PHYTOREMEDIATION OF CRUDE OIL CONTAMINATED SOIL USING VETIVER (Chrypsopogon zizanioides)

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Abstract

Soil contamination is mainly attributed to certain factors such as industrialization and increasing population with negative impact on natural resources such as petroleum. The petroleum industry affects the environment through oil spills with negative effect on human health and the surrounding ecosystem due to presence of Polycyclic Aromatic Hydrocarbons (PAHs) that can be carcinogenic to humans. The aim of this research is to compare the effectiveness of Chrypsopogon zizanioides also known as vetiver grass under the influence of biosurfactants and N.P.K. fertilizer in degrading and immobilizing persistent oil pollutants particularly the 16 Polycyclic Aromatic Hydrocarbons (PAHs) classified by United States Environmental Protection Agency (US EPA) as priority pollutants. The experiment was conducted in a glasshouse by growing the plant C. zizanioides in a freshly spiked crude oil contaminated soil and a weathered soil added with biosurfactant (ramphnolipids) produced by Pseudomonas aeruginosa. Similarly, all contaminated samples were amended with N.P.K fertilizer to promote the growth of C. zizanioides and microbial activities. Likewise, the assessment of the (bio) distribution of the petroleum hydrocarbons particularly the PAHs was carried out via Gas Chromatography Mass Spectrometry (GC MS). The result of this research has already indicated an improvement in plant growth and biomass in samples amended with N.P.K. fertilizer. It is also highly anticipated that the findings of this research will help in dissipating persistent contaminants such as PAHs in the crude oil contaminated soils under the influence of C. zizanioides and ramphnolipids and N.P.K. fertilizer as compared to the control samples.

PHYTOREMEDIATION OF CRUDE OIL CONTAMINATED SOIL USING VETIVER GRASS (*Chrypsopogon zizanioides).*

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Introduction

- High rate of industrialization and population growth has created more pressure on petroleum resources thereby affecting human health and the surrounding environment through oil spills (Gupta, 2006; Kang, 2014).
- Soil treatment through engineering and chemical methods add more harm to the environment (Batty and Dolan, 2013). As a result scientists are exploring the use of plants as a cost effective and environmentally friendly approach for cleaning the environment (Szczygłowska et al., 2011; Mench et al., 2009).
- Most research on phytoremediation of organic contaminants have focused on rhizodegradation (Badri et al., 2009; Maqbool et al., 2012). However, the importance of phytodegradation using tolerant plant such as Vetiver grass is yet to be fully elucidated. Hence, the need to conduct a research on phytodegradation using vetiver grass that has (long roots and tolerance to all temperatures and environments) under the influence of nitrogen, phosphorus and potassium (N.P.K.) fertilizer and biosurfactants for a cost effective, environmentally friendly and sustainable approach for cleaning crude oil contaminants in the soil.

Motivation : To create a cost effective, environmentally friendly, and sustainable approach for restoring the environment following spillages leading to contamination of the soil.

General Aim : To determine the tolerance, growth rate and efficiency of Vetiver grass in treating crude oil contaminants from soil, such as the Polycyclic Aromatic Hydrocarbons (PAHs) that are capable of causing cancer and other health effects in humans.

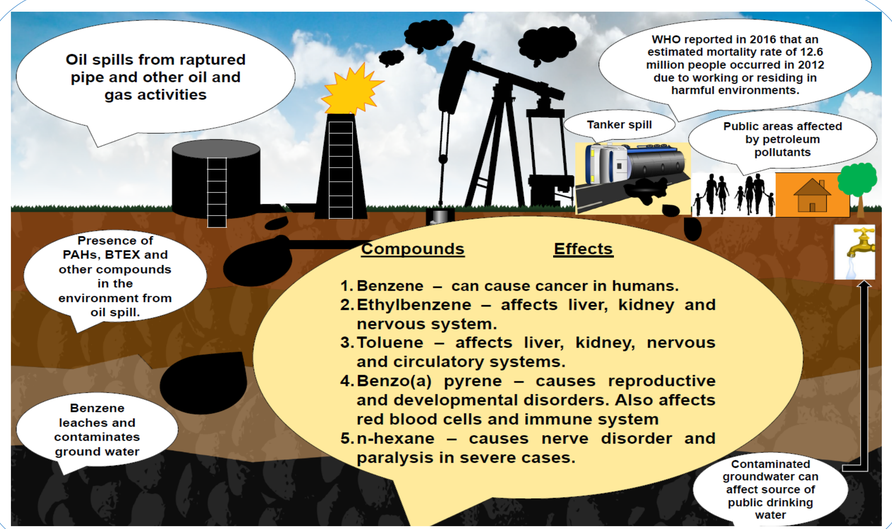


Fig.2: Effects of oil spill on human health and the environment.

Method

- The experiment was conducted in a glasshouse by growing vetiver grass in a freshly spiked crude oil contaminated soil in the ratio of 1:70 (oil and soil) respectively under the influence of bio-surfactants (95% (Mono-Rhamnolipid dominant), 95% (Di-Rhamnolipid dominant) and N.P.K. fertilizer. Their impacts on plant (culms) and height was then measured after 72 days of growth.
- Some of the control samples were left uncontaminated (oil free) while others were left unplanted (plant free) to assess the growth of the grass and fate (degradation) of crude oil in the absence of the grass.
- The concentration of oil was analyzed with GC MS to determine the level of degradation of PAHs in the contaminated soil as a function of spiking exposure condition including samples treated with doses of (oil only, biosurfactants or N.P.K. fertilizer).

Result

The result has indicated improvement in plant biomass after a period of 72 days with more plant culms and heights emerging in samples treated with N.P.K. fertilizer only followed by samples treated with N.P.K. and biosurfactants. The three elements in the fertilizer including nitrogen, phosphorus and potassium (N.P.K.) are generally essential for promoting plant growth (Priyadarshani et al., 2013; Kumar and Nikhil, 2016). Biosurfactants are also known to increase the bioavailability, mobility and removal of organic compounds (Banat et al., 2010).

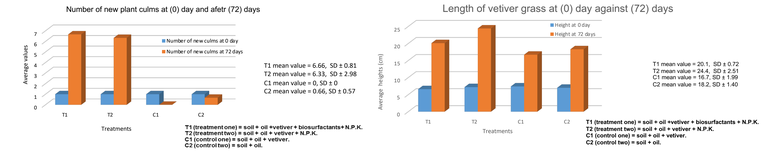


Fig.1: Impact of each treatment on plant biomass.

Conclusion

The findings of this study has demonstrated the plant growth promoting potentials of N.P.K. fertilizer and biosurfactants on vetiver grass during phytoremediation after a period of 72 days. Most of the samples treated with the N.P.K. fertilizer (T_2) and a combination of N.P.K. fertilizer and biosurfactants (T_1) have performed effectively in promoting the growth of vetiver grass by producing more culms and heights. Whereas the control samples with no additives (C_2) or oil only (C_1) have performed poorly. This suggests that the use of N.P.K fertilizer and biosurfactants can improve the process of phytoremediation by promoting the plant biomass. It can also potentially enhance the uptake and dissipation of organic contaminants in the soil but is subject to further investigations.

Future Work

The future work involves growing vetiver grass in a weathered crude oil contaminated soil under the influence of N.P.K. fertilizer and biosurfactants to determine the efficiency of the plant in treating the weathered soil. It will also involve growing different species of grasses to determine their effectiveness in treating crude oil contaminated soil.

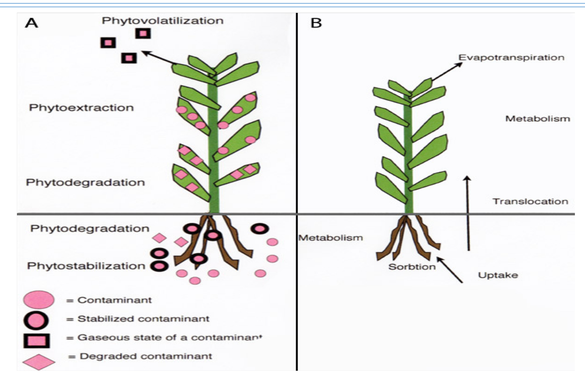
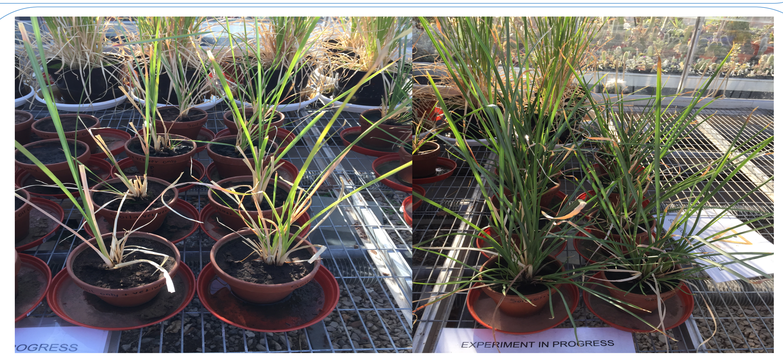


Fig.3: Types and mechaninisms of phytoremediation (Greipsson, 2011).



(A) Unfertilised soil at 72 days. (B) Fertilised soil at 72days.

Fig.4: Experiment in progress.

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