

## **Effect of Reduced Tillage on Soil Properties and Cowpea Yield in Rainforest Zone of South West Nigeria**

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**Abstract:** In order to investigate the suitability of zero and reduced tillage methods for cowpea production under a humid tropical condition, the soil properties and grain yield given by five tillage treatments, namely: zero tillage, manual clearing, ridging once, twice and thrice for three cowpea crops were compared. Compared with ridging, zero tillage and manual clearing increased soil nutrient and moisture status. Zero tillage and manual clearing gave higher soil bulk density and lower values of grain yield. Soil bulk density decreased and grain yield increased with increased frequency of ridging.

**Key words:** Reduced tillage, cowpea, soil, Nigeria

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### **INTRODUCTION**

A wide range of tillage methods are used in different regions of humid tropical Africa for cowpea (*Vigna unguiculata* Walps). In region of alfisols such as found in Southwest Nigeria, farmers plant cowpea and other grain crops on ridges, heaps and manually cleared soils. However reduced tillage is gaining ground especially in areas susceptible to water erosion. In order to sustain reduced tillage methods which include planting on old ridges and manual clearing.

Studies conducted in the humid tropics dealt with comparison of mechanized and herbicide-based zero tillage (Lal, 1976; Olaoye, 2002) and manual clearing (Ojeniyi and Adekayode, 1999; Ojeniyi *et al.*, 2000). Most of the studies found that cowpea benefited from tillage (Ojeniyi, 1989, 1991) although Olaoye (2002) who worked in the derived savanna zone of Nigeria found that zero tillage soil had least bulk density and highest cowpea yield compared with ploughed soils. There is need for further investigation into effects of soil conserving reduced tillage methods such as use of old ridges. Therefore this work was conducted to the selected soil properties and cowpea yield given by different frequency of manual ridging, cleaning and zero tillage in rainforest zone of Southwest Nigeria.

### **MATERIALS AND METHODS**

#### **Field Experiment**

Field experiment was conducted at Akure in the rainforest zone of Southwest Nigeria on a sandy loam Oxic Tropudalf. The tillage treatments compared were as follows:

- Zero tillage in which paraquat (1-1 dimethyl 1-4-4 bipyridium) was sprayed at 2.5 L/ha after manual clearing and one week before planting each of three cowpea crops (ZT).
- Manual clearing with cutlass for each of three cowpea crops (MC).
- One initial manual ridging (with hoe) for three crops (IR3C).
- Two alternate manual ridging for three cowpea crops.
- Three manual ridging for three-cowpea crops i.e., ridging for each crop (3R3C).

The five treatments were replicated three times in a randomized complete block design. Cowpea seeds were planted single stand in each 16 cm<sup>2</sup> plot at 90×90 cm. The first, second and third cowpea crops were established in July 2000, April 2001 and July 2001, respectively.

#### **Determination of Soil Properties**

Soil bulk density and gravimetric moisture content were evaluated at 1, 5 and 10 weeks after planting. Core samples collected at 5 to 15 cm depth were used for evaluation of bulk density and moisture content after placement in oven for 24 h at 100°C. Five core samples were collected from a plot at each sampling. Mean values of soil parameters were calculated.

For the third crop, composite surface (0-15 cm) soil samples were collected before planting and at harvest per plot. The soil samples were air-dried and pass through 2 mm sieve. Organic matter was determined by Walkey-Black dichromate method and total N was determined using Kjeldahl approach. Available P was extracted using Bray-P1 solution and determined using molybdenum blue colorimeter (Bray and Kurtz, 1945). The pH in soil-water (2:1) was determined using a glass calomel electrode. The exchangeable k, Ca and Mg were extracted with ammonium acetate. k was determined on flame photometer and Ca and Mg by EDTA titration (Tel, 1984).

Ten plants per plot were used for determination of grain yield on air-dry basis.

## **RESULTS**

#### **Bulk Density**

Table 1 shows data of soil bulk density under first, second and third cowpea crops. Ridging treatments reduced soil density compared with zero tillage and manual clearing from the first to third crop. Manual clearing gave higher soil bulk density than zero tillage. As from second crop, increase in frequency of ridging reduced soil density. The overall mean densities for zero tillage, manual clearing one, two and three ridging were: 1.42, 1.45, 1.26, 1.24 and 1.21 Mg m<sup>-3</sup>, respectively.

#### **Moisture Content**

In Table 2, values of soil moisture content are shown. In case of first, second and third cowpea crops, ridging significantly reduced soil moisture content compared with manual clearing and zero tillage ( $p = 0.05$ ). As from the second crop, soil moisture content was reduced with increased frequency of ridging.

Table 1: Effect of frequency of tillage on soil bulk density (Mg m<sup>-3</sup>)

Tillage	Crop 1	Crop 2	Crop 3
One ridging	1.18	1.27	1.33
Two ridgings	1.20	1.22	1.31
Three ridgings	1.18	1.20	1.24
Zero tillage	1.39	1.42	1.46
Manual clearing	1.41	1.45	1.48
LSD (0.05)	0.06	0.06	0.03

Table 2: Effect of frequency of tillage on soil moisture content (%)

Tillage	Crop 1	Crop 2	Crop 3
One ridging	14.70	25.7	21.7
Two ridgings	14.20	23.9	21.4
Three ridgings	14.80	22.5	19.9
Zero tillage	22.30	43.0	36.1
Manual clearing	21.40	38.7	30.8
LSD (0.05)	0.06	1.9	1.0

Table 3: Effect of frequency of tillage on preplanting soil chemical composition

Tillage	pH (2:1) H <sub>2</sub> O	P Mg kg <sup>-1</sup>	Organic matter (%)	N%	K	Ca	Mg
One ridging	6.30	12.8	2.0	0.14	4.2	8.9	1.40
Two ridgings	6.20	16.7	2.0	0.14	4.4	7.2	1.40
Three ridgings	6.00	19.7	2.0	0.15	4.3	9.3	1.40
Zero tillage	6.60	32.5	2.2	0.17	4.8	11.3	1.60
Manual clearing	6.40	30.1	2.1	0.17	4.0	10.5	1.60
LSD (0.05)	0.02	4.7	NS	0.10	NS	1.6	0.10

Table 4: Effect of frequency of tillage on soil chemical composition at harvest

Tillage	pH (2:1) H <sub>2</sub> O	P Mg kg <sup>-1</sup>	Organic matter (%)	N%	K	Ca	Mg
One ridging	6.1	11.8	1.9	0.14	4.1	7.5	1.40
Two ridgings	6.1	15.7	1.9	0.14	3.9	6.1	1.40
Three ridgings	5.9	17.7	1.9	0.15	4.3	8.6	1.40
Zero tillage	6.4	29.9	2.1	0.17	4.7	10.9	1.60
Manual clearing	6.3	24.5	2.0	0.16	4.3	9.1	1.60
LSD (0.05)	NS	4.4	NS	NS	NS	1.5	0.10

Table 5: Effect of frequency of tillage on grain yield of a cowpea plant

Tillage	Crop 1	Crop 2	Crop 3
One ridging	45.8	48.6	45.4
Two ridgings	50.6	52.7	79.3
Three ridgings	44.4	64.4	87.3
Zero tillage	30.8	34.7	45.3
Manual clearing	28.6	29.5	37.4
LSD (0.05)	2.1	11.5	9.3

Hence the soil that was ridged thrice had the least moisture content. Therefore zero tillage enhanced soil moisture status while increase in frequency of ridging reduced soil moisture status. Manual clearing gave lower moisture content compared with zero tillage.

#### Nutrient Content

Table 3 shows pre-planting soil nutrients content for the third crop and Table 4 contains soil nutrient contents at harvest. Compared with ridged soils, zero tillage and manually cleared soils had higher soil nutrients especially with regard to Ca and Mg. Hence pH values of untilled soil were slightly higher.

Total N in untilled soil was higher. Frequency of tillage (ridging) did not influence soil chemical composition significantly ( $p = 0.05$ ) with regard to organic matter, pH, N, K, Ca and Mg. However, available P increased with frequency of ridging.

#### Grain Yield

Compared with ridging treatments, zero tillage and manual clearing gave lower values for cowpea grain yield. Therefore cowpea benefits from ridging. Also increase in frequency of ridging increased grain yield. Hence yield increased in the order manual clearing, zero tillage, one, two and three ridging. The overall mean values of grain yield per plant were 31.8, 36.9, 46.6 and 65.3 g, respectively (Table 5). However, yield of the third crop given by three ridging was not significantly higher than that of two ridging. Therefore, number of ridging could be reduced to two per three crops.

### DISCUSSION

Ridging tended to reduce soil moisture content compared with zero tillage. This finding could be due to increased presence of organic matter and mulch on zero tillage and manually cleared soils (Ojeniyi and Adekayode, 1999), which should have reduced temperature and conserved moisture. Ridging which reduced soil density should have increased soil macro porosity thereby reducing conduct

of heat into soil during the day. Ojeniyi *et al.* (2002) and Agele *et al.* (2002) found that ridging accelerated soil drying and increased soil temperature compared with surface hoeing.

Increased porosity and oxidation of soil under ridging compared with zero tillage should have enhanced loss of organic matter. Also the fact that ridging brought less fertile sub-soil to surface should have contributed to lower nutrient of ridged soil compared with unridged soil.

Untilled soil with bulk densities above 1.40 Mg m<sup>-3</sup> had lower cowpea yield compared with ridged soil. With critical strength for cowpea. Also increased frequency ridging reduced soil density and increased cowpea yield. Therefore the soil that received the highest number of ridging had the least density and highest yield.

It is implied that cowpea was very sensitive to soil density and that high soil density adversely affected cowpea yield. For example, manually cleared soil with highest density had least cowpea yield although it had relatively high moisture content. Also the increased looseness of soil due to frequent ridging should have enhanced soil aeration, a situation which increases N fixation, presence of rhizobium and nodulation in leguminous crop (Osundina, 1998).

### CONCLUSIONS

The present research relative effect of frequency of ridging, zero tillage and manual clearing on selected soil properties and yield of cowpea under humid tropical condition on alfisols in Southwest Nigeria. Although untilled soils had higher nutrient status and moisture content, loose soil given by ridging significantly enhanced cowpea yield. Yield of cowpea given by two ridging for three crops was not significantly different from that of three ridgings.

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