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Response of *ZEA MAYS* to Oilfield Wastewater Treatment

Jaja, E. T. and Nwauzoma, A. B.

Department of Applied & Environmental Biology, Rivers State University of Science and Technology, PMB 5080, Port Harcourt, Nigeria.

ABSTRACT
This study was carried out to determine the impact of various concentrations (0%, 25%, 50%, 75% and 100%) of oilfield wastewater treatment on the physiology of *Zea mays* L(maize) *which is* commonly cultivated in the Niger Delta. The Physiology of the plants such as plant height and girth, leaf length, width and area and root density were determined (Akonye and Nwauzoma,2003); chlorophyll content, crude fibre and total ash were also determined using AOAC(1984) method difference at . Statistical analysis using one way ANOVA showed significant difference *P= 0.005* for all the physiological characteristics of the plant. Chlorophyll content was highest at 50% for *Z. mays* . The girth and height of *Z. mays* were highest at 50% on the 56th day after planting (DAP). Generally, the leaf area was highest at 50% concentrations except at the 14th DAP. The control plants were consistently taller and had highest values at 14 DAP; leaf area was generally highest in the control. At 56 DAP; the leaf area was also highest at the 50% concentration. Fibre content and total ash for *Zea mays* was highest in control and the 100% concentrations respectively. Absorption of total hydrocarbon and other hazardous constituents of the oilfield wastewater by the plants which serve as sources of food for humans pose a serious health hazard. The oilfield wastewater has been shown to have serious deleterious effect on soil and plants, leading to eco-toxicological and agro soil fertility problems that could create an artificial food scarcity.

INTRODUCTION

Wastewater is the natural water that occurs in association with oil and gas deposits in reservoir. Being denser, it lies under the hydrocarbons (Wills, 2000). Wastewater (also called formation water, oilfield brine, oilfield wastewater or connate water) is water that occurs in association with oil and gas in reservoir rocks and is present in the rocks immediately before drilling (Amyx *et al.,* 1960; Obire and Amusan, 2003). Produced brines emanate from formations deep beneath the earth's surface and can be very salty, up to four times higher than se a water(Wills,2000). Oilfield wastewaters may include chemical additives used in drilling and production operations and the oil/water separation process. Produced water from gas operation includes condensed water and has higher content of low-molecular weight aromatic hydrocarbons such as benzene toluene ethyl benzene and xylene (BTEX) than those from oil operation, hence they are relatively more toxic.
Wastewater contains inorganic and organic constituents (Wardley-Smith, 1979); as well as hydrocarbon components (Koons *et al.*, 1979) and have variations in their chemical composition and behaviour (James, 1999). Crude oil (including refined petroleum products) is not the only pollutant of the environment from petroleum exploration and productive activities. The oil-field wastewater resulting from crude oil exploration activities is one of the major pollutants of both terrestrial and aquatic environments (Obire and Wemedo, 1996). Kelly *et al.,* (2003); Utvik, (2003) and Scott *et al.,* (2007) stated that the numerous inorganic and organic constituents dissolved in formation water can be potentially or actually far more hazardous than the crude oil itself.

Wastewater discharged onto terrestrial and into aquatic environment is very devastating because this could lead to eco-toxicological and agro soil fertility problems that would create an artificial food scarcity due to damage to vegetation and aquatic organism (Odeigah *et al.,* 1997; James, 1999). The Federal Environmental Protection Agency (FEPA) and Department of Petroleum Resources (DPR) by Decree 58 of December 30th, 1988, have decried indiscrimination discharge of oilfield produced water onto terrestrial and into aquatic environment.
While dealing with environmental problems, studies on the biological effects of contaminants should form an integral complement to chemical analysis for potential toxic components. It is therefore necessary to carry out investigation on the impact of oilfield wastewater on the physiology of some plants.
Since there is often no petroleum-related sheen associated with spills of these highly saline fluids, they can go unnoticed initially, becoming evident much later when overlying vegetation begins to show signs of stress or dies (Bennmoussa and Achouch, 2005). Of the major economic sectors, the ones most vulnerable to environment pollution or degradation are agriculture and fisheries, mainly because they are dependent on natural systems and resources. The Niger Delta is home to several petroleum and petroleum related exploration activities and

petroleum industries. The intense industrial activities have attracted a lot of research interest especially in petroleum hydrocarbons in soil and aquatic environments and in organisms. However, most of these researches are classified information and as a result, there is little or no literature on the impact of oilfield produced water on the environment and organisms especially plants.

The plant used for this study was *Zea mays* L (Maize). This plant was chosen because of its availability and the fact that it is commonly grown, cultivated and consumed in the Niger Delta region. It also represents a major plant group – cereals.

The aim of the study is to ascertain the impact of various concentrations of oilfield wastewater on the physiology of the plant.

Materials and Methods

Collection of Produced Water Samples

Freshly treated produced water samples from the outlet of the separation/treatment plant of an Agip oilfield flow station located at Kwale Community in Ndokwa East Local Government Area of Delta State were collected in plastic jerry cans.

Collection of Soil

Soil samples were collected from the biological garden behind the department of Applied and Environmental Biology of the Rivers State University of Science and Technology, Port Harcourt. Soil samples are collected from a depth of 0.15 and sieved through a 2mm sieve to remove debris. Thereafter, one kilogramme (1kg) was weighed and put in a black polythene bag. These bagged sieved soil samples were kept in the green house. Each experimental polythene bag was appropriately labelled with the concentration of oilfield wastewater to be used as treatment. Five (5) viable seeds were sown into each bag of soil and treatment with the different concentrations of oilfield wastewater commenced two (2) weeks after the seeds were sown. This was to allow the seeds to germinate before treatment. Treatments were repeated at weekly intervals until 8 weeks when plants were harvested for physiological analysis.

Plants were harvested after 8 weeks of age and analyzed for chlorophyll content, Ash and Fibre content. Growth parameters such as plant height, Leaf width, Leaf length and Leaf area index (LAI) were also measured and recorded. All soils used for planting and soils without planting were taken for analysis.

The randomised complete block design (RCBD) expriemental design was used. All treatments were replicated four times

RESULT

While chlorophyll content was highest at 50% was for *Zea mays*.

The whole plant of *Zea mays* plants from the treated soils showed better root density compared to treated and indicating the impact of the different concentrations (Plate 1). The results indicate that, the higher the concentration of the oilfield wastewater the greater the impact on the physiology of the plant. Statistical analysis using ONE WAY ANOVA Showed that there was significant difference at $P = 0.005$ in the following physiological characteristics of *Zea mays*.

Plant height and girth of *Zea mays*

Day after planting Height – 100%

Day after planting Girth – Control, 25%, 50%, 75%, and 100%

Leaf Length, width, and area of *Zea mays*. Day after planting, Width – Control, 25%, 50%, 75%, and 100%

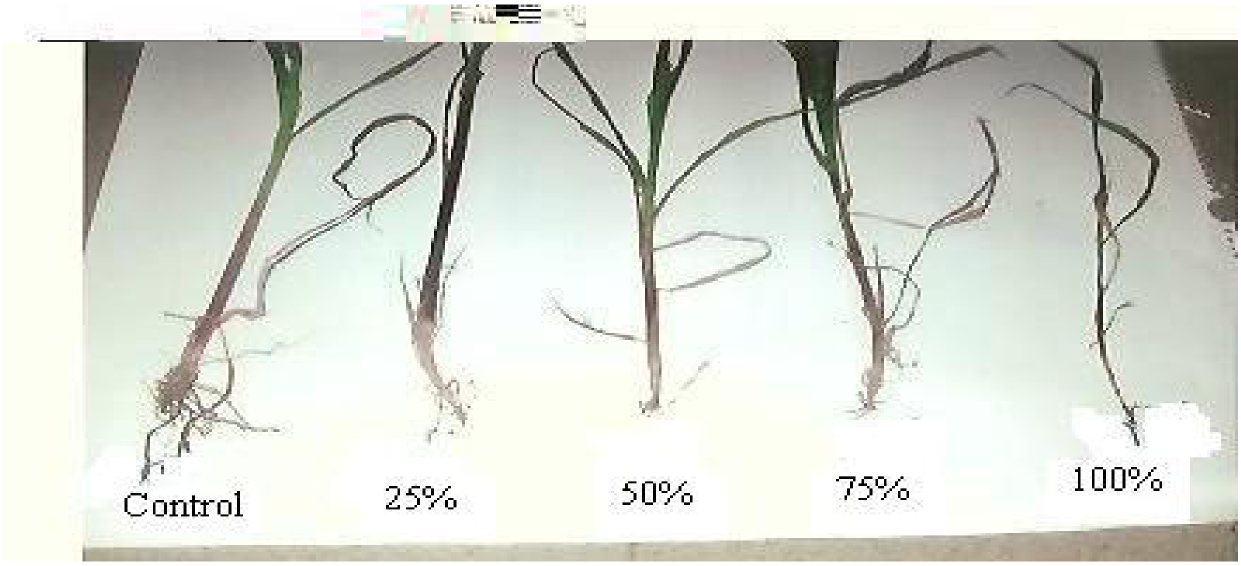
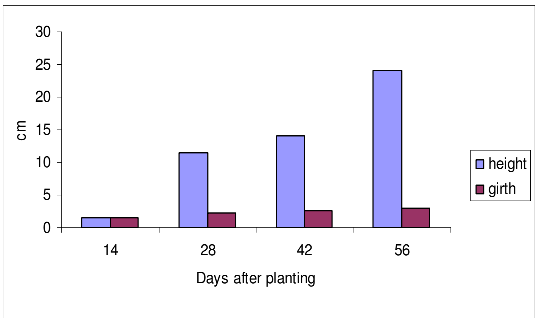
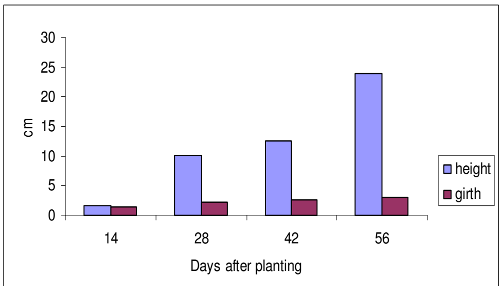


Plate 1: Whole plant of Zea mays from the treated soils showing root density and indicating the impact of the different concentration of the oilfield wastewater

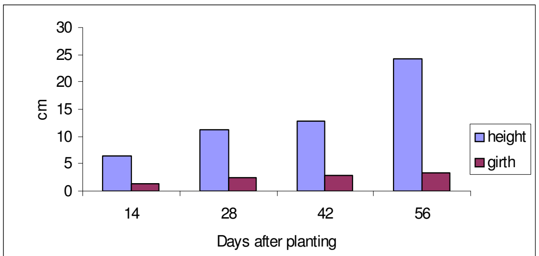
The Mean values of the Plant height (cm) and girth(cm) of *Zea mays* with the various treatments are as shown in Fig. 4.27. The plant got to its highest height at 24.2 on 56th day after planting (DAP) at 50% concentration. The girth of the plant was also greatest at the 50% concentration of oilfield waste



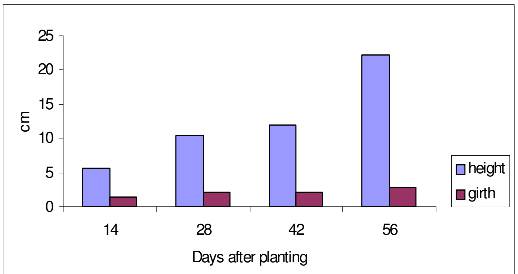
Plant height and girth under control condition (*Zea mays*)



Plant height and girth under 25% condition (*Zea mays)*



Plant height and girth under 50% condition (*Zea mays*)



Plant height and girth under 75% condition (*Zea mays*)

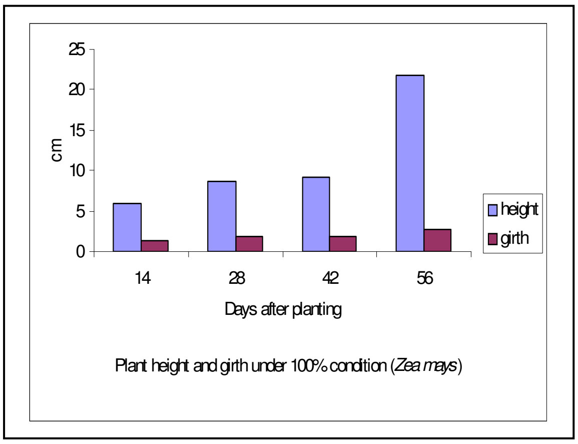


Fig4. 1: Mean values of the Plant height (cm) and girth (cm) of *Zea mays* from soil with the various treatments

The Mean Values of the Leaf length (cm), width (cm) and Area (cm^2) of *Zea mays* with the various treatments are as shown in Fig. 4.28. Generally, the leaf area was highest at 50% concentrations except at the 14th DAP. The leaf area was best at 50% concentration of oilfield wastewater at 56th days after planting.

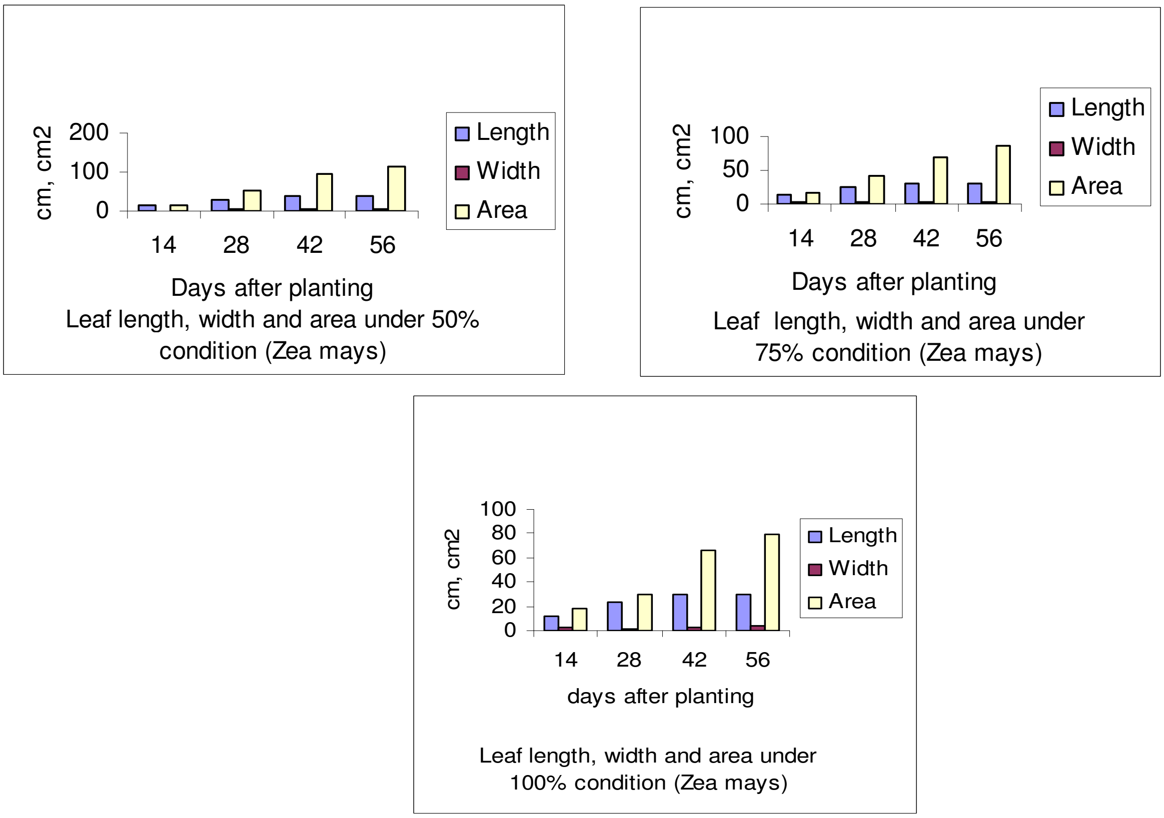


Fig4. 2: Mean values of the Leaf length (cm), width (cm) and Area (cm^2) of *Zea mays* from soils with the various treatments

DISCUSSION

The present study has unravelled the concentrations of the physicochemical constituents including heavy metals of oilfield wastewater and constituents and textural class of soils treated with various concentrations of oilfield wastewater. The study has also revealed the constituents of soils treated with various concentrations of oilfield wastewater planted with various plants which unravelled the impact of the oilfield wastewater on the physicochemical constituents of the soils and on the physiology of the plant, *Zea mays* used in this study.
While the chlorophyll content of *Zea. mays* was generally higher in plants from the treated soils than the control. Reduction in chlorophyll results in reduced produced and yield of the plant.

The Plant height (cm) and girth (cm) of Zea mays with the various treatment showed that the plant got to its highest height at 24.2 on 56th day after planting (DAP) at 50% concentration. The girth of the plant was also greatest at the 50% concentration of oilfield wastewater. The Leaf length (cm), width (cm) and Area (cm2) of Zea mays with the various treatments showed that generally, the leaf area was highest at 50% concentrations except at the 14th DAP. The leaf area was best at 50% concentration of oilfield wastewater at 56th days after planting.

The crude fibre content of Zea. mays was highest in the control plant as compared to those of the treated plants, the reverse was the case for the total ash content. Total ash was however highest in Z. mays at the 100% concentration of oilfield wastewater.
The higher the fibre content, the hardier the plant (Udo and Fayemi, 1975). That is, the plant can withstand more stress. The results of this investigation have shown that treatment with oilfield wastewater had an impact on the hardiness of the various plants and hence their inability to withstand stress which is shown in this study

Conclusion

The oilfield wastewater used in the study has been proven to be a pollutant to the soil. The discharge of oilfield wastewater into the terrestrial environment has been shown to have serious deleterious effect on soil and plants.

Recommendations

Oilfield wastewater is known to contain some carcinogenic chemicals. Pollution of agricultural soils with toxic substances such as oilfield wastewater is a frequent problem of oil exploration and exploitation. The hazardous components/constituents of the oilfield wastewater are taken up by the plants which in turn are eaten by humans. This poses a serious health hazard.

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