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*Full Length Research Paper*

# Effect of oil palm sludge on cowpea nodulation and weed control in the humid forest zone of Nigeria

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**A field trial was conducted at the Rivers State University of Science and Technology Research and Training farm Port Harcourt to test the effect of oil palm sludge on cowpea nodulation and weed control. The cultivars of cowpea used were Dan Kano, Bornu local and Sokoto local while the oil palm sludge levels applied were 0, 4000, 6000 and 8000 l/ha. The trials were conducted during the rainy and dry season of 2004. It was observed that as the level of oil palm sludge increased, the length of root showed remarkable decrease in length irrespective of cultivars or season. Dan Kano cultivar had the longest root length (26.60 cm) in control plot and least (23.17 cm) was obtained from the highest level (8000 l/ha) of oil palm sludge application during wet season. This development could be attributed to low wet ability and anaerobic condition created before decomposition by Oil palm sludge which had higher concentration on the top soil with the majority of the cowpea roots in this highly concentrated zone. On nodulation, results indicated that increase in oil palm sludge favored more number of functional root nodules during both seasons and in all the cultivars and reverse being the case with the non-functional nodules. Weed count was higher (35) in the control plots and lowest in the 8000 l/ha plots (2.0). Similarly, the highest weed weight (670 g/ha) was obtained in control plots while the lowest (170 g/ha) was recorded in 8000 L/ha. On the cultivars tested oil palm sludge at 8000 l/ha favoured more root nodules development and hence more yield with excellent weed control ability.**

**Key words:**Dan Kano, Sokoto local, Bornu local cultivars, oil palm sludge, nodulation, weed control.

## INTRODUCTION

The oil palm (*Elaeis guineensis* jacq) is a native of the humid tropics of West Africa. It occurs wild along the banks of rivers and streams in transition zone between rain forest and open Savannah. The area covered by the oil palm belt varies from a few kilometers to 80 km or more. In such region, oil palms are often the predominant trees and in some limited areas (as in eastern Nigeria), wild oil palms in the forest may be so dense as to give the impression of a deliberate plantation (Onwueme and Sinha, 1991).

Cowpea, *Vigna unguiculata* (L) WAP; is an important food legume and a versatile crop cultivated between 35$^o$N to 30$^o$S of the equator, covering Asia and Oceania, the middle East, Southern Europe, Africa, Southern USA, and Central and South America (Fery 1985, Fery et al., 1994; Mishra et al., 1985; Heiji, 1987; Hadjichristodoulou, 1991a,b; Perrino et al., 1992, 1993). However, being a drought tolerant crop with better growth in warm climates, cowpea is most popular in the semi arid regions of the tropics, where other food legumes do not perform well. Cowpea has the unique ability to fix nitrogen even in poor soils (pH range 4.5 09.9, organic matter < 0.2% and a sand content > 85). Also, it is shade-tolerant and therefore, compatible as an inter crop with a number of cereals and root crops, as well as with cotton, sugar cane and several plantation crops. Coupled with these attributes, its quick growth and rapid ground cover have made cowpea an essential component of sustainable subsistence agriculture in marginal land and drier regions of the tropics, where rainfall is scanty and soils are sandy with little organic matter. At the same time, if early maturity erect/ semi-erect varieties are grown as a pure crop with

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**Table 1.** Impact of oil palm sludge on 3 cultivars of cowpea length or roots at 6 and 8 WAP in wet and dry season.

| Oil palm sludge level (l/ha) | 6 WAP | | | | | | 8 WAP | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wet season | | | Dry season | | | Wet season | | | Dry season | | |
| | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local |
| 0 | 26.60 | 24.67 | 21.37 | 26.23 | 18.17 | 18.17 | 20.43 | 19.00 | 22.87 | 19.23 | 19.07 | 22.50 |
| 4000 | 25.93 | 21.67 | 19.50 | 17.73 | 15.00 | 15.67 | 18.33 | 18.33 | 19.00 | 17.20 | 17.87 | 20.00 |
| 6000 | 24.77 | 20.67 | 18.77 | 15.00 | 14.67 | 12.33 | 17.83 | 16.83 | 18.17 | 15.25 | 14.83 | 16.57 |
| 8000 | 23.17 | 18.69 | 15.87 | 11.93 | 11.93 | 12.07 | 17.07 | 16.83 | 18.17 | 14.83 | 14.90 | 16.77 |
| LSD (0.05) | | 0.60 | | | 0.55 | | | 0.56 | | | 0.32 | |

required inputs, cowpea has the potentials of yielding as high as cereals on a productivity per day basis (Singh and Sharma, 1996).

Owing to ever increasing numbers of palm oil mills, the attendant problems of indiscriminate disposal of oil palm sludge cannot be overemphasized. Sludge is capable of contaminating portable water like well, stream, river etc. when deposited very close to them. Also oil palm sludge affects soil microbial activities because the sludge is capable of causing impeded aeration in soil and consequently soil microbial activities is negatively affected. This investigation evaluates the effect of oil palm sludge on cowpea nodulation and weed control in the humid forest zone of Nigeria

## MATERIALS AND METHODS

### Study site

The wet and dry season experiments were conducted at the Teaching and Research Farm of the Rivers State University of Science and Technology, Port Harcourt during the 2004 planting season. Port Harcourt is located at 18 m above sea level in the humid tropic zone and has a bimodal rainfall pattern.

### Experimental materials

The experiment involved Cowpea and Oil palm sludge. Three cowpea cultivars. Namely Dan Kano, Borno local and Sokoto local obtained from Federal University of Agriculture Umudike, Umuahia, Abia state and Oil palm sludge (OPS) was obtained from a palm oil mill in Elele, Ikwerre local Government area, Rivers State of Nigeria.

### Experimental design

The experimental design was a factorial arrangement fitted into Randomized Complete Block design (RCB). Cowpea cultivars such as Dan Kano ($A_1$), Borno local ($A_2$) and Sokoto local ($A_3$) where factor "A" while factor "B" is the application levels: 0 l/ha ($B_1$), 4000 l/ha ($B_2$), 6000 l/ha ($B_3$), and 8000 l/ha ($B_4$). These twelve treatments combination used were $A_1$ $B_1$, $A_1$ $B_2$, $A_1B_3$, $A_1B_4$, $A_2B_1$, $A_2B_2$, $A_2B_3$, $A_2B_4$, $A_3B_1$, $A_3B_2$, $A_3B_3$ and $A_3B_4$. The treatment combinations were randomized within each block and replicated three times to give a plot of 17 x 17 m. However, the planting distance and number of stands were the same as in all plots. The Cowpea cultivars were planted at 20 x 30 cm after applying the oil palm sludge and allowed to percolate for 7 days.

### Data collection and sampling techniques

In both seasons, viability test was carried out before clearing the main field to ascertain the cowpea viability. Oil palm sludge (OPS) was applied in both seasons and allowed to percolate for 7 day before planting commenced. Soil sample was also taken from every plot and composited for soil analysis before and after oil palm sludge application. The following parameters were analyzed: length of roots, number of functional root nodules at 6 and 8 WAP, weed infestation and dry matter yield.

### Data analysis

Data were subjected to ANOVA test and differences between means were determined at 5% level of probability using LSD.

## RESULT

### Length of roots (cm) at 6 and 8 WAP

Dan Kano cultivar had the longest root length (26.60 cm) in the control plot and the least (23.17 cm) was obtained from the highest level of oil palm sludge during wet season (Table 1). Other cultivars have similar result. Similar trends of performance were observed during dry season.

### Number of functional root nodules at 6 and 8 WAP

The highest level of oil palm sludge applied (8000 l/ha) recorded more functional root nodules (29) for Dan Kano cultivar while the least (10) was obtained at 4000 L/ha plot. Bornu local cultivar umber of functional root nodules was highest (21) at 8000 l/ha plot and least (13) in 4000 l/ha level. Sokoto local cultivar was more favoured by all levels of oil palm sludge. Although highest number of functional root nodules (50) was recorded in 8000 l/ha and least (17) in 4000 l/ha plot. At 8 WAP, similar result was recorded as in 6 WAP.

During dry season planting, result obtained did not vary

**Table 2.** Effect of oil palm sludge levels on number of non-functional root nodules at 6 and 8 WAP during wet and dry season.

| Oil palm sludge level (l/ha) | 6 WAP | | | | | | 8 WAP | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wet season | | | Dry season | | | Wet season | | | Dry season | | |
| | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local |
| 0 | 12 | 11 | 18 | 9 | 14 | 18 | 10 | 12 | 22 | 11 | 12 | 12 |
| 4000 | 10 | 11 | 13 | 7 | 11 | 17 | 12 | 10 | 16 | 11 | 13 | 24 |
| 6000 | 18 | 18 | 26 | 25 | 27 | 31 | 21 | 10 | 31 | 29 | 24 | 35 |
| 8000 | 29 | 21 | 31 | 39 | 34 | 50 | 35 | 27 | 36 | 37 | 28 | 39 |
| LSD (0.05) | | 0.83 | | | 1.01 | | | 0.80 | | | 0.03 | |

**Table 3.** Influence of oil palm sludge levels on number of non-functional root nodules at 6 and 8 WAP during wet and dry season.

| Oil palm sludge level (l/ha) | 6 WAP | | | | | | 8 WAP | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wet season | | | Dry season | | | Wet season | | | Dry season | | |
| | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local | Dan Kano | Bornu Local | Sokoto Local |
| 0 | 5 | 4 | 10 | 7 | 7 | 13 | 6 | 6 | 11 | 5 | 9 | 9 |
| 4000 | 7 | 3 | 6 | 5 | 5 | 8 | 10 | 5 | 11 | 4 | 8 | 15 |
| 6000 | 4 | 2 | 4 | 4 | 5 | 7 | 6 | 4 | 6 | 3 | 6 | 8 |
| 8000 | 4 | 2 | 4 | 4 | 4 | 5 | 6 | 2 | 3 | 3 | 4 | 7 |
| LSD (0.05) | | 0.91 | | | 2.96 | | | 1.02 | | | 2.01 | |

significantly from what was obtained during wet season planting. In general, results indicated that increase in oil palm sludge favored more functional root nodules irrespective of the cultivar of cowpea (Table 2).

### Number of non-functional root nodules at 6 and 8 WAP

During wet season, Dan Kano had more non-functional root nodules in 4000 l/ha plot while the least number of non-functional root nodules was obtained in 8000 l/ha plot. Bornu local cultivar has more of the non-functional root nodules in control plot whereas 4000, 6000 and 8000 l/ha did not vary significantly (Table 3). Sokoto local cultivar followed similar trend. In dry season, all the cowpea cultivars did not vary from the wet season planting trend. The number of non-functional root nodules decreased as the level of oil palm sludge increased.

### Weed infestation during wet and dry season

At weed count, guinea grass (*Panicum maximum jacq*), *Sida acuta* and *Ashilia africana* were in abundance of the experimental plot. However, all the treatment levels have equal number of weed species. The control plot had the highest weed score of 3.5 than other levels of oil palm sludge applied. The lowest weed score of 2.0 was recorded in 6000 and 8000 l/ha (Table 4).

Similarly, the highest weed weight (670.45 g/ha) was obtained in control plot while the lowest (170.73g/ha) was recorded in 8000 l/ha. During dry season planting, similar result was obtained (Table 5).

### Number of seeds/pod and dry matter yield at 14 WAP

Control plot recorded the least number of seeds per pod. Bornu local cultivar had more of seeds per pod in 6000 lha whiles the least (23) was obtained in control plot during wet season. During dry season, the cultivars of cowpea recorded more seeds per pod as the level of Oil palm sludge was increasing. Dry matter yield at 14 WAP indicated Sokoto local, Bornu local and Dan Kano cultivars of cowpea had their highest yield of 0.30, 0.27 and 0.25 l/ha at increase level of oil palm sludge (Table 6). Control and 4000 l/ha did not show any significant difference irrespective of the cultivar.

## DISCUSSION

There were significant differences observed in cowpea length of roots as the rates of application of oil palm sludge increased. Most of the oil palm sludge applied was concentrated on the top soil and as cowpea has majority of its roots in this highly concentrated zone, it is likely to absorb more of the sludge effects. Roots enhance efficient growth and development of plant.

**Table 4.** Impact of oil palm sludge levels on weed species incidence during wet season.

| Oil palm sludge level | Weed species | Sub class | Abundance (%) | Weed score |
|---|---|---|---|---|
| Control | *Panicum maximum* jacq | Monocot | 50.0 | |
| | Asphilia africana | Dicot | 30.0 | 3.5 |
| | *Sida acuta* | Dicot | 12.0 | |
| 4000 l/ha | *Panicum maximum* jacq | Monocot | 48.0 | |
| | *Asphilia africana* | Dicot | 38.0 | 3.0 |
| | *Sida acuta* | Dicot | 8.0 | |
| 6000 l/ha | *Panicum maximum* jacq | Monocot | 40.0 | |
| | *Asphilia africana* | Dicot | 50.0 | 2.5 |
| | *Sida acuta* | Dicot | 6.0 | |
| 800 l/ha | *Panicum maximum* jacq | Monocot | 35.0 | |
| | *Asphilia africana* | Dicot | 28.0 | 2.0 |
| | *Sida acuta* | Dicot | 4.0 | |

**Table 5.** Impact of oil palm sludge levels on weed species incidence during dry season.

| Oil palm sludge level | Weed species | Sub class | Abundance (%) | Weed score |
|---|---|---|---|---|
| | *Panicum maximum* jacq | Monocot | 46.0 | |
| Control | Asphilia africana | Dicot | 30.0 | 3.0 |
| | *Sida acuta* | Dicot | 28.0 | |
| | *Panicum maximum* jacq | Monocot | 40.0 | |
| 4000 l/ha | *Asphilia africana* | Dicot | 30.0 | 2.5 |
| | *Sida acuta* | Dicot | 25.0 | |
| | *Panicum maximum* jacq | Monocot | 35.0 | |
| 6000 l/ha | *Asphilia africana* | Dicot | 25.0 | 2.5 |
| | *Sida acuta* | Dicot | 20.0 | |
| | *Panicum maximum* jacq | Monocot | 30.0 | |
| 800 l/ha | *Asphilia africana* | Dicot | 15.0 | 1.5 |
| | *Sida acuta* | Dicot | 10.0 | |

**Table 6.** Influence of oil palm sludge levels on fresh weight of weed at 5 WAP (kg/ha) during wet and dry seasons.

| Oil palm sludge levels (l/ha) | Fresh weed weight ($g/m^2$) during wet season | Fresh weed weight ($g/m^2$) during dry season |
|---|---|---|
| Control | 670.45 | 520.30 |
| 4000 | 540.56 | 460.40 |
| 6000 | 392.62 | 300.50 |
| 8000 | 170.73 | 110.52 |
| LSD (0.05) | 2.60 | 1.82 |

A well developed root system ensures efficient nutrient uptake and water absorption and anchors the plant firmly to the soil (Ewusie, 1971). In contrast to this study where cowpea length of root decreased with increasing oil palm sludge, Harper (1939) reported some enhancement of growth of crops in gas and oil contaminated soils. Other workers, McGaill (1980), Odu (1981) and Zuofa et al. (1985) also indicated that long term effect of oil in soil may be beneficial for crop production in terms of nutrient supply.

Functional root nodules of the test crops; Dan Kano, Bornu local and Sokoto local cultivars of cowpea varied as the rate of application increased. The number of functional root nodules variations among the application rate may be attributed to increase in organic matter, nitrogen, phosphorus and oil content. This assertion supports the claim made by Isirimah et al. (1989) that adequate amount of organic matter and nutrient elements are contained in oil palm sludge which is eventually released in the process of degradation of the oil palm sludge.

Contrary to number of functional root nodules increasing with more oil palm sludge, non-functional root nodules decreased with increasing oil palm sludge. This trend could be explained to be due to decrease in available nitrogen in untreated plots and less amount of oil palm sludge may result to immobilization of nutrient resulting in dead root nodules.

The rate of oil palm sludge applied significantly affected weed infestation. At high level of 6000 l/ha and above, the oil palm sludge formed soil cover which prevents enough sunlight to penetrate soil surface thereby smothering the weeds especially the low growing ones. It also displaces air from soil pores creating anaerobic condition. This is in accordance with Kloke and Ley (1963) who reported on complete elimination of grass growth by 3.3% (by weight) in soil. The result as indicated on Tables 4, 5 and 6 supports the fact that for good ground coverage and weed suppression, it is best to apply higher oil palm sludge on weedy environment.

## Conclusion

This work has shown that oil palm sludge increases soil nutrients as it degrades thereby enhancing increase crop production. It is also capable of smothering weeds as seen in this study. Instead of indiscrimate dumping of the sludge, it should be carefully used to improve the soil fertility and reduce weed infestation in farms.

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