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AN ASSESSMENT OF THE PERFORMANCE OF MAIZE (*Zea Mays* L.) AS AFFECTED BY PALM OIL MILL EFFLUENTS IN ABRAKA, DELTA STATE, NIGERIA

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ABSTRACT

The study was carried out to investigate the possible toxic effect of palm oil mill effluents on maize at varying concentrations. 2kg of soil samples obtained from site II, Delta State University, Abraka was contaminated with different concentrations (25, 50, 75 and 100%) of palm oil processing effluent alongside the control which served as guide for the determination of the toxicity of palm oil processing effluents. The results showed that maize seeds sown in the control soil had 100% germination with germination sighted at the 4th day after planting. 100% germination rate was also recorded in 25% palm oil effluent contaminated soils with germination commencing at the 4th day after planting. 50% concentration showed 55.6% germination rate starting at 6 days after planting. 75% concentration showed 27.6% germination rate starting at day 6 after planting. 100% concentration showed no growth with 0% germination. The highest plant height with mean value of 4.54cm was recorded in the control. The least value of height across the different concentration was observed in the 75% soil contaminated with palm oil mill effluents with plant height of 1.91cm. Seeds sown in 100% POME recorded no growth. The highest leaf number with mean value of 1.71 was recorded in the control. The study showed that pH varied among the different concentration of palm oil mill effluent with a range of 4.06 to 4.34. The study showed that palm oil processing effluents have negative effects on the germination and growth of maize.

Keywords: Assessment, Performance, Maize, Palm oil mill effluents

INTRODUCTION

Oil Palm (*Elaeis guineensis* Jacq.) belongs to the family Aracaceae. It is the most productive oil producing plant globally as well as the world's most important edible oil (Iyankndue *et al*., 2017). It is processed locally and industrially in Nigeria. Oil palm generates many by-products and wastes outside the liquid wastes. Palm oil mill effluents (POME) both in the raw and treated form are nutrient-packed including N, P, K and Mg as well as 90-95% of water. It also contains high amount of oil, fat and grease as well as Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD). The fresh POME has the pH of 3.3-4.6, high in temperature and solids. Sridhar and Adeoluwa (2009) established that every part of the oil palm has notable economic value locally and industrially. For example, the trunk can be used for mulching, particle bead, fibre bead, plywood, paper production and as organic fertilizers (Dutta, 2010). Soil contamination from palm oil mill effluents is on the increase because the effluents are discharged directly on agricultural land and into water bodies. Effluents from palm oil mills can cause a lot of changes to the soil physicochemical parameters, biological alternation of the soil and consequently, the growth and productivity of agricultural crops (Rosenani *et al*., 2016; Amirul *et al*., 2022).

Maize, an annual crop with so many uses (Agbogidi *et al*., 2006) grows well in various agro-ecologies and is parallel to any other crop because of its ability to adapt to any environment. It is the commonest cereal of global importance as food source for man and livestock; industrial and ready availability for research purposes (Agbogidi *et al*., 2007a; Agbogidi *et al.*, 2007b; Shiferaw *et al*., 2011). The high demand for maize in the developed world and predicted higher demand in the developing world is due to the rapid growth in poultry industry to feed the world teeming population. Similarly, the changing climatic conditions coupled with the high incidences of biotic stresses and abiotic stresses including pollution and heightened anthropogenic factors have also affected maize production (Agbogidi, 2021). It is against this background that a study to assess the performance of maize as influenced by palm oil mill effluents has been embarked upon with a view to documenting their effects on the plant and proffering solutions to rural maize farmers. Prior studies have been on water spinach (*Ipomea aquatica*), tomato (*Solanum esculentus*) and soybean (*Glycine max*) and they showed significant reductions in the growth properties of the plants (Falodun *et al*., 2011; Gandahi and Hanafi, 2014; Loh *et al*., 2019 and Maliki *et al*., 2020). Earlier studies by Okwute and Isu (2007) noted some changes in the soil quality of palm oil mill effluent contaminated soil when compared with unimpacted soils. Most of the palm oil mill effluents are not treated before released into the surrounding especially by small scale mills causing pollution problems. If untreated, POME contains huge amount of protein, carbohydrate, fatty acids and other materials that can affect the micro-flora and soil conditions. Hence, this study was carried out to evaluate the effects of palm oil mill effluents (POME) on the germination and seedling growth of maize, a universal crop plant.

MATERIALS AND METHODS

Study area

This experimental research was set up at the Department of Botany Annex, Site II, Delta State University, Abraka, Delta State. Abraka lies between latitude 05°47'N and longitude

06^{o}06'E of the equator with an annual rainfall of 3,097mm, annual relative humidity of 83% and annual mean temperature of 30.6^{o}C (Efe and Aruegodor, 2003).

Soil preparation and effluent treatment

The soil was homogenized and air-dried in the laboratory of the Department of Botany, Delta State University, Abraka for two weeks before the commencement of the trial. Two (2) kg of soil was weighed into bottom perforated polypots. The contamination of the soil samples with the POME was done by thoroughly mixing the soil with the different levels of the effluents (0, 25, 50, 75 and 100%) and replicated three times.

Seed planting

The contaminated soil samples were watered one week to allow proper absorption of water and the effluents by the soil. Three seeds of maize were planted directly into the polypots and they were laid out in a complete randomized design. The setup was monitored for 2 weeks after planting while parameters were measured.

Collection of data

Parameters measured were germination characteristics (% germination, germination rate and days to germination) and early seedling growth (plant height, number of leaves, plant girth and leaf area).

Determination of percentage germination and germination rate

Percentage germination for each concentration was determined using the method of Agbogidi (2010), this was done using the formula below:

$$\frac{\text{No of seedlings}}{\text{No of seeds planted}}\ x\ 100$$

Grain sprouting began on the 4th day after which other parameters were measured and documented. Other parameters measured were plant height (cm), number of leaves and leaf area (cm^2). Plant height was measured from soil level to terminal bud at 3 weeks after planting (WAP) using a measuring tape. The number of leaves was determined by mere counting of the leaves while the leaf area was determined with the length and breadth measurements of the longest leaf per plant while correction factor of 0.75 was used to multiply the value following the procedure of Agbogidi *et al*. (2007).

Determination of soil physicochemical parameters and trace metals

Soil physical and chemical parameters including pH, conductivity and cations (Ca, Mg, K and P) were determined using the official method of analysis by AOAC (2009) while the heavy metals (Pb, Fe, Cd, Cr and Al) were determined by Atomic Absorption Spectrophotometry following AOAC (2009)

Statistical analysis

Data collected were subjected to one way analysis of variance (ANOVA) while significant treatment means were separated using the Duncan's Multiple Range Tests using SAS (2000).

RESULTS AND DISCUSSION

The results obtained from the germination experiments are presented in Table 1.

The results showed that maize seeds sown in the control soils had 100% germination and rate of germination with seed sprouting observed at the 4th day after planting. 100% germination rate was also observed in soils with 25% palm oil effluents and days to germination was also 4. Significant reductions were however observed in seeds treated with 50% (55.6%) and 75% (27.6%) treatments respectively as the seeds sprouted at day 6 after planting. No growth was recorded for maize seeds grown in 100% contaminated soils; there was 0% germination (Table 1).

Table 1: Germination characteristics of maize as influenced by palm oil mill effluents

Concentration of effluents (%)	Percentage germination	Days to germination	Rate of germination
0	100.0^a	4^a	100.0^a
25	100.0^a	4^a	100.0^a
50	55.6^b	6^b	55.6^b
75	27.6^c	6^b	27.6^c
100	0.0^c	0.0^c	0.0^c

The means in the same column with same letters are not significantly different (P<0.05) using Duncan's Multiple Range Tests (DMRT)

The plant height of maize seedlings grown in the palm oil mill effluents (POME) is shown in Table 2.

The highest plant height was recorded for plants grown in the control with 4.54 cm and this was closely followed by seedlings in 25% (2.97 cm). The least plant height was recorded for seedlings subjected to 75% palm oil contaminant (Table 2).

Table 2: Plant height of maize grown in different concentration of palm oil mill effluents

Concentration of effluents (%)	Height (cm)/Days after planting (DAP)						
	2	**4**	**6**	**8**	**10**	**12**	**14**	Mean
0	0.0	2.0	2.2	3.1	5.7	8.6	10.2	4.54^a
25	0.0	1.1	2.1	0.0	2.6	6.8	8.24	2.97^b
50	0.0	0.0	1.0	1.8	2.1	4.3	6.50	2.24^c
75	0.0	0.0	1.6	1.9	2.3	3.1	4.50	1.91^c
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0^d

Values are presented in Mean. Values with different superscript are significantly different using Duncan's Multiple Range Tests (DMRT).

There was a significant reduction ($P<0.05$) in the number of leaves, plant girth and leaf area (Table 3, 4 and 5 respectively) with increasing concentration of the effluents.

Table 3: Number of leaves of maize grown in different concentrations of palm oil mill effluent

Concentration of effluents (%)	Number of leaves /Days after planting (DAP)							
	2	**4**	**6**	**8**	**10**	**12**	**14**	**Mean**
0	0.0	1	1	2	2	3	3	1.71[a]
25	0.0	1	1	1	2	2	2	1.28[b]
50	0.0	0.0	1	1	1	0	0	0.42[c]
75	0.0	0.0	1	0.0	0.0	0.0	0.0	0.14[d]
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0[d]

Values are presented in Mean. Values with different superscript are significantly different using Duncan's Multiple Range Tests (DMRT).

Table 4: Plant girth (cm) of maize seedlings as affected by palm oil mill effluents

Concentration of effluents (%)	plant girth(cm)/Days after planting (DAP)							
	2	**4**	**6**	**8**	**10**	**12**	**14**	Mean
0	0.0	0.4	0.6	0.8	1	1.3	1.5	0.8[a]
25	0.0	0.3	0.4	0.5	0.7	0.8	1.0	0.5[b]
50	0.0	0.2	0.2	0.3	0.4	0.6	0.7	0.3[c]
75	0.0	0.1	0.2	0.2	0.4	0.5	0.6	0.2[d]
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0[d]

Values are presented in Mean. Values with different superscript are significantly different using Duncan's Multiple Range Tests (DMRT).

Table 5: Leaf area (cm^2) of maize seedlings as influenced by palm oil mill effluents

Concentration of effluents (%)	Leaf area (cm^2)/Days after planting (DAP)							
	2	**4**	**6**	**8**	**10**	**12**	**14**	Mean
0	0.0	3.4	4.8	10.1	12.8	14.6	17.6	9.04[a]
25	0.0	2.0	3.2	5.6	7.2	8.9	10.0	5.27[b]
50	0.0	0.0	1.0	1.3	1.8	3.7	4.0	1.68[c]
75	0.0	0.0	0.0	0.6	0.8	1.8	2.1	0.75[d]
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0[d]

Values are presented in Mean. Values with different superscript are significantly different using Duncan's Multiple Range Tests (DMRT).

Discussion

The observed significant reduction in the germination characteristics and growth indices of the maize plants including percentage germination, rate of germination, plant height, plant girth, number of leaves and leaf area with increasing level of the POME showed that POME has deleterious effects on the growth and performance of maize. The delayed germination observed in polypots with 50% and 75% contaminant also shows the negative effects of POME on the studied plant. Delayed germination had been reported by Agbogidi *et al.* (2006) and Uhegbua *et al.* (2012) for maize in the presence of crude oil and spent engine oil respectively. Similarly, tomato, soybean and spinach has been reported by Falodun *et al.* (2011), Gandahi and Hanafi (2014) and Loh *et al.* (2019) respectively to exhibit growth reduction at different concentrations of POME. The delayed germination and growth could be attributed to the alteration caused to the soil by the presence of some substances in the POME that could have affected the maize plants. The absence of germination in seeds grown in 100% of the POME could be attributed to the clogging of seeds that could have negatively affected the respiratory process of the seed embryo, hence, it could not sprout. Similar findings have been reported for okra, soybean and cowpea pumpkin by Agbogidi and Nweke, F.U. (2005), Agbogidi *et al*. (2006) and Agbogidi (2010) for crude oil and its products. The embryo could have contacted the POME and hence its inability to sprout.

The reduced growth parameters in plants grown in the contaminated plots when compared with the maize in the uncontaminated soils could be attributed to the disorganisation of soil microflora that affected soil fertility. Nizor *et al.* (2018) and Maliki *et al.* (2020) had prior findings on tomato and oil palm and Brazilian spinach. Agbogidi *et al.* (2007b) noted that oil in soil affects all soil properties. The flora and soil fauna could have been affected as the spaces for oxygen could have been displaced by the presence of the oil particles. This observation in in line with that of Okwute and Isu (2007) and Chinyere *et al.* (2018).

CONCLUSION

The study has shown that palm oil mill effluents have a significant effect of reducing the performance of maize in terms of germination characteristics and growth parameters hence productivity of maize and consequently, food insecurity.

RECOMMENDATION

It is recommended that proper environmental monitoring and treatment should be carried out before the disposal of POME. Environmental education is recommended to farmers for sustainability.

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