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The performance of maize (*Zea mays*) in soil contaminated with palm oil mill effluent (POME) in South, South Central Nigeria

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ABSTRACT: The work on the performance of maize (*Zea mays*) in soil contaminated with POMEW in South, South Central Nigeria was conducted between 1st March, 2009 and 31st May, 2009 at Ozoro to examine the impact of POME on soil properties as well as maize's performance. Plot of land measuring $25m^2$ subdivided into 5 sub plots was mapped out within POME contaminated and non POME contaminated soils in the same site for the study. Western yellow seeds of maize were planted at each treatment at spacing distance of 50cm x 50cm between and within rows. The performance parameter measured were germination rate (%), height (m) leaf area (cm^2) tasselling rate (%) and yield. It was observed that soil in POME contaminated site had better/stabilized structure, higher organic matter, nitrogen, phosphorus and exchangeable base content than non-contaminated soil. More so, the performance of maize in terms of germination rate, height, leaf area, tasselling rate and yield was significantly better in POME contaminated soil. It was therefore recommended that POME should be used as soil amendment materials for the growth of maize. However further researches on the dosage of POME to be used for per hectare, period of application prior to planting as well as mode of application should be looked into.

Keywords: Maize; Zea mays; Performance; Soil contamination; Palm oil mill effluent.

Introduction

Waste materials have been applied to agricultural land for centuries (Smith, 1973). Crop residues animal wastes, municipal and more recently industrial wastes and by-products are among the many materials applied to land for treatment and disposal (Henson, 2003).

Many studies have recommended treatment and disposal on land as being the ultimate method for reducing the adverse impact of many types of waste materials (Clay, 2004). But, it must be handled with caution. Recent activities aimed at environment decontamination have led to many innovations in waste handling and treatment (Friends of the Earth, (FOE), 2005).

Two systems developed recently for liquid waste management involve spraying or surface irrigating agricultural land with the liquid waste instead of dumping them into the streams and rivers (Anderson, and Wallace, 1971).

Palm, soybean and other edible oils obtained from agriculturally grown plants are used for cooking and other products. During the process of extraction of oil, many wastes are produced and disposed off on the land. One of the most common wastes emanating from palm oil processing is Palm Oil Mill Effluent (POME).

In South Central Nigeria, especially the upland areas, between 60 and 70% of the families have oil palm plantation as such processing of palm fruits is one of the major activities that goes on in the area (Personal Communication). It has been observed that almost all the Palm Oil Processing Waste (POME) are being disposed

off indiscriminately on the ground. It therefore become very imperative to question the impacts of this waste on soil properties and performance of crop so as to justify its potential on land and crop. Many studies on the impacts of agricultural wastes such as crop residues and animal wastes on soil properties and crop performance have proven positive and hence the use of these wastes as soil amendment materials (Allison 1999, Kock, 2005, and Smith, et al, 2007). However, little or no study on the impacts of POME on soil's properties and crop performance has not been carried out within the zone of study and thus dearth of information. This work was therefore necessitated in order to generate useful data on the impact of POME on soil properties and performance of maize in South, South Central Nigeria. Thus, the main objective of the work was to examine the impact of POME on the properties of soil and maize performance in South, South Central Nigeria.

Materials and Method

The study was carried out in Delta State Polytechnic, Ozoro agronomic farm located between latitudes $5^0 30^1$N and $5^0 45^1$N longitude $6^0 05^1$E and $6^0 13^1$E. The mean annual rainfall is between 2,500mm and 3000mm and the mean temperature is between 28^0C and 30^0C with swampy and derived guinea savannah vegetations, its altitudinal position is below 50 meters above the sea level (Ofunne, 1993). The soil of the study area is acidic and were structured.

Raw POME, POME contaminated soil and non contaminated soil in the same environment were collected and analysed for some of their properties using the soil analysis standard method prescribed by Black (1965).

A piece of land measuring $25m^2$ each in POME contaminated and uncontaminated soils were subdivided into 5 subplots for the experiment. Maize (Zea mays) seeds of Western Yellow I (WYI) variety were planted at a spacing distance of 50cm by 50cm between and within the row in both treatments. The experiment lasted for 12 weeks between 1st March 2009 and 30th May, 2009. The performance parameter observed and measured were: Germination rate (%) plant height (m), leaf area (cm^2), Tasselling rate (%), Cob weight (kg) at harvest, Cob weight (tons) per plot and Cob weight (tons) per hectare at harvest. All the data were subjected to Student "t" test.

Results and Discussion

The characteristics of the soil of the soil of the study area.

The characteristics of the soil of the study area are shown in Table 1. The soil is loamy sand textured, well structured and acidic with high content of organic matter, nitrogen and potassium. This may be attributed to the nature of parent material and the economic activities of the people. However, the POME contaminated soil has more stable aggregates, higher organic matter, nitrogen and exchangeable base content than non-POME contaminated soil. This may be attributed to the characteristics and contents of POME that may have been transferred to the contaminated soil (Table 2).

Germination Rate (%) of Maize

The germination rate within the first - six days after planting ranges from 30 – 100% as shown in table 3. It was observed that at the first two days after planting, zero germination was recorded in both treatments but at the 3rd day, 60% of the maize planted in POME contaminated soil has germinated while only 30% germination was recorded in non POME contaminated soil. At the 4th day after planting, 100% germination was recorded in POME contaminated soil while in non-contaminated soil, 65% germination was recorded. At the 5th and 6th day after planting, 80% and 100% germination was recorded respectively in non-contaminated soil. However, germination rate was significantly higher in POME contaminated soil at the 3rd, 4th and 5th day after planting except on the 6th day.

Height (m) of Maize

The average height (m) of maize shown in table 4 ranges from 0.2m to 2.1m between the 2nd and the 12th week. The height of maize varies between the two treatments at different weeks the experiment lasted. However, the growth/height of maize was higher in POME contaminated soil than the non-POME contaminated soil throughout the period of the study. At the 2nd week after planting, the height ranged from 0.20 to 0.31m. At the 4th week, it

ranges between 0.60m and 1m. At the 6th week, the height ranged from 0.9m to 1.2m. At the 8th week, it ranges from 1.0m to 1.5m, at the 10th week, it ranges from 1.3m to 1.8m and 1.5m to 2.1m at the 12th week. In all, maize height was significantly higher in POME contaminated soil. However, maize plants in non-contaminated soil were more resistance to wind throw/logging.

Table 1: The characteristics of soil of the study area.

Parameters	Measured Value (NPCS)	Measured Value (PCS)
Clay	16%	18%
Silt	10%	10%
Fine sand	50%	52%
Coarse sand	24%	20%
Total sand	74%	72%
Textural class	Loamy sand	Loamy sand
Bulk density	1.25g/dm^3	1.35g/dm^3
Porosity	47.1%	50.9%
MWDW	0.816	1.126%
MWDD	1.203	1.403%
PH (H_2O)	5.6	5.8%
PH (kcl)	4.1	4.6%
Carbon	0.64%	1.2%
Organic matter	1.10%	2.1%
Nitrogen	0.124%	2.0%
Sodium	0.05 meg/100g	0.25 meg/100g
Potassium	0.03 meg/100g	4.2 meg/100g
Calcium	0.50 meg/100g	1.2 meg/100g
Magnesium	0.59 meg/100g	1.5 meg/100g
ACEC	5.2 meg/100g	6.8 meg/100g
ECEC	4.8 meg/100%	10.8 meg/100%
B. Sat.	25%	70.4%
Phosphorus	3.5ppm	6.8ppm
Aluminum	2.8%	2.6%
Hydrogen	0.8%	0.4%
Exchangeable Acidity	3.6%	3.0%

NPCS: Non Palm Oil Processing Waste (POME) contaminated soil.
PCS: POME Contaminated Soil.
Source: Lab. 2008.

Leaf Area (cm^2) of Maize

The leaf areas between the 6th and 12th week as shown in table 5 ranged from 310(cm^2) to 900(cm^2). The leaf area was significantly larger in POME contaminated soil throughout the period the study lasted. At the 6th week, the leaf area was between 310cm and 446cm, at the 8th week, it was between 310cm and 520cm, at the 10th week, it ranges from 400cm to 700cm and at the 12th week, it was between 430 to 900cm.

Tasselling Rate (%) of Maize

Taselling rate between the 8th and 12th week after planting as shown in table 6 ranged from 53% to 100%. The tasselling rate was significantly higher in POME contaminated soil at both the 8th and 10th week after planting. At the 8th week, the range was between 53% and 90%, at the 10th week, it ranges from 85 to 100%. At the 12th week, 100% tasselling was recorded in both treatments.

Yield of Maize

The average weight (kg) of Cob at harvest per maize plant as shown in table 7 ranged between 0.4kg to 0.6kg. The higher weight (0.6kg) was recorded in POME contaminated soil. Better performance/higher yield obtained from maize in POME contaminated soil may be attributed to favourable growth/development conditions created by the impact of POME on the soil. Better/more stabilized structure, higher organic matters, nitrogen, phosphorus and exchangeable bases content in POME contaminated soil may have contributed to the better performance of maize and consequently higher tons of maize Cob per hectare as shown in table 8. The maize planted in POME polluted soil yields 2.4 tons/hectare while maize planted in non-POME contaminated soil yields 1.6 tons/hectare.

Conclusion and Recommendation

Maize grown in POME contaminated soil significantly performed better than the maize grown in non-contaminated soil. More so, POME contaminated soil has better physical and chemical properties compared with non-contaminated soil within the same environment/site. It was therefore recommended that POME should be used as soil amendment materials for the growth of maize plant. However, further researches on the dosage of POME to be used per hectare, the period of application prior to planting for better plant production and other crops that will respond positively to POME application as well as mode of application should be looked into.

Table 2: The characteristics of POME

Parameters	**Measured Values**
pH	5.0
Nitrate	35 ppm
Total Nitrogen	760 ppm
Total Carbon	N.A
Phosphorus	180 ppm
Potassium	2,275 ppm
Magnesium	2 ppm
Manganese	615 ppm
Calcium	437 ppm
Iron	46.5 ppm
Boron	7.6 ppm

Source: Lab. 2008.

Table 3: Germination rate (%) of maize at 1st to 6th day after planting.

Days After Planting	**POME Contaminate Soil (PCS)**	**Non POME Contaminated Soil (NPCS)**
1	-	-
2	-	-
3	60	30
4	100	65
5	100	80
6	100	100

Table 4: Average maize height (m) at various weeks after planting.

Weeks After Planting (WAP)	POME Contaminate Soil (PCS)	Non POME Contaminated Soil (NPCS)
2	0.31	0.20
4	1.0	0.60
6	1.2	0.9
8	1.5	1.0
10	1.8	1.3
12	2.1	1.5

Table 5: Average Leaf Area (cm^2) at various weeks after planting.

Weeks After Planting	POME Contaminate Soil (PCS)	Non POME Contaminated Soil (NPCS)
6	446	310
8	520	320
10	700	400
12	900	430

Table 6: Tasselling rate (%) at various weeks after planting.

Weeks After Planting	POME Contaminate Soil (PCS)	Non POME Contaminated Soil (NPCS)
8	90	53
10	100	85
12	100	100

Table 7: Average weight (kg) per Cob of maize at harvest.

Treatments	Weight (kg/cob)
PCS (POME Contaminated Soil)	0.6
NPCS (Non POME Contaminated Soil)	0.4

Table 8: Average weight (tons) of Cob per hectare.

Treatments	**Tons/hectare**
PCS (POME Contaminated Soil)	2.400
NPCS (Non POME Contaminated Soil)	1.600

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