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Impact of Oil Palm Sludge on Cowpea Nematode (Meloidogyne incognita) Populations in the Humid Forest Zone of Nigeria

EDITH CHUKU, SOLOMON CHUKU & JOSEPH OSAKWE
Rivers State University of Science and Technology, Port Harcourt, Nigeria

Abstract

The impact of oil palm sludge on cowpea nematode (*Meloidogyne incognita*) populations in the humid forest zone of Nigeria was tested at the Research and Training farm of Rivers State University of Science and Technology, Port Harcourt. Nematodes are among the serious pests militating against the high productivity of cowpea in the humid tropics . As an agrarian society, oil palm from where the oil palm sludge is obtained is usually disposed off during palm oil processing and as such readily available hence its utilization as a biotechnological approach for control of soil nematodes. Dan Kano, Borno Local and Sokoto Local were cowpea cultivars used and oil palm sludge's application levels were 0 lit/ha (control) 4000lit/ha, 6000lit/ha and 8000lit/ha. The highest population of root knot nematode was found on the control plots (8,553) during the rainy season while the least (2,005) was found on 8000lit/ha plots during the same season. Generally, there was decrease in the nematode population with increase in sludge application. In the humid tropics, high populations of nematode militate against cowpea production which due to their parasitic nature form knots on cowpea roots, the latter where symbiotic Rhizobia also form nodules. Since oil palm sludge at levels above 6000lit/ha drastically reduced nematode population, it is therefore recommended for profitable cultivation of cowpea in humid tropics especially during rainy season.

Keywords: cowpea cultivars, nodulation, knots nematode, rhizobia, oil palm sludge

Introduction

Oil palm tree (*Elaeis guineensis Jacq*) is one of the oil seed crops which fruits from 4 – 6 years after transplanting and may continue to bear fruit for 30 years economically (). Its biological life span is between 50 – 80 years. It is an important source of oil in West Africa. Oil palm gives a higher yield of oil per unit area than any other crop. Two distinct types of oil namely palm oil and palm kernel oil are produced both of which are industrially important. Palm oil is obtained from the fleshy orange mesocarp of the fruit which contains 45 – 55% oil, and palm kernel oil obtained from the kernel or endosperm (after it has been removed from the stony endocarp) which contains about 50% oil (Onwueme & Sinha, 1991).

Nematodes (also called eelworms, threadworms, or roundworm) are abundant in the soil. Majority of them are harmless, but many species parasitize plants, including food crops causing losses in both quantity and quality. Virtually every plant has nematode parasites, and some nematodes are parasite on many crops. This lack of specificity in a parasite can make control difficult, because if one of its hosts is not available, another crop may be. Cowpea, (*Vigna unguiculata L. walp*,) unfortunately is one of the crops with the greatest pests and disease incidence (1) among which are the root-knot nematodes. Three species of root-knot nematode have been found in Nigeria, *Meloidogyne incognita, M. arenaria*, and *M.javanica*. All the species appear to be endemic as they have been found in all areas of the country and recovered from virgin forest soils. It is doubtful whether any considerable area is free of these pests.

Cowpea are the second most important food grain legume crop in tropical Africa, the most important being *Phaseolus vulgaris*, the common bean. Nigeria, Niger, Burkina Faso, Uganda and Senegal grow cowpea for the market, but they are widely grown as a subsistence crop for home use in nearly all African countries south of Sahara. It is the predominant food grain legume in African regions of moderate to abundant rainfall. Cowpea are grown extensively in South-East Asia and in Latin America, and to a limited extent in the Southern part of the USA.

Due to increasing domestic and industrial uses of Oil palm in the rain forest belt of West Africa (Purseglove, 1972), there has been a conscious effort in establishment of palm oil processing mills. These mills produce sludge, which are disposed around the vicinity, majority of which are farmlands and as such a major source of soil pollutant. Presently there is no effective means of disposing palm oil sludge. This work therefore is aimed at assessing the impact of palm oil sludge on cowpea nematode population.

Materials and Methods

The study was conducted at the Teaching and Research farm of the Rivers State University of Science and Technology, Port Harcourt during the 2012 early and late planting seasons. Port Harcourt is located at 18m above sea level in the humid tropical zone and has two peak rainy months in July and September respectively (FAO, 1994). The soil is a typical paleudult (Sandy loam). The University Teaching and Research Farm was also chosen because of its accessibility and effective security system put in place for conducting a research of such magnitude. The availability of land for scientific research is also one of the leading factors for choosing the site.

Experimental Materials

The experiment involved three cultivars of cowpea: Dan Kano, Bornu Local and Sokoto Local. They were obtained from Federal University of Agriculture, Umudike, Abia State Nigeria.

Experimental Design/Planting of Cowpea

The experimental design was a factorial arrangement fitted into Randomized Complete Block Design (RCB). Cowpea varieties such as Dan Kano (A_1) Bornu local (A_2) and Sokoto local (A_3), are factor A while the oil palm sludge concentrations 0(B_1), 4000 (B_2), 6000(B_3) and 8000lit/ha (B_4), are factor B. These twelve treatment combinations were randomized within each block and replicated three times to give a plot of 17m x 17m.

However, the planting distance and number of stands were the same in all plots. The cowpea cultivars were planted at 20cm x 30cm.

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 days before planting. Soil sample was also taken from every plot and composited for soil analysis before and after oil palm sludge application. The root knot nematode (Meloidogyne incognita) populations were verified before and after oil palm sludge application. Plant height, leaf area, number of flowers, length of pod, number of seeds/pod, fresh and dry pod weight and total grain yield, number of roots, length of roots and number of functional and non-functional root nodules at 6 and 8 weeks after planting were estimated.

Data Analysis

Data were subjected to ANOVA test and differences between means were determined at the 5% level of probability using the New Duncan multiple range test (DMRT).

Results

Length of Roots (cm) at 6 and 8 WAP

During wet season, Dan Kano cultivar had the longest root length (26.60cm) in the control plot and least (23.17m) was obtained from the highest level plot i.e. 8000lit/ha. Bornu local maintained longest length of root at control plot while least length of root was recovered in the highest level of application. Sokoto local cultivar recorded similar trend as the others. Dry season planting was not different from wet season hence similar trend was observed as in wet season. Dan Kano cultivar had the longest length of root (26.23cm) in the control plot whereas the 8000lit/ha plot recorded the least length of root. 6000 and 8000lit/ha did not record any significant different value. Generally, increasing level of Oil palm sludge decreases the length of root of three cultivars of cowpea. At 8 WAP, Dan Kano recorded the longest length of roots, (20.43cm) in control plot while the least (17.97cm) was obtained at 6000lit/ha level. Bornu local had the longest length of root (19.00cm) in the control plot whereas 6000 and 8000lit/ha levels did not vary. Sokoto local recorded the longest length of root (22.87) in control plot. This was closely followed by 4000lit/ha plots. However, levels 6000 and 800olit/ha did not vary significantly during wet season.

In dry season, Dan Kano length of root was favored in the control plot as shown in Table 1. This was followed by 4000lit/ha plots. The least length of root (14.83cm) was obtained from 8000lit/ha plots. Bornu local cultivar had the longest root length (19.07cm) at control plot and least in 6000 and 8000lit/ha levels recorded the same value. Decrease in length of root as a result of increase in Oil palm sludge applied was observed as shown in Table 1.

Number of Functional Root Nodules at 6 and 8 WAP of three Cultivars of Cowpea during wet and dry seasons.

During wet season, the highest level of Oil palm sludge applied (8000lit/ha) recorded more functional root nodules (29) for Dan Kano cultivar while the least (10) was obtained at 4000lit/ha plot. Bornu local cultivar number of functional root nodules was highest (21) at 8000lit/ha plot and least (13) in 4000lit/ha level. Bornu local cultivars recorded the highest (34) in 8000lit/ha while the least was obtained in 4000lit/ha. Sokoto local cultivar was more favoured by all levels of Oil palm sludge. Although, highest number of functional root nodules (50) was recorded in 8000lit/ha and least (17) in 4000lit/ha plot. At 8 WAP, Dan Kano cultivar had the highest number of functional root nodules in 8000lit/ha. This was followed by 6000lit/ha level. The least (10) was obtained at control plot. Bornu local recorded 27 functional root nodules at 8000lit/ha while the least number (10) was observed in 4000lit/ha plots. Similarly, Sokoto local cultivar had the highest number (36) of functional root nodules in 8000lit/ha whiles the least was recorded in control plot. However, Sokoto local cultivar was favoured than other cultivars irrespective of level of oil palm sludge applied.

Dry season planting did not show different performance when compared with wet season planting. Dan Kano had the highest (37) at 8000lit/ha and control plots. Bornu local cultivar number of functional root nodules was highest (28) at 8000lit/ha whereas least (13) was recorded at control plot. Sokoto local indicated the highest (39) in 8000lit/ha while the least (12) was recorded in control plot.

Number of non-functional Root Nodules at 6 and 8 WAP during wet and dry seasons.

During wet season, Dan Kano recorded more non-functional root nodules in 4000lit/ha plots. Least number was observed in 8000lit/ha plots. Bornu local had more in control plot whereas 4000, 6000 and 8000lit/ha did not vary significantly. Sokoto local cultivar obtained more number of non-functional root nodules (10) in control plot while the least number was recorded in 8000lit/ha level. In dry season, Dan Kano cultivar also had highest number in control plot while least number was recorded in 8000lit/ha. Bornu local cultivar had least number in 8000lit/ha and had highest in control plot. Sokoto local cultivar also maintained similar trend where increasing Oil palm sludge increases the number of non-functional root nodules remarkably as indicated in Table 3.

Nematode Population

The impact of Oil palm sludge levels on root knot nematode (Meloidogyne incognita) population during wet and dry season in Table 4. Results showed that during wet season, control plot had the highest number of root knot nematode

(Meloidogyne incognita) population before and after application even when no Oil palm sludge was applied. This was closely followed by 4000lit/ha plots where there was no significant difference before and after application. However, there was a remarkable difference before and after Oil palm sludge application in plots applied with 6000 and 8000lit/ha. Before Oil palm sludge application, nematode population count was 8,553 whereas significant reduction was observed in 6000 and 8000lit/ha to 2,632 and 2,005 respectively. During dry season, a similar trend was recorded before and after Oil palm sludge application as shown in Table 4.

Number of Seeds/pod and dry matter yield at 14 WAP during wet and dry seasons

The results in Table 5 indicated that Control plot recorded the least number of seeds per pod. Bornu local cultivars had more of seeds per pod in 6000lit/ha while the least number of seed per pod was obtained in Control plot. Sokoto local cultivar recorded more seeds/pod in 8000lit/ha while the least (23) was obtained in control plot during wet season. In dry season, Dan Kano cultivar did not vary significantly in 4000lit/ha and 6000lit/ha plots while 8000lit/ha plot had more seeds per pod. Bornu local cultivar recorded more seeds/pod in 8000lit/ha and least in Control plot. Sokoto local cultivar recorded better performance in 6000 and 8000lit/ha plots and least obtained in plot with 4000lit/ha level. Generally, as the oil palm sludge level increases, the number of seeds increased.

Dry matter yield at 14 WAP during wet and dry season is shown on Table 5. During wet season, Dan Kano cultivar had the highest weight (0.25t/ha) in 8000lit/ha and recorded the least weight (0.15t/ha) in 4000lit/ha plot. Bornu local recorded more yield (0.27t/ha) in 8000lit/ha plots. Sokoto local had more yield (0.30t/ha) in 8000lit/ha level of application. In dry season, Dan Kano cultivar had more weight (0.24t/ha) in 8000lit/ha plot and least yield (0.15t/ha) in control plot. Sokoto local cultivar had better performance in yield over other cultivars of cowpea tested irrespective of season and oil palm sludge level applied.

Table 1: Impact of Oil Palm Sludge on three Cultivars of Cowpea Length of Roots at 6 and 8 WAP in both Wet and Dry Seasons in 2012.

	6 WAP						8 WAP					
	Wet season			Dry season			Wet season			Dry season		
OPS level (lit/ha)	Dan Kano	Bornu local	Sokoto Local	Dan Kano	Bornu local	Sokoto local	Dan Kano	Bornu Local	Sokoto Local	Dan Kanu	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
DMRT (0.05)		0.69			0.55			0.56			0.32	

Table 2: **Effect of Oil palm sludge levels on number of functional root nodules at 6 and 8 WAP of three cultivars of cowpea during wet and dry seasons.**

	6 WAP						8 WAP					
	Wet season			Dry season			Wet season			Dry season		
OPS level (lit/ha)	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
DMRT (0.05)	0.83			0.01			0.80			0.03		

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

	6 WAP						8 WAP					
	Wet season			Dry season			Wet season			Dry season		
OPS level (lit/ha)	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
DMRT (0.05)	0.91			2.96			1.02			2.01		

Table 4: **Impact of Oil Palm Sludge Levels on root knot Nematode Population during Wet and Dry Seasons in 2012.**

OPS Level (lit/ha)	Before Application	After Application	Before Application	After Application
0	8,553	8,554	6.695	6.697
4000	8,553	8,554	6.695	6,149
6000	8,553	2,632	6.695	2,001
8000	8,553	2,005	6.695	1,660

Table 5: **Effect of Oil palm sludge levels on number of seeds/pod dry matter yield at 14 WAP during wet and dry seasons.**

Table 5: **Effect of Oil palm sludge levels on number of seeds/pod dry matter yield at 14 WAP during wet and dry seasons.**

	6 WAP						8 WAP					
	Wet season			Dry season			Wet season			Dry season		
OPS level (lit/ha)	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	13	18	23	11	14	19	0.17	0.26	0.24	0.14	0.15	0.15
4000	12	18	23	12	15	18	0.15	1.24	0.24	0.18	0.18	0.18
6000	14	19	23	17	16	19	0.23	0.27	0.26	0.24	0.22	0.23
8000	14	18	25	12	17	20	0.25	0.25	0.30	0.16	0.25	0.24
DMRT (0.05)		0.50			0.26			0.15			0.12	

Legend
OPS = Oil Palm Sludge
WAP = Weeks after planting
Lit/ha = Litre per hacter

Discussion

The lengths of roots for the three cowpea test crops were taken at 6 and 8 weeks after planting. There were significant differences observed in cowpea root lengths as the rates of application increased. Length of roots decreased as the treatment levels decreased in cowpea cultivars used. Most of the oil palm sludge is concentrated in the top soil and cowpea has majority of its roots in this highly concentrated zone, it is likely to absorb more of the sludge application effects. Roots enhance efficient growth and development of plant. 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 McGill (1980), Odu, (1981), and Zuofa, et al., (1989) also indicated that long term effect of oil in soil may be beneficial for crop production in terms of nutrient supply.

Number of 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 highest number of functional root nodules was obtained at 8000lit/ha of oil palm sludge applied. The lowest number of functional root nodules was obtained at control and 4000lit/ha plots. The number of functional root nodules variations among the application rate may be attributed to increase in organic matter, nitrogen, phosphorus and oil content.

Contrary to functional root nodules number increasing with oil palm sludge increase, non-functional root nodules number decreased with increasing oil palm sludge. As the level of oil palm sludge increased, number of non-functional root nodules decreased significantly. This trend could be explained to be due to decrease in available nitrogen in untreated plot and less amount of Oil palm sludge may result to immobilization of nutrient resulting in dead root nodules.

Nematode form knots (galls) that are parasitic in nature while Cowpea has the ability to fix nitrogen through the nitrogen fixing bacteria which exhibit similar characteristics and compete for space in the galls. Parasitic nematodes sap salt and minerals from the knots while Rhizobium organisms fix nitrogen to the soil. It therefore implied that there is a significant reduction in nematode population through the oil palm sludge application hence adverse competition between the two organisms. Oil palm sludge influenced the production or formation of seeds per pod of the cultivars of cowpea irrespective of the level of oil palm sludge applied. However, as the level of oil palm sludge increased, the number of seeds per pod increased as well. This finding is in agreement with McGill (1980) who reported that crude oil pollution up to 1% could easily be degraded by natural rehabilitation in soils as the oil could be expected to increase organic matter in the soil and improve the fertility, physical and chemical properties of the soil. There were yield variations among the cultivars at different levels as a result of increase in organic matter, nitrogen in the soil, phosphoric and oil content. McGill (1980) attributed this trend to increased atmospheric N_2 bacteria since bacteria participated most in the degradation of oil and because they require a near neutral soil reaction (pH) for optimal activity.

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Authors' Brief Bio

Prof. Edith Chuku, Department of Applied and Environmental Biology,
Rivers State University of Science and Technology, Port Harcourt, Nigeria.
Email: chuku.edith@yahoo.com.

Solomon Chuku, Department of Applied and Environmental Biology,
Rivers State University of Science and Technology, Port Harcourt, Nigeria.
Email: Ovundah4solomon@yahoo.com.

Joseph Osakwe, Department of Soil/Crop Science,
Rivers State University of Science and Technology, Port Harcourt, Nigeria.
Email: Josephosakwe@yahoo.com