



EFFECT OF ORGANIC MANURE ON GERMINATION AND EARLY GROWTH STAGES OF MAIZE (*Zea mays* L.) GROWN ON OIL POLLUTED SOIL

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ABSTRACT

The study was carried out to investigate the effect of organic manure on germination and early growth stages of maize grown on oil polluted soil at the Agronomy Laboratory of the Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University Bauchi. The treatment consisted of poultry manure, cow dung, poultry manure + engine oil, poultry manure + premium motor spirit, cow dung + engine oil, cow dung + premium motor spirit and a control. These were arranged in completely randomized design (CRD) repeated three times. The soils were collected from an arable field, air-dried and artificially contaminated with engine oil and premium motor spirit to simulate an oil spill scenario. Cow dung, and poultry manure were used as source of organic manure. Data were collected on plant height, number of leaves, stem girth and leaf area. All data collected were subjected to Analysis of variance (ANOVA) and means were separated using Duncan's multiple range test. The result shows a significant ($P < 0.05$) difference in plant height on various soils polluted with oil in week 1 and no significant difference was observed in week 2 and week 3. The soil polluted with engine oil (EO) and soil with cow dung (CD) had the tallest plants (42.3 and 41.1) in week 1, followed by control, polluted soil with engine oil plus cow dung (EO+CD) as remediation and premium motor spirit (PMS). On number of leaves, there's no significant difference ($P < 0.05$) in week 2 and week 3 while significant difference ($P < 0.05$) was observed in week 1. Control has the highest number of leaves (4.0) followed by CD, EO+CD, EO+PM and PMS which are 3.33, 3.33, 3.33 and 3.67 respectively. Leaf area on the other hand, a significant difference ($P < 0.05$) on oil polluted soils remediated with cow dung and poultry manure in week I and week 2 with no significant difference ($P < 0.05$) in week 3. On stem girth however, the result shows no significant difference ($P < 0.05$) between all the treatments in week 2 and 3. However significant difference ($P < 0.05$) was observed in week 1. It can be concluded that, oil polluted soils have effect on early growth stages of maize plant and organic manure can be used to reduce the effect of oil polluted soil. Based on the result of this study, oil polluted soil should not be used for maize production even if remediated with organic manure and Further research is recommended on the use of combination of organic manures and inorganic fertilizer.

Keywords: Manure, Growth, Maize, Oil, Pollution, Soil

INTRODUCTION

Soil is the key component of natural ecosystem and environmental sustainability depends largely on sustainable ecosystem (Adesodun, 2008). It is the topmost part of the earth crust that supports agricultural activities. However, soil is contamination by petroleum hydrocarbons is a significant environmental issue, particularly in regions with extensive oil exploration and extraction activities such as the Niger-Delta regions in Nigeria. These hydrocarbons, which include crude oil and its refined products, are known to negatively impact soil health and fertility by adversely affecting soil ecosystem through absorption to soil particles, provision of an excess carbon that might be unavailable for microbial use and an induction of a limitation in soil nitrogen and phosphorus (Atlas *et al.*, 2011). When soil is polluted by oil, it undergoes several adverse changes such as reduced aeration, decreased microbial activity, and altered physical and chemical properties. These processes which affect drastically soil enzymatic activities result in a very slow biodegradation of crude oil polluted soils (Al-Dosary *et al.*, 2021). This not only impedes plant growth but also poses risks to



food security and human health. Consequently, various soil amendments have been used in bioremediation strategies to hasten the process for the actualization of sustainable ecosystem.

In Nigeria, most of the terrestrial ecosystem and shore-lines in oil producing communities are important agricultural land under continuous cultivation. The adverse effects of crude oil pollution on these arable agricultural lands have given rise to various soil treatment options such as the use of surfactants, alternate carbon substrates, organic and inorganic manures and bioremediation plants as bioremediation strategies (Luo *et al.*, 2012).

Organic manures as well as plants have over time been used to improve soil fertility (Njoku *et al.*, 2009). Their efficacy in promoting plant growth in crude oil polluted Nigerians soils has also been well documented (Ogbo *et al.*, 2011).

The effectiveness of these treatments has however been conflicting (Nwaogu *et al.*, 2008). This might be attributed to the heterogeneity of soils and crude oil samples as well as possible interactions between the soil amendments and the natural soil constituents (Konokhua *et al.*, 2007).

One promising approach to mitigating the negative effects of oil pollution on soil and enhancing the growth of crops like maize is the application of organic manure. Organic manure, derived from decomposed plant and animal matter, is rich in essential nutrients and beneficial microorganisms. When applied to oil-polluted soil, organic manure can facilitate the biodegradation of hydrocarbons through microbial activity, improve soil structure, and restore fertility. This remediation process not only reduces the concentration of toxic substances in the soil but also creates a more conducive environment for seed germination and plant growth.

Maize (*Zea mays* L.), a staple crop in many parts of the world, is particularly sensitive to soil conditions. When planted in oil-polluted soils, maize seeds often struggle to germinate, and those that do may exhibit stunted growth, reduced vigor, and lower yields. The presence of hydrocarbons in the soil can hinder water uptake, nutrient absorption, and root development, all of which are critical for the healthy growth of maize. This study is therefore carried out to study the effects of organic manure in remediation of oil polluted soils and early growth of maize seedlings.

MATERIALS AND METHODS

Study Area

The study was conducted at the agronomy laboratory of the Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University Bauchi, Bauchi State. Bauchi is located in the northeastern region of Nigeria. Bauchi State lies between latitude 10°30'N and 10°31'N and longitude 9°50'E and 9°55'E, with an altitude of approximately 690 meters above sea level. The region experiences a tropical climate, characterized by a distinct dry and wet season. The soil type predominantly found in Bauchi State is sandy-loam, which is favorable for agricultural activities, particularly maize cultivation.

Treatments and Experimental Design

The study was designed as a controlled in-vitro experiment to assess the effect of organic manure on the remediation of oil-polluted soil and its subsequent impact on the germination of maize. The experiment involved three main stages:

- Soil contamination
- Application of organic manure
- The germination test.

Soil Collection and Preparation

Soil samples were collected from an agricultural field in Abubakar Tafawa Balewa University (ATBU), Bauchi, Bauchi State with no prior history of contamination to serve as the control. The soil was air-dried, sieved through a 2 mm mesh, and divided into uniform portions for the experiment.

Oil Contamination

The soil was artificially contaminated with engine oil and premium motor spirit (PMS) to simulate an oil spill scenario. The contaminants used were obtained from a local oil depot and applied



to the soil samples at a concentration of 5% (v/w), which represents moderate contamination levels. The contaminated soil samples were thoroughly mixed to ensure uniform distribution of the oil.

Application of Organic Manure

Two types of organic manure were selected for the remediation process: cow dung, and poultry manure. These organic manures were sourced locally from Bauchi State. The organic manures were applied to the contaminated soil at a rate of 10% (w/w). The treated soil samples were as follows:

- Control (C): Non-contaminated soil
- Treatment 1 (T1): Soil contaminated with petrol
- Treatment 2 (T2): Soil contaminated with engine oil
- Treatment 3 (T3): Non-contaminated soil + Cow dung
- Treatment 4 (T4): Non-contaminated soil + Poultry manure
- Treatment 5 (T5): Soil contaminated with petrol + Cow dung
- Treatment 6 (T6): Soil contaminated with petrol + Poultry manure
- Treatment 7 (T7): Soil contaminated with engine oil + Cow dung
- Treatment 8 (T8): Soil contaminated with engine oil + Poultry manure

Germination Test and Plant Growth Measurement

Seed source

Maize seeds (*Zea mays* L.) were sourced from a local agricultural supply store in Bauchi State.

Germination Test

The germination test was conducted in a growth chamber under controlled conditions. For each treatment and control, 2 maize seeds were planted in pots filled with the respective soil samples. The pots were arranged in a completely randomized design (CRD) repeated three times for each treatment and control group.

Measurement of Germination and Growth Parameters

Germination was monitored daily, and the germination rate was calculated as a percentage of seeds that germinated over the total number of seeds planted.

Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) to determine the significant differences between treatments. The means were compared using Duncan's Multiple Range Test (DMRT) at a 5% significance level. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software version 25.0

RESULTS AND DISCUSSION

Plant Height (cm)

Result of the effects of organic manure on plant height of maize grown on oil polluted soil is presented in Table 1. The result shows a significant ($P < 0.05$) difference in plant height on various soils polluted with oil in week 1 and no significant difference was observed in week 2 and week 3. The soil polluted with engine oil (EO) and soil with cow dung (CD) organic manure had the tallest plants (42.3 and 41.1) in week 1, followed by natural fertile soil as control, polluted soil with engine oil plus cow dung (EO+CD) as remediation and premium motor spirit (PMS). The result also showed that PMS + cow dung (PMS+PM), engine oil plus poultry manure (EO+PM), natural soil plus poultry manure (PM) and PMS+PM are all below the control with EO+PM (23cm) as the highest next to the control and PMS+PM (6.9cm) as the lowest respectively. In week 2 some of the plants increase in height while some shrinks back, the control and CD on natural soil has an increase in height while others reduced in height as a result of drying of the shoot apex. This could be as a result of heat effect in the soil because of the pollution and the remediation's (CD and PM) added to the soil. In week 3 all the plant reduces in height, this may be as a result of poor photosynthesis because of the glass covering direct radiation from the sun. The result of this study is in line with that of Konokhua *et al.*, (2007). Who reported that too much heat in the soil as a result of PMS caused the plant to wilt and die eventually, it



also lends support from the findings of Al Dosary *et al.*, (2021) who reported same in his research remediation of crude oil polluted soil using organic amendments and cropping systems.

Table 1: Effects of Organic Manure on Plant Height of Maize Grown on Oil Polluted Soils

Variable	Week1	Week 2	Week 3
Control	33.8 ^{ab}	44.6	42.6
Cow dung	42.3 ^a	50.0	34.5
Engine oil	41.1 ^a	30.1	28.0
Engine oil + cow dung	34.4 ^{ab}	27.0	17.3
Poultry manure	15.5 ^{cd}	14.5	13.0
Engine oil + poultry manure	24.2 ^{bc}	16.3	11.7
PMS	36.2 ^{ab}	29.5	28.8
PMS + cow dung	28.2 ^{abc}	22.0	9.7
PMS + poultry manure	6.9 ^e	00.0	00.0
SEM	6.22	14.78	17.01
P-Value	<0.001**	0.086	0.216

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant.

Number of Leaves

Table 2 presented the result of leave number of maize grown on oil polluted soil which is remediated with cow dung and poultry manure. The result showed that there was no significant difference ($P<0.05$) in week 2 and week 3 in the number of leaves per plant on the various soils while significant difference ($P<0.05$) was observed in week 1. The result also revealed that the control has the highest number of leaves (4.0) followed by CD, EO+CD, EO+PM and PMS which are 3.33, 3.33, 3.33 and 3.67 respectively. The lowest was observed in PMS+PM and PMS+CD. This result is in agreement with the findings of Ojeniy *et al.*, (2002) who reported that too much heat present in the soil from PMS, PM and OM affect plant growth.

Table 2: Effects of Organic Manure on Number of Leaves of Maize Grown on Oil Polluted Soil

Variable	Week1	Week 2	Week 3
Control	4.00 ^a	4.67	5.00
Cow dung	3.33 ^{ab}	4.33	3.67
Engine oil	3.33 ^{ab}	2.67	3.33
Engine oil + cow dung	3.67 ^{ab}	4.33	1.67
Poultry manure	3.00 ^b	2.33	1.33
Engine oil poultry manure	3.33 ^{ab}	2.33	1.33
PMS	3.67 ^{ab}	2.67	28.8
PMS + cow dung	3.00 ^b	2.33	1.33
PMS + poultry manure	2.00 ^c	0.00	0.00
SEM	0.35	1.38	1.93
P-Value	0.002**	0.079	0.306

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant.

Leaf Area (cm²)

Results of effects of organic manure as remediation agents on leaf area of maize grown on oil polluted soils is presented in Table 3. The result indicated that, there was a significant ($P<0.05$) difference in the leaf area of maize grown on oil polluted soils remediated with cow dung and poultry manure in week I and week 2. And no significant difference ($P<0.05$) was observed in week 3. It shows that cow dung (CD) and soils that are polluted with either engine oil or PMS has the highest leaf area with 34.3, 34.9 and 33.3 respectively. The second highest observed was CD+EO (25.3) and the lowest was observed in PMS+PM followed by PMS+CD, EO+PM and the control in week 1.



In week2 CD was the highest stand followed by the control then, PC+EO. The lowest was observed in PMS+PM followed by PMS+CD then PMS. This agrees with the findings of ogboghodo *et al.*, (2001) who said that leaf area index increases with increasing both organic and inorganic fertilizer.

Table 3: Effects of Organic Manure on Leaf Area of Maize Grown on Oil Polluted Soil

Variable	Week1	Week 2	Week 3
Control	22.1 ^{ab}	39.1 ^{ab}	44.1
Cow dung	34.4 ^a	44.5 ^a	35.3
Engine oil	34.9 ^a	18.8 ^{bcd}	21.4
Engine oil + cow dung	25.3 ^{ab}	33.4 ^{abc}	13.1
Poultry manure	9.8 ^{bc}	4.6 ^d	12.0
Engine oil + poultry manure	12.0 ^{bc}	15.7 ^{bcd}	12.5
PMS	33.3 ^a	22.5 ^{abcd}	27.4
PMS + cow dung	16.4 ^{bc}	13.8 ^{cd}	7.70
PMS + poultry manure	3.02 ^c	0.00 ^d	0.00
SEM	7.22	10.70	16.84
P-Value	0.002**	0.007**	0.263

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant.

Stem Girth (cm)

Table 4 presented the result of stem girth of maize grown on oil polluted soil remediated with cow dung and poultry manure. The result showed that there was no significant difference ($P < 0.05$) between all the treatments in week 2 and 3. However, a significant ($P < 0.05$) difference was observed between the treatment in week 1 after germination. The maize stem was thicker in PMS, followed by CD then, EO+PM. The lowest stem girth was found under PMS+PM followed by PMS+CD then, EO, CD+EO and EO+PM which were all statistically the same. The result of this study is in conformity with the findings of Njoku *et al.* (2009) who reported that too much heat in the soil as a result of PMS affect growth and yield of plant.

Table 4: Effects of Organic Manure on Stem Girth of Maize Grown on Oil Polluted Soil

Variable	Week1	Week 2	Week 3
Control	0.93 ^{bc}	0.93	0.97
Cow dung	1.00 ^{ab}	1.07	0.90
Engine oil	0.88 ^{bcd}	0.60	0.60
Engine oil + cow dung	0.88 ^{bcd}	0.93	0.38
Poultry manure	0.80 ^{cd}	0.58	0.23
Engine oil + poultry manure	0.88 ^{bcd}	0.58	0.38
PMS	1.10 ^a	0.63	0.57
PMS + cow dung	0.73 ^{de}	0.50	0.23
PMS + poultry manure	0.60 ^e	0.00	0.00
SEM	0.075	0.31	0.43
P-Value	<0.001**	0.098	0.289

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant.

COCLUSION AND RECOMENDATION

It can be concluded that, oil polluted soils have effect on early growth stages of maize plant and organic manure can be used to reduce the effect of oil pollution of soil. Based on the result of this study, oil polluted soil should not be used for maize production even if remediated with organic manure and further research is recommended on the use of combination of organic manure and inorganic fertilizer.



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