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Potentials of bioremediations of palm oil mill effluent: Effects on growth and yield parameters of maize plant (*Zea mays L.*)

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Abstract

This greenhouse study was conducted in the Greenhouse of the Department of Applied Biology, Ebonyi State University, Abakaliki, to evaluate the effect of palm oil mill effluent (POME) on the shoot fresh weight, shoot dry weight, root fresh weight and root dry weight of maize plant *(Zea mays)*. POME is produced in large quantity in Nigeria and its disposal is a major concern among palm producing industries; and maize is known to be one of the world's most important crop plants. The growth and development of maize plants with treatment of various quantities of POME (25 ml, 50 ml, 75 ml and 100 ml) were investigate and studied using a randomized complete block design (RCBD). A total of 100 maize seeds (four seeds per replicate) were sown and raised in 10 cm in diameter with a volume of 644 ml sterilized container prepared with cotton wool and irrigated every third day for 12 days with different quantities of POME ranging from 0 ml, 25 ml, 50 ml, 75 ml to 100 ml which represents the following treatment groups; T1, T2, T3, T4 and T5 respectively that were each replicated 5 times (R_1, R_2, R_3, R_4 and R_5). T1 is the control group and was irrigated with distilled water. Germination percentage data of the treatment groups were taken every 24 hours and the seedling harvested after 20 days post-planting. The shoot and root fresh and dry weight were taken and recorded. Percentage germination of the treatment groups were subjected to a one-way ANOVA which indicated that a significant differences $(F(3,20) = 28.013, p = 0.001)$ exist between different groups. The shoot fresh weight and shoot dry weight decreased from 0.97 g to 0.42 g and 0.63 g to 0.21 g respectively with increased quantity of POME treatment. However, maximum (0.68 g) root fresh weight was in recorded in T1 and least (0.47 g) in T_3. Results indicated that highest (0.37 g) root dry weight was also recorded in T2 but unlike root fresh weight, least (0.26) root dry weight was obtained in T5. The study revealed that at lower concentrations, POME showed a favourable effect on the parameters measured; but at higher concentrations, inhibitory effects on development of maize were observable.

KEYWORDS: Pome, Shoot Dry Weight, Maize, Root Dry Weight, Shoot Fresh Weight.

Introduction

Studies on the use of palm oil mill effluent as soil amendments have gained attention in recent times. The controlled application of the effluent has been reported to increase soil pH, K, Ca, Mg and organic matter (Poon, 1982; Lim and P'ng 1983; Onyia *et al.*, 2001; Okwute and Isu, 2007), soil water holding capacity and porosity. The application of palm oil mill effluent has been reported to increase the growth, dry matter, grain yield and nutrient content of maize (Nwoko and Ogunremi, 2010) and the growth of tomato plant (Nwoko *et al*., 2010).

A lot of POME is generated from many states in Nigeria with little or no agricultural utilization to ascertain its potentials (Nwoko *et al*., 2010). The solid waste products that result from the milling operation are fruit bunches, palm fibre and palm kernel. In both traditional and modern milling settings, these solid waste products are all put to economically useful purposes such as fuel material and mulch in agriculture (Nwoko *et al*., 2010). It is the POME that is usually discharged into the environment, either raw or treated. Raw POME consisting of complex vegetative matter is thick, brownish, colloidal slurry of water, oil and solids including about 2 % suspended soils originating mainly from cellulose fruit debris, that is, palm mesocarp (Bek-Nielsen *et al*, 1999).The raw or partially treated POME has an extremely high content of degradable organic matter, which is due in part to the presence of unrecovered palm oil (Ahmad *et al*., 2003).This highly polluting waste can cause pollution of water ways due to oxygen depletion and other related effects as reported by (Ahmad *et al*., 2003). Rajeev *et al.* (2013) suggested that POME can be used safely for kidney bean (*Phaseolus vulgaris*) cultivation.
It has been observed that most of the POME produced by the small-scale traditional operators undergoes little or no treatment and is usually discharged into the surrounding environment (Hartley, 1988). Thus, while enjoying a most profitable commodity, palm oil, the adverse environmental impact from the palm oil industry cannot be ignored.
In Nigeria, palm oil effluent is discharged into the environment in its raw form especially by small-scaled operators. This study tried to evaluate the effect of POME on selected growth parameters of maize.

Materials and Methods

Study Area

Greenhouse study was conducted in Ebonyi State University, Abakaliki, Ebonyi State; with an average temperature of 32 ^{0}C. It is located between longitude 8^{0}06’11’E and latitude 6^{0}20’49’N and 118 m above sea level. The climate of Abakaliki is tropical with two major seasons; rainy (April- October) and dry (November - March) seasons. The rainy season is associated with prevalence of moisture laden maritime south-west trade wind from the Atlantic Ocean; while the dry season is influenced by the dry wind blowing from the Mediterranean Sea across Sahara desert and down to southern Nigeria. Rainfall is bimodal, peaking usually in July and September with a brief drops in August. Minimal rainfall occurs in January and February, followed by the onset of heavy rainfall in April. The mean annual rainfall is 2300 mm, while the mean relative humidity is about 70 %. Abakaliki is both commercial and agrarian city producing varieties of arable crops including maize.

Experimental Design

Palm oil mill effluent (POME) was obtained from the point of its discharge at Afikpo, Ebonyi State, while the maize seeds Apo Supper variety was obtained from the International Institute for Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria.

The POME was mixed with sawdust in a ratio of 4:1 to absorb the remaining oil content before putting it in a pre-cleaned 25 litre container. The POME was analysed before application as described by (Mylavarapus and Kennelley, 2002). The syringe was calibrated up to 100 ml. Wire gauze and net were used in the direct covering of the sowed maize seeds to prevent assess of insects, birds and other external factors that may contribute to the poor growth and development of the seeds (Shahnaz and Sheikh, 1980). A total of 25 sterilized containers of 10 cm in diameter with a volume of 644 ml each were laid out in a randomised complete block design (RCBD) with five treatment groups (T1, T2, T3, T4 and T5) indicating different quantities of POME (0 ml, 25 ml, 50 ml, 75 ml and 100 ml respectively) and each treatment replicated five times (R1, R2, R3, R4 and R5). Cotton wool was placed inside each of the containers to provide support and platform for the seeds.

A known volume of distilled water and POME of different quantities were prepared as stated below:

T1; 100 ml distilled water; the control
T2; 25 ml POME diluted with 75ml distilled water
T3; 50 ml POME diluted with 50ml distilled water
T4; 75 ml POME diluted with, 25ml distilled water
T5; 100 ml POME, was measured into the Petri-dish.

A total of 4 maize seeds were sown per replicate in all the five treatments. A 100 ml syringe was used in the collection and application of the POME into the container, to irrigate the maize seeds sown based on the treatment group. This was done in order to obtain an accurate result by preventing imbibitions of the maize seeds. Containers were irrigated every third day for 12 days, according to the treatment group and finally allowed to stay for additional 8 days, making it a total of 20 days post-planting period.

Measurement of Parameters

Germination percentage were measured every 24 hours for 20 days using a method described by

(Marli *et al.,* 2009). Afterwards, the seedlings were harvested alongside the roots and arranged in replicates according to their treatment groups. The shoots and roots of each group were weighed and later subjected to dryness in an oven at 72 ^{0}C for 72 hours. Values obtained were weighed accordingly and recorded.

Data Analysis

Values for germination percentage were collected for every replicates and arranged in spreadsheet according to the treatments. Analysis of variance was carried out to evaluate the overall differences and later post-hoc comparisons done to evaluate the pair-wise differences among treatment group means. The homogeneity of variance was determined using Leven's test. The fresh and dry root and shoot weight were measured using a sensitive weighing balance and their mean values recorded in grams (g).

RESULTS

The analysis of Germination Percentage (G) of maize showed there was a statistically significant difference between group means as determined by one-way ANOVA *(F(3,20) = 28.013, p = 0.001)* - Figure 1. Multiple comparison using Tukey showed the difference between the means of T5 and all the treatment groups (T1, T2, T3 and T4) were statistically significant ($p < 0.05$) -Table 1. Significant differences exist between T1 and T3 (*p = 0.013*) and T3 and T4 (*p = 0.001*). The assumption homogeneity of variance was tested and was found tenable using Leven's Test, ($F(4,20) = 2.6$, $p = 0.167$).

However, results of the analysis of mean values of the treatment groups showed that maximum shoot fresh weight (0.97) was observed in the T1 followed by T2 (0.92), while minimum mean shoot fresh weight (0.42) was observed in T2 -Figure 2. Like shoot fresh weight, maximum shoot dry weight (0.63) was recorded in T1 and least (0.21) seen in T5 -Figure 3.

The result also indicated that, highest (0.68) mean root fresh weight was recorded in T1 and least (0.47) recorded in T3 -Figure 4. However, mean root dry weight was maximum in (0.37 g) in T2 and least (0.26 g) in T5 - Figure 5.

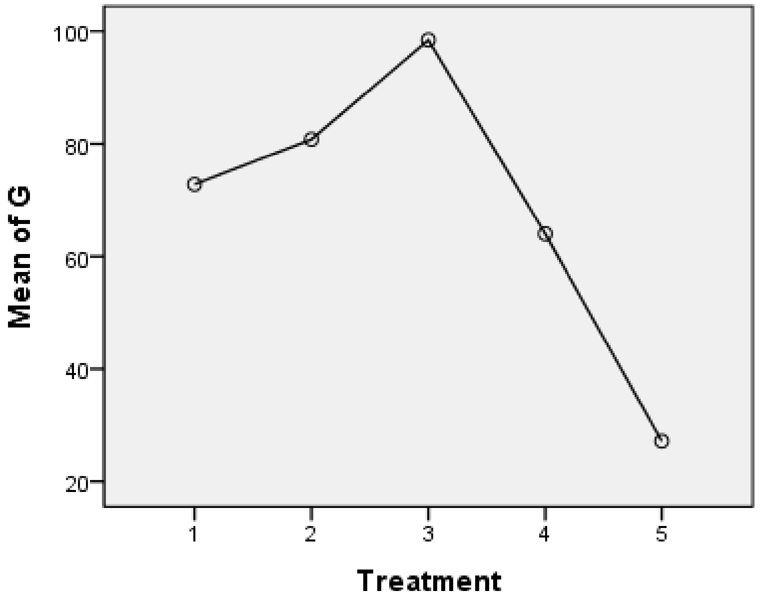

Figure 1: Mean Germination Percentage (G) of Maize Treatment with POME

Table 1: Matrix of means of G of the Treatment Groups

	T1	T2	T3	T4	T5
T1	1	-8.1	-25.6*	8.8	45.6*
T2		1	-17.6	16.8	53.6*
T3			1	34.4*	71.2*
T4				1	36.8*
T5					1

*Post-hoc comparison using Tukey, * shows the mean differences is significant at the 0.05 level*

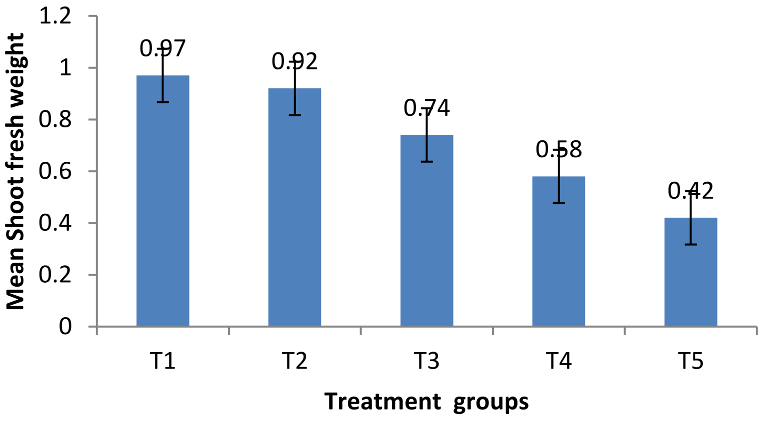

Figure 2: Effects of POME on the Shoot Fresh Weight of Maize Plant (*Zea mays L*)

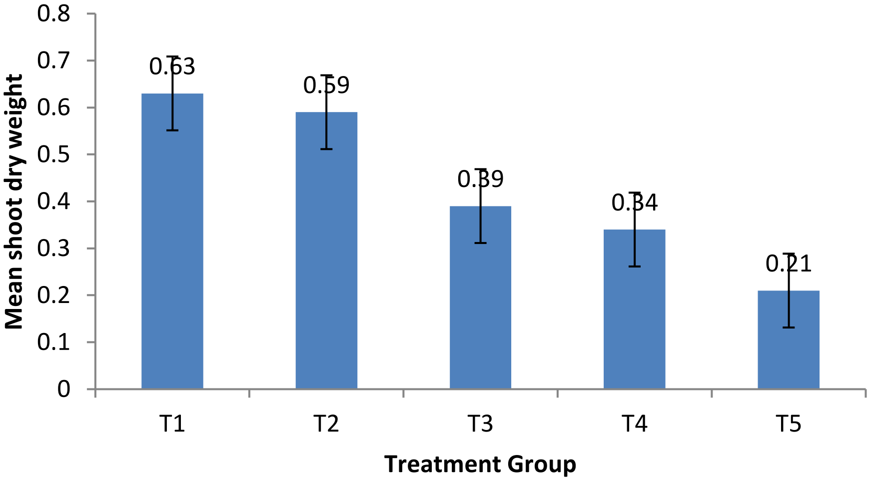

Figure 3: Effects of POME on the Shoot Dry Weight of Maize Plant (*Zea mays L*)

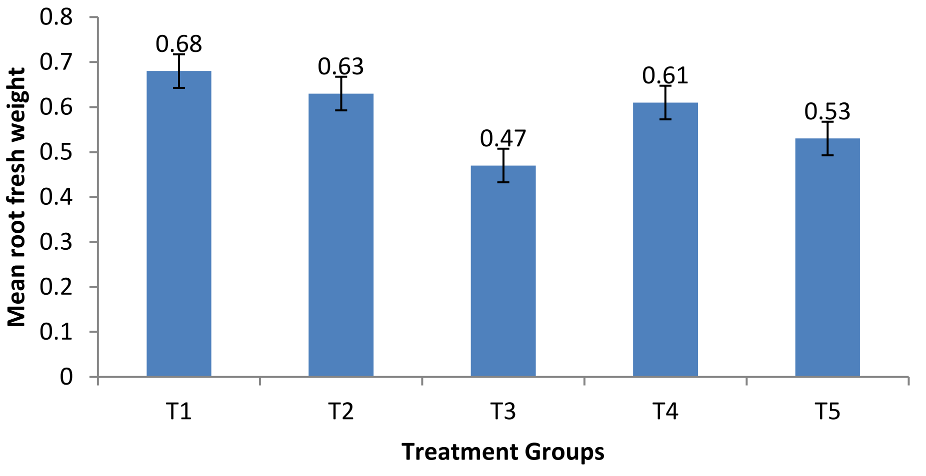

Figure 4: Effects of POME on the Root fresh Weight of Maize Plant (*Zea mays L*)

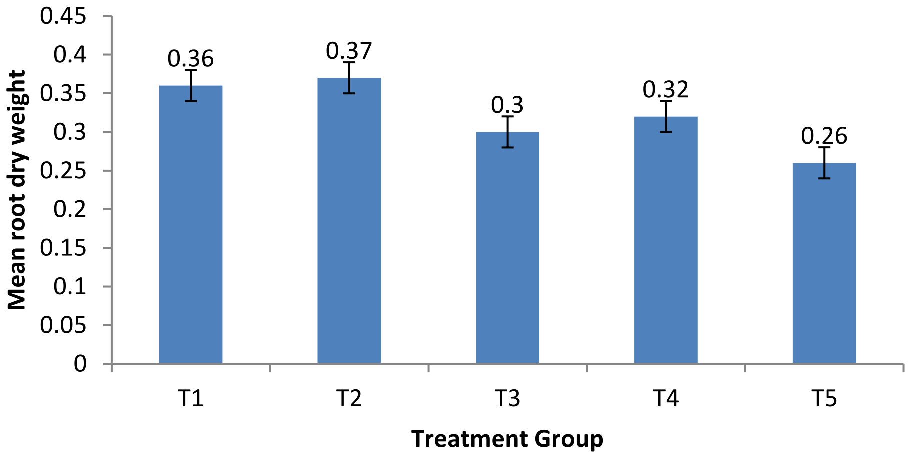

Figure 5: Effects of POME on the Root Dry Weight of Maize Plant (*Zea mays L*)

Discussion

Germination percentage was significantly ($p < 0.05$) lowered by increase in POME concentration. This is a true reflection that at moderate concentration, POME can enhance plant germinability as seen in high germination percentage recorded in T3. Perez *et al.* (1992) stated that POME has high concentration of a phytotoxic substances called polyphenols which are known to possess antibacterial properties. The antibacterial property of POME invariably can provide conducive environment to enhance seed germination, maximum growth and development. Ijah and Antai (2003) in a similar study reported that POME is rich in nitrogen and phosphorus, substances which are crucial in the biodegradation of organic pollutants. This property of POME also portrays it as a good sources of inorganic substances needed for optimal growth in plant when carefully applied. Moreover, Some earlier studies also viewed POME to be non-toxic and bio-degradable substances (Hemming, 1977; Bek-Nielsen *et al*., 1999).

However, it was notable that aside the control group (T1), moderate application of POME had a relative positive effects on the growth and development of maize seedlings as reflected in the maximum mean weight recorded in all the growth parameters (i.e. shoot fresh weight, shoot dry weight, root fresh weight and root dry weight) determined. Improved relative yield efficiency obtained when POME was moderately applied might be due to the cumulative effects of nutrients released by the effluent. Law-Ogbomo (2011) reported that integration of POME and NPK fertilizer in soil provides additional benefits to plants than sole use of POME or NPK.

Conclusion and Recommendation

The study suggest that palm oil mill effluent has nutrients that are necessary for growth and development of maize plant and it is safe when adequately and moderately applied. We therefore recommend further research should be carried out to determine how palm oil mill effluent could be harnessed and used as an alternative to inorganic fertilizer since it is produced in large quantity in most parts of Nigeria.

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