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Growth and Yield Performance of Test Crops under Oil palm Sludge Application in Humid Agro ecology of Rivers State, Nigeria

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Abstract: *This study on growth and yield performance of test crops under oil palm sludge application in humid agro ecology of Rivers State was conducted at the Teaching and Research Farm of Rivers State University of Science and Technology, Port Harcourt, Nigeria. The aim of this study was to determine the effects of varying rates (0, 4000, 8000, 12000 lit ha^{-1}) of palm oil sludge on Okro (Abelmoschus esculentus), maize (Zea mays L), and cowpea (Vigna unguiculata(L) Walp) in the study area. The experimental design was split – plot design fitted into a randomized complete block design with four (4) replications. The results indicate that oil palm sludge at the rate of 4000 lit ha^{-1} enhanced growths and yield of test crops. On growth, okra plant height was 150.25cm and attained a maximum leaf area of 558.02cm^2 while maize was tallest (533.28cm) and produced maximum leaf area of 1629.48cm^2. Okra, maize and cowpea yielded 2398kg/ha, 4560kg/ha and 2782.50kg/ha respectively. Higher rates of 8000lit/ha and above impeded the parameters measured but controlled weed infestations. Therefore, 4000lit/ha rate and evenly distributed on agricultural land is recommended for agronomic performance of the crops studied.*

Keywords: *Agronomic performance, test crops, oil palm sludge, agro-ecology, Rivers State*

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I. Introduction

In Nigeria, population growth had been at a rate of 3% while the aggregate food production increased by only 1.8% (Enabor, 1988). The bulk of the food in Nigeria today is produced by smallholder farmers who practice shifting cultivation systems. But this system is gradually phasing out considering the population increase and pressure on land.

In the guest for economic emancipation and survival, coupled with pressure on land due to increase in population, agricultural activities are also carried out in homesteads. Within these homesteads and farm roads, are small scale industries such as palm oil mill for processing of palm oil during which a bi-product called sludge is produced. Both activities (i.e. farming and milling) are carried out in the rural areas where most farmers reside and do their farming operations while oil mills are established because of the favourable environment for oil palm production.

Therefore crop cultivation is even carried out on lands contaminated with the oil palm sludge. And in order to ensure food production in areas flooded with this oil palm sludge there is need to determine the effects of oil palm sludge on crops. The oil palm sludge is also known as palm oil mill effluent (POME). It is the liquid waste from palm oil purification (extraction). It is essentially an emulsion containing 3-8% solids and 92-97% water. The residual oil content is usually less than 1% although occasionally the effluent of NIFOR oil mill company gives almost 3% oil content (Okiy 1985). There are several sources of sludge namely: Sewage, household and oil palm waste. But attention and interest is on the liquid waste from palm oil processing. Their consistent disposal to arable land is a source of concern, hence this work. And the selected crops for this study are maize, which is a cereal crop, cowpea, which is a leguminous crop, and okra which is a vegetable crop.

The objectives of this study are to determine the effects of oil palm sludge on the growth and yield performance of maize, cowpea and okra; to determine the effects of different levels of sludge application on the selected crops and to assess weed incidence as influenced by oil palm sludge.

II. Materials And Methods

This experiment was conducted in the rainy season from March to July 2013 at the Research farm of the Rivers State University of Science and Technology Port Harcourt. The area is located in a tropical humid zone with distinct wet and dry season. It is situated on latitude 4.5^0N and longitude 7.01^0E with an elevation of 18m above sea level (FAO, 1984). The rainfall pattern is essentially bimodal with peaks in June and September while in April and August there are periods of lower precipitation. The long rainy season is between April and August whereas the short rainy season is between late August and October. The dry season lasts from November to March with occasional interruption by sporadic down pours. Annual rainfall is variable and ranges from an average of 2000mm to 2680mm. The mean monthly temperature ranges between 80^0C and 33^0C while the monthly minimum is between 20^0C and 23^0C. The highest temperature figures are recorded during the months of December to March. A total land area of 30m x 30m ($90m^2$) was cleared and used for the experiment. The experiment was carried out on a Typic Paleudult Soil. The initial fertility status of the soil was determined. The chemical properties analyzed are, N, P, K, Ca, and Mg. The experimental design was a split – plot design fitted into a randomized complete block design with four (4) replications. Each treatment was replicated four (4) times with the treatment appearing once in every row. The palm oil sludge which is a liquid waste from palm oil purification (extraction) was collected from the mill of an oil palm company (Risonpalm Limited) in Rivers State of Nigeria. The sludge was applied at the rates of 0, 4000, 8000, and 12000lit/ha. This was applied evenly using a watering can measuring 10litres. The test crops (maize, okra and cowpea) were planted seven (7) days after palm oil sludge application.

Data collected and recorded included percentage emergence, plant height, leaf area, weed infestation and pod/cob yield. Percentage emergence was taken or counted seven (7) days after planting. Plant height were measured at 2 weeks after planting (i.e. 14 days), and at intervals of 14 days till 12 WAP.

Leaf areas were estimated at 2 WAP, 4 WAP, and 6 WAP. The method used was the tracing method where the leaf is laid flat on paper and the leaf outlines are traced. Then centimeter grid was placed on it and the actual count on the leaf was taken. This method has earlier been used by Ramaunjam and indira (1978) who found it to agree with planimeter readings. The determination of weed infestation was made with a quadrant measuring 100 x 100cm. The density of weeds was estimated using scale of 0-5, where 0 represents no weed or minimum weed density and 5 represents maximum weed coverage. This method has earlier been adopted by Ossom (1986). The weed species subclass and relative abundance were also recorded in each plot. Harvesting of cobs/pods started 8 WAP, therefore harvesting continued every two (2) weeks and this continued until 16 WAP. The pods/cobs were harvested, counted and weighed. The oil palm sludge was analyzed chemically for N, P, K, Ca, and Mg, and the result was recorded. This was done before its application. These effects were statistically assessed by analyses of variance techniques and treatment means compared by LSD as described by Steel Torrie (1960).

III. Results And Discussion

Table 1 shows the results of analysis of some soil chemical properties carried out before planting and the chemical properties of the present oil palm sludge before application and the results of earlier study carried out by other scientists or workers. The result indicates that the soil is acidic. The percentage total Nitrogen (N) and calcium of the soil are below the critical level but other chemical properties of the soil are more than the critical levels. The low Nitrogen (N) level recorded could be as a result of continuous cropping on the experimental site which might have led to nutrient removal from the soil. The low Calcium (Ca) content of the soil could also be attributed to extensive rain fall which might result to leaching the nutrients from the top soil down to the soil profile or horizontal removal of nutrient from the top soil due to water erosion. Different workers on sludge did similar analysis and their result was compared with present study. The result of the present study did not differ so much with other workers result (Hwangi *et al.*, 1978). N, P, K, Mg and Ca were found to be consistently present in relatively large amounts in the sludge, thus confirming the probable usefulness of the sludge at optimal to the test crops.

The effects of various rates of palm oil sludge treatments on percentage crop emergence, plant height, leaf area, yields and weed infestation are presented in Tables 2, 3 and 4.

On percentage crop emergence, the oil palm sludge rates, 0 - 8000lit/ha had significantly higher emergence percentages than 12,000lit /ha. The low percentage of crop emergence due to high level of oil palm sludge application is attributable to poor aeration and wettability (Strafford 1973).

Plant height was not affected by oil palm sludge up to 4000lit/ha but higher rate of application reduced plant height significantly for okra and maize. For cowpea, the treatment did not affect the height up to 8000lit/ha but decreased as the application rate increased. The largest leaf area of 558.09, 1629.48 for okra and maize respectively was obtained at oil palm sludge rate of 4000lit/ha while cowpea has the highest leaf area of 240.19 at 8000lit/ha rate. Subsequent rate has a less leaf areas. Invariably, as the rate increases, the leaf area decreases. Consequently, the leaf area index (LAI) of the plants followed a similar trend. There was a positive correlation (r=0.33) between leaf area and fresh yield of the crops, however, the correlation coefficient was not statistically significant. These results are in agreement with the findings of Watson (1937) and Ashley (1965) on relation of cotton leaf area index to plant growth fruiting. Leaf area measurements are often used in growth analyses and are important in current estimates of potential photosynthesis of crop canopies (Francis *et al*., 1969). According to Isirimah *et al*., (1989), the upper safe level of crude oil for good maize grain yield can be considered as 0.5% oil (by weight) in the soil. And this further supports the earlier conclusion by McGill, 1977 that about 2% crude oil (by weight) in soil imposes serious detrimental effects on economic crops and seeds.

Yield

The yield of the test crops (okra, maize and cowpea) varies as the application rate increases. The highest yield for okra and maize was obtained at 4000lit/ha palm oil sludge application while cowpea obtained its highest yield from 8000lit/ha. The lowest yields were obtained at 12000 lit/ha palm oil sludge. The fresh weight of yield also followed the same trend. The yield variations among the application rate may be attributed to increase in organic matter, nitrogen in the soil, phosphorus and oil content. The 4000 lit/ha application proved an adequate amount of organic matter and nutrient elements. As the application increases the organic matter and nutrients decreased and was detrimental to the yield increases.

This was confirmed by Isirimah, *et al.,* (1989) when it was observed that available nitrogen decreases with increase in percent oil concentration application. Decrease in available nitrogen with increase in oil levels may be due to immobilization resulting from the use of carbon materials as an energy source by microbes resulting in an increase in population. The resultant increase in the microbe population would demand more nitrogen and thus the available nitrogen in the soil would decrease. It was further reported that available phosphorus in the soil increased with increase in oil levels up to 2.0% level and then decreased. Increase in palm oil sludge will increase microbial activities in the soil which will increase the demand for soil nutrients thereby reducing the available nutrients (N, P) in the soil. This will in turn reduce crop yield.

Weed Infestation

The dominant weed species in the experimental plots is shown on Table 4. Monocot weeds formed the most dominant weed species in all the plots. Guinea grass (*Panicum maximum* Jacq) has the highest percentage of weed abundance in each of the treatment levels. All the treatment levels have equal number of weed species. The control plot has the highest weed score of 3.0 than all other treatment levels of 10-30lit per plot or 4000-12000lit/ha while the lowest weed score of 2.0 was observed in the highest rate (30 lit/plot or 12000 lit/ha). As the palm oil sludge rate is increased, weed infestation decreased. Weed population decreased significantly with increase in palm oil sludge rate. On fresh weight of weeds the same trend was also observed. The highest weight (591.75g) of weeds was received in the control plot while the highest rate has the lowest weed infestations. The results of this experiment indicated that for good ground coverage and weed suppression, it is best to apply higher palm oil sludge level on weedy environment. This confirms earlier report by Kloke (1963) on complete elimination of weed growth resulted from 3.3% oil (by weight) in soil. The oil content in the sludge displaces air from soil pores creating anaerobic situation. This treatment method is the best and economical in weed management.

In conclusion, the results obtained from the study on the effect of palm oil sludge on some crops especially okro, maize and cowpea, showed that it enriches the soil and enhances crop performance at a considerable level of application.

The chemical content of the sludge especially organic matter improves the fertility of the soil. At a treatment level of 10lit plot (4000lit/ha) the test crops performed better. On weed suppression, the control treatment has more weed infestation. As the sludge quantity increases the weed infestation decreases. Weed control was better in higher treatment levels of the sludge, weeds score at the highest sludge level 30lit/plot or 12000lit/ha) was 2.0 while the zero treatment level was 3.0.

In establishing oil palm mill, effort should be made to provide a lagoon or ditches where the oil palm sludge can be discharged so as to avoid polluting the agricultural land. It is only beneficial if a smaller quantity is discharged to agricultural land for crop improvement and soil fertility. The recommended level in the light of this research is 10lit/plot of 25cm^2 or 4000lit/ha of farm evenly distributed. It is also useful for weed control at higher levels.

Table 1: Chemical Analysis of soil and oil palm sludge

Chemical properties	Initial soil samples	Critical level	Present study of Oil palm sludge	Earlier study by Hwangi *et al.*, (1978)
Soil Ph	4.58	-	-	-
Total Nitrogen (%)	0.05	1.5	1.91	1.73
Available P (ppm)	26.22	10.15	0.32	0.31
Potassium (ppm)	29.15	0.24	3.86	3.10
Magnesium (cmol/kg)	2.65	1.9	1.48	1.88
Calcium (cmol/kg)	0.12	3.8	0.40	0.21

Source of critical levels for N & P: Adepetu *et al.*, 1986.
Sources of critical levels for K, Mg & Ca: Agboola and Ayodele 1987

Table 2: Effects of various rates of oil palm sludge on percentage crop emergence, plant height and leaf area of test crops.

POME (lit/ha)	Crop emergence (%)			Plant height (cm)			Leaf area (cm^2		
	Okro	Maize	Cowpea	Okro	Maize	Cowpea	Okro	Maize	Cowpea
0	92[a]	92[a]	92[a]	82.43[b]	413.44 [b]	406.52 [b]	508.25 [b]	1312.51 [b]	227.55 [b]
4000	90[b]	90[b]	90[b]	105.25[a]	533.28 [a]	531.38 [a]	558.02 [a]	1629.48 [a]	233.58 [a]
8000	90[b]	90[b]	90[b]	79.24 [b]	319.16[c]	539.12[a]	402.05[c]	1223.90[b]	248.19[a]
12000	88[c]	88[c]	88[c]	73.15 [c]	233.14[d]	389.41[b]	241.61[d]	937.02[c]	200.77[b]
P (5%)	0	0	0	5.437	42.45	28.36	30.49	122	30.16

Means followed by the same letter do not differ significantly at 5% probability levels as determined by Duncan Multiple Range Test

Table 3: Effects of various rates of oil palm sludge on fresh weight yields of test crops (kg/ha)

POME (lit/ha)	Okra	Maize	Cowpea
0	1399.75 [b]	2395 [b]	1612.50 [b]
4000	2398 [a]	4560 [a]	2782.50 [a]
8000	1055[b]	2480[b]	1747.54[b]
12000	605[c]	2328[c]	876.75[c]
P (5%)	455.53	160.62	200.37

Means followed by the same letter do not differ significantly at 5% probably levels as determined by Duncan Multiple Range Test

Table 4: Effects of various rates of oil palm sludge on weed infestation

POME (lit/ha)	Weed species	Sub class	% Abundance	Weeds score	Fresh wt (g/ha)
0	*Calapogonium mucuniods* *Panicum maximum* Jacq *Commelina benghalensis* linn *Axonopus compressus* Beav	Monocot Monocot Monocot Monocot	7.0 45.0 10.0 38.0	3.0	591.75
4000	*Calapogonium mucuniods* *Panicum maximum* Jacq *Commelina benghalensis* Linn *Axonopus compressus* Beav	Monocot Monocot Monocot Monocot	13.0 58.0 13.0 16.0	2.6	471.50
8000	*Calapogonium mucuniods* *Panicum maximum* Jacq *Commelina benghalensis* Linn *Axonopus compressus* Beav	Monocot Monocot Monocot Monocot	11.0 49.0 7.0 33.0	2.5	296.5
12000	*Calapogonium mucuniods* *Panicum maximum* Jacq *Commelina benghalensis* Linn *Axonopus compressus* Beav	Monocot Monocot Monocot Monocot	11 47.0 7 35	2.0	77.25

References

[1]. Adepetu, J. A. (1986). Soil fertility and fertilizer requirement in Oyo, Ogun and Ondo States of Nigeria. Federal Department of Agriculture and Land research (Publication).
[2]. Agboola, A. A and Ayodele, D (1987). Soil test calibration for upland rice in south western Nigeria. Forest Research 14: 227 - 274
[3]. Ashley, D. A. (1965). Relation of Cotton leaf area index to plant growth and fruiting. *Agronomy Journal* 58:61-64.
[4]. Food and Agricultural Organization, FAO (1984) agroclimatological data, Africa. Vol. 1.
[5]. Hwang, T. K. (1978). Chemical composition of palm oil mill effluents. *Technical Article Planter*, Kuala Lumpur 54: pp.749 – 756.

[6]. Isirimah, O.N., K. Zuofa and P. Loganathan (1989). Effect of crude oil on maize performance and soil chemical properties on the Humid Forest Zone of Nigeria. Discovery and Innovation vol. 1 No 3.
[7]. Kloke, A and O. H. Leh (1963). Soil and Fert. 26:2389.
[8]. McGill, W. B. and N. Nyborg (1975). Reclamation of West Forest soils subjected to oil spills, Alberta institute of Pedology. Pub. No. 6-75 University of Alberta, Edmonton, Alberta, 129pp.
[9]. McGill, W. B. (1977). Soil restoration following oil spills a review J. Canadian Pet. Tech; montral Canada 8pp.
[10]. Muthurajah, R. N. (1976). Direct Utilization of palm oil mill waste by direct application to land Pro. Agro-ind., waste symp. Kuala Lumpur 1975 p. 213.
[11]. Okiy, D. A. Evolving trends in End-use research in the oil palm industry. NIFOR Benin City.
[12]. Ossom, E.M. (1986). Effects of Plant population on yield and weed infestation of cassava-maize intercropping. Indian Journal Agric. Science 56 (10). 732-734
[13]. Steel, R. G.D and Torrie, J.H. (1960). Principles and procedures of statistics with special reference in the Biological Sciences.
[14]. Strafford, G. A. (1973). Essentials of plant physiology, 2nd edition pp201-211. Ibadan: Heinemann Educational books Limited.
[15]. Watson, D. J. (1937). The estimation of the leaf area in field crop Journal of Agric. Science 27:474-483.

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