0.46b	0.76b	0.20b	0.92c	0.76b	0.22	0.69	0.76
	CU	0.31b	0.52b	1.10c	0.23b	0.49b	0.69b	0.07	0.51	0.85
	DP	0.17a	0.22a	0.47a	0.11a	0.31ab	0.51a	0.14	0.27	0.49
	DPH	0.21a	0.52b	0.69b	0.09a	0.29a	0.48a	0.15	0.41	0.59
	DPHR	0.21a	0.52b	0.69b	0.09a	0.29a	0.48a	0.15	0.41	0.59
	Mean	0.23	0.46	0.74	0.16	0.46	0.63	0.16	0.46	0.68

* Sampling was done in the last week of each month.
+ NT =No tillage, CHP = Chisel ploughing, CU = Cultivator, DP = Disc ploughing.
DPH = Disc ploughing + harrow, DPHR = Disc ploughing + harrowing + ridging.
** Values are means of 3 replications with 2 sub-samples per plot.
In each column and each month, means followed by the same letter are not significantly different at P<0.05 using Duncan's New Multiple Range Test.

Table 5: Effect of tillage method on mean** soil water content (% w/w) at different soil depths.

Month	Tillage Method	Year 1			Year 2			Mean		
		Soil depth (cm)			Soil depth (cm)			Soil depth (cm)		
		7	14	21	7	14	21	7	14	21
July*	NT+	6.8b	9.3b	9.0a	10.3b	11.4b	12.8b	8.6	10.4	10. 9
	CHP	6.5b	7.1ab	8.8a	9.7ab	9.9ab	10.5ab	8.1	8.5	9.7
	CU	7.6b	8.6b	8.5a	10.1b	9.5ab	11.2ab	8.9	9.1	9.9
	DP	6.2b	5.7a	7.5a	9.1ab	9.8ab	10.2ab	7.7	7.8	8.9
	DPH	5.8b	5.1a	8.3a	8.5a	8.9a	9.4a	7.0	7.0	8.9
	DPHR	4.5a	5.4a	7.3a	8.1a	8.6a	9.2a	6.3	7.0	8.3
	Mean	6.23	6.87	8.23	9.30	9.68	10.60	7.77	8.30	9.43
Aug	NT	5.6b	6.2b	7.4b	8.6b	8.9b	9.2a	7.1	7.6	8.3
	CHP	5.3b	6.8b	7.0b	8.1ab	8.4ab	8.9a	6.7	7.6	8.0
	CU	5.0ab	5.9b	6.1ab	7.9ab	8.0ab	8.4a	6.5	7.0	7.3
	DP	4.7a	5.2b	5.8a	6.6a	7.1a	7.5a	5.7	6.2	6.7
	DPH	3.9a	3.8a	4.2a	6.2a	7.8a	7.9a	5.1	5.8	6.1
	DPHR	3.8a	3.9a	4.7a	6.1a	6.6a	7.0a	5.0	5.3	5.9
	Mean	4.72	5.30	5.87	7.25	7.80	8.15	6.02	6.58	7.05
Sept	NT	8.7b	11.2b	10.1c	12.2b	12.6b	12.9a	10.5	11.9	11.5
	CHP	8.9b	9.3ab	9.9bc	11.8b	12.4a	12.4a	10.4	10.7	11.2
	CU	9.0b	9.6ab	9.1bc	11.7ab	12.9a	12.9a	10.4	11.0	11.0
	DP	9.0b	7.9a	9.5bc	11.0ab	12.0a	12.0a	10.0	9.5	10.8
	DPH	7.9ab	8.6ab	8.6ab	10.1a	10.7a	10.7a	9.0	10.1	9.7
	DPHR	6.2a	7.9a	7.2a	9.8a	11.0a	11.0a	8.0	9.1	9.1
	Mean	49.7	9.08	9.07	11.1	11.93	11.98	9.72	10.38	10.55

* Sampling was done in the last week of each month.

+ NT =No tillage, CHP = Chisel ploughing, CU = Cultivator, DP = Disc ploughing.
DPH = Disc ploughing + harrow, DPHR = Disc ploughing + harrowing + ridging.

** Values are means of 3 replications with 2 sub-samples per plot.

In each column and each month, means followed by the same letter are not significantly different at $P<0.05$ using Duncan's New Multiple Range Test.

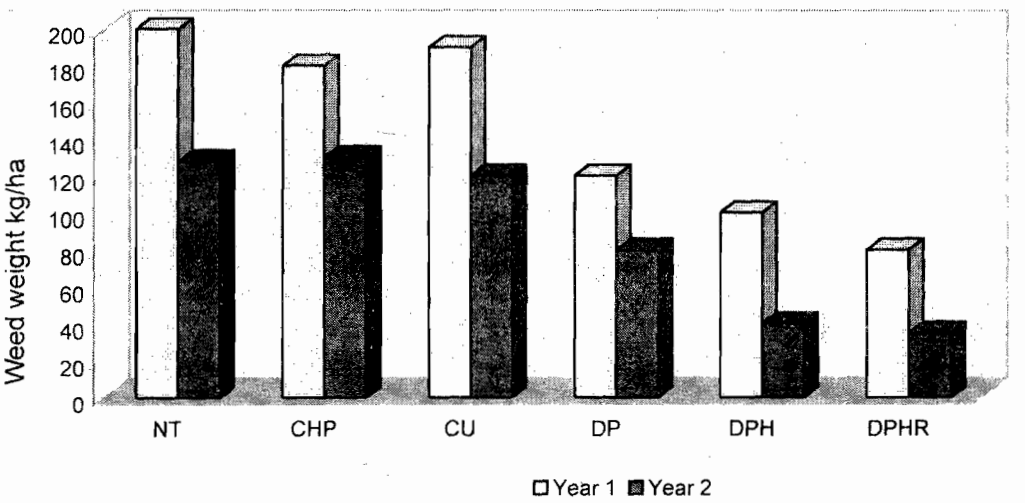

Fig. 2: Effect of tillage method on weed control, NT = No tillage, CHP = Chisel plough, CU = Cultivator, DP = Disc plough, DPH + Disc plough + harrow, DPHR = Disc plough + harrow + ridger

served with the conservation tillage practices, four eks after planting (WAP).The highest weed growth s obtained with NT, followed by CU, CHP, DP, DPH d the least was obtained with DPHR. Thus, it is clear it as mechanical cultivation decreased, the need for more frequent weeding increased. The conventional tillage practices performed better in weed control because of the soil inversion and pulverization which exposed the weeds and their root/seeds. By the time the disc was used, followed by the harrow and then the ridger, the

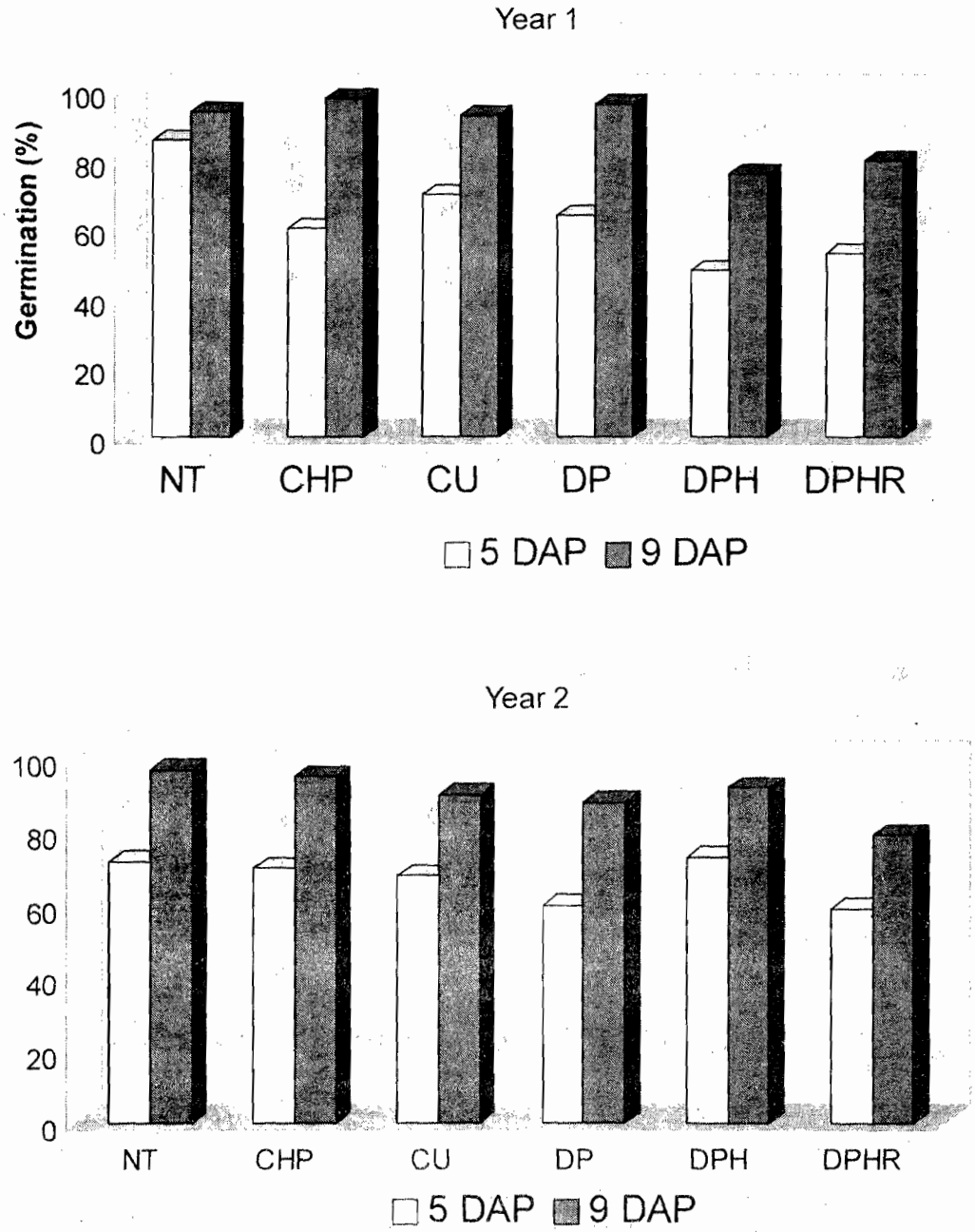

Fig. 3: Effect of tillage method on germination (%) of soybean. NT = No tillage, CHP = Chisel plough, CU = Cultivator, DP = Disc plough, DPH = Disc plough + harrow, DPHR = Disc plough + harrow + ridger, DAP = Day after planting.

weeds were completely destroyed, making it less likely for more weeds to germinate, thus the less weeds obtained after 4 weeks. In the case of conservation tillage, the weeds were initially completely killed by the herbicide but after a few weeks they were up again. The relative poor performance of conservation tillage practices in weed control has been reported by other researchers (Hayes, 1982; Young, 1983). This is why in most cases; the herbicide application is combined with mechanical cultivation after a few weeks. This also underscores the need for more research into more efficient means of controlling weeds in conservation tillage systems without excessive use of herbicides which may cause environmental problems.

Tillage Effects on Soybean Growth and Yield

Soybean germination was affected significantly by till-

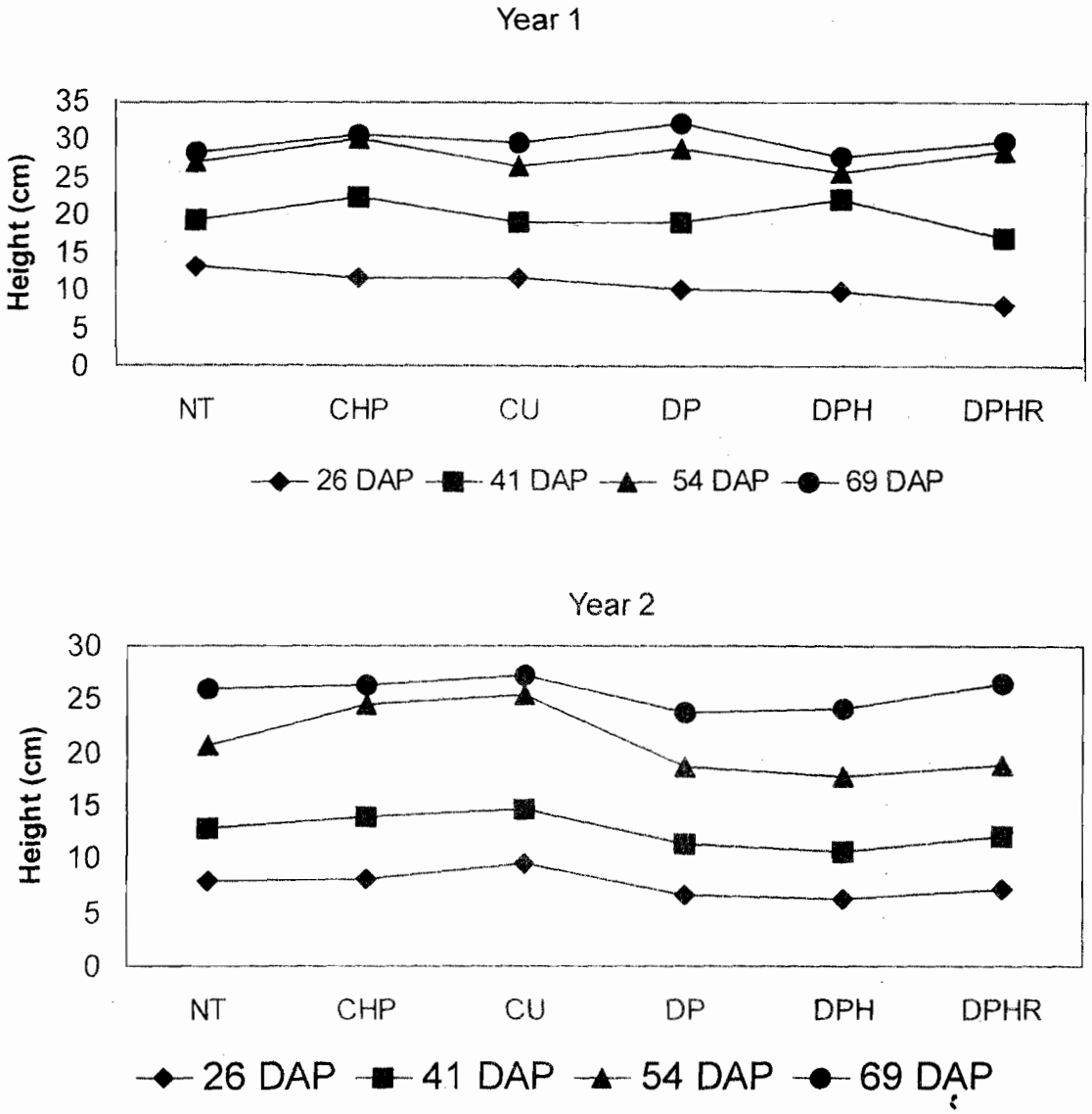

Fig. 4: Effect of tillage on height (cm) of soybean. NT = No tillage, CHP = Chisel plough, CU = Cultivator, DP = Disc plough, DPH = Disc plough + harrow, DPHR = Disc plough + harrow + ridger, DAP = Days after planting.

age method as shown in Fig.3. Better crop establishment was obtained with conservation tillage practices than conventional tillage. The general order of variation was CHP > NT > DP > CU > DPH > DPHR. The better performance of conservation tillage practices is attributed to the better moisture conservation (Table 5) observed with conservation tillage.

In general, soybean height monitored at various growth periods (26, 41, 54, 69 days after planting, DAP) were higher with conservation tillage practices than conventional tillage as shown in Fig.4. This better performance can be attributed to the better germination obtained with the conservation tillage practices. It can also be linked to the higher moisture associated with conservation tillage practices, and to the beneficial effects of mulching.

The effects of tillage methods on yield of soybean are shown in Fig 5. The highest yield of soybean was obtained with disc + harrow + ridge (DPHR) in Year 1. This was followed by DP, DPH, CHP, NT and CU. In Year 2, the highest yield was obtained with DPH followed by CU, DP, CHP, DPHR and NT. For the mean of the two years, the order of variation was DPH > DPHR > DP > CU > CHP > NT. Thus, we can see that the conservation tillage practices performed well in terms of yield. In fact, analysis of variance (not shown) did not show any significant differences in the yield obtained from the different tillage systems.

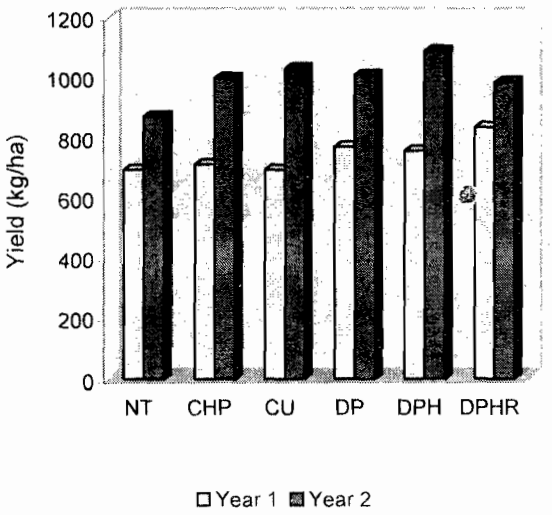

Fig. 5: Effect of tillage method on yield (kg/ha) of soybean, NT = No tillage, CHP = Chisel plough, CU = Cultivator, DP = Disc plough, DPH + Disc plough + harrow, DPHR = Disc plough + harrow + ridger.

Overall Performance

From the results presented above, no-tillage and other soil conservation tillage practices exhibited better moisture conservation. However, they exhibited higher soil strength than conventional tillage practices. The yield of soybean from conservation tillage was comparable to that from conventional tillage. In overall performance (soil properties, crop growth, and crop yield), the two extremes of no-tillage and conventional tillage performed worse than the other conservation tillage methods. It is therefore recommended that for the this location, any of the conservation tillage practices (except no tillage) can be used to obtain good crop establishment and yield and at the same time conserve soil, water and energy.

CONCLUSION

Four conservation and two conventional tillage practices were evaluated for two years to determine their effects on soil physical properties, establishment and yield of soybean. In overall performance, the conservation tillage practices of cultivator (CU), chisel ploughing (CHP) and disc ploughing alone (DP) are recommended for this crop and soil, in this zone.

REFERENCES

Ahaneku, I.E., Onwualu, A.P. and Jasanya, A.A. 1998. Soil physical properties and cowpea production as affected by different tillage method in a Nigeria Haplustalf. Journal of Science, Engineering and Technology. 6 (2):1854-1872.

Anazodo, U.G.N., Oni, K.C and Braide, F.G. (Editors) 1983. Proceeding of the First National Tillage Symptoms, Nigeria Society of Agricultural Engineers (NSAE), Ilorin.

Anazodo, U.G.N., Onwualu, A.P. and Watts, K.C. 1991. Evaluation of alternative tillage systems in the absence of herbicides for maize production in a Savannah loamy sand. J. Agric. Engineering Res. 49:259 - 272.

Babalola and Opara-Nadi, O.A. 1993. Tillage system and soil properties in West Africa. Soil and Tillage Res. 27:149- 174.

Benites, J.R. and Ofori, C.S. 1993. Crop production through conservation - effective tillage in the tropics. Soil and Tillage Res. 27:9 – 3 3.

Eje, B.E; Oluka, S.I. and Onwudinjo, E.U. 2001. Effect of tillage methods on cowpea yield and physical properties of Acrisol soil. Proceedings of the Nigerian Institution of Agricultural Engineers. 23:83-86.

Hayes, W.A.1982. Minimum tillage farming. No till Farmer Inc., Brookfield, Wisconsin.

Jasanya, A.A, Onwualu, A.P. and Ahaneku, I.E. 1997. Till-

age effects on soil physical properties and maize production under dry land farming in Ilorin. Proceedings, 23rd Annual Conference of Soil Science Society of Nigeria.

Lal, R. (ed.) 1979. Soil Tillage and Crop Production. IITA Proceedings Series No. 2, Ibadan.

Lal, R. 1983. No-till Farming. Soil and Water Conservation and Management in the Humid and sub-Humid Tropics. Monograph Series No. 2, IITA, Ibadan.

Lal, R. 1997. Tillage effects on soil degradation, soil resilience, soil quality and sustainability. Soil and Tillage Res. 27: 1 - 8.

Lal, R. 1997. Long term tillage and maize monoculture effects on a tropical Alfisol in Western Nigeria I: Crop yield and soil physical properties. Soil and Tillage Res. 42(3): 145 - 60.

Mutasaers. H.J.W. 1991. Opportunities for second cropping in south western Nigeria. RCMP Research Monograph No.4., IITA, Ibadan.

Nangju, D. 1979. Effect of tillage methods on growth and yield of cowpea and soybean. IITA Proceedings series No. 2, IITA, Ibadan, pg.93.

Obi, I.U. 1986. Statistical Methods of Detecting Difference Between Treatment Means. Snaap Press Nig. Ltd., Enugu pg. 8 - 20.

Obi, M.E. and Nnabude, P.C. 1988. The effect of different management practices on the physical properties of sandy loam soil in southern Nigeria. Soil and Tillage Res.12:81-9.

Ojeniyi, S.O 1986. Effects of zero tillage and disc ploughing on soil water soil temperature and growth and yield of maize. Soil and Tillage Res. 7:173-182.

Olaoye, J.O. 2002. Influence of tillage on crop residue cover, soil properties and yield components of cowpea in derived Savannah ectones of Nigeria. Soil and Tillage Res. 64(3):179-187.

Oni, K.C. (Ed.). 1997. Proceedings of ISTRO-Nigeria Tillage Symposium. International Soil Tillage Research Organization, Nigeria Branch, Ilorin. 160 pgs.

Onofiok, O.E.1988. Spatial and temporal variability of some soil physical properties following tillage of a Nigeria Paleustult. Soil and Tillage Res.12:285-298.

Onwualu, A.P. and Ahaneku, I.E. 1996. Sustainable agriculture in Nigeria: An Overview. Proceeding of the NSAE 18:434-441.

Yiljep, Y.D. and Yusuf, D.D. 2000. Yield response of maize to tillage treatment under different fertility regimes. Journal of Agricultural Engineering and Technology. 8:51-54.

Young (Jr), H.M. 1983. No-till Farming. No-till Farmer Inc., Brookfield, Wisconsin.