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Growth of *Calopogonium mucunoides* Desv. in Crude Oil Contaminated Soil: A Possible Phytoremediating Agent

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ABSTRACT

Calopogonium mucunoides Desv. was subjected to varying concentrations of crude oil equilibrated with water. Five treatments viz 0, 5, 10, 20 and 30% were used in a Randomized Complete Block Design (RCBD) with three replicates. These treatments were applied once to two weeks old seedlings of *C. mucunoides* using ring method and the plants were allowed to stand for eight weeks. The effects of these treatments on plant height, leaf area and biomass of *C. mucunoides* were studied. The total chlorophyll contents were also studied. The study showed that 5% treatment gave the highest value for plant height and biomass content while 10% treatment gave the highest value for leaf area and chlorophyll content when compared to control (0%) respectively. It was observed that as the concentration of the crude oil increases, there were corresponding reduction in the plant height, leaf area, biomass and chlorophyll content. These results implied that *C. mucunoides* can tolerate to some degree of crude oil contamination and thus can be used for phytoremediation in crude oil contaminated soil.

Key words: Growth, crude oil contaminated soil, *C. mucunoides*

INTRODUCTION

Calopogonium mucunoides Desv. is a vigorous, creeping and twining hairy herbaceous perennial plant, forming tangled foliage of about 30-40 m deep in height. In recent years, *C. mucunoides* has been used as cover plant for soil palm and rubber plantations. It is a shade tolerant plant and can quickly establish a dense cover and secrets chemical substances which inhibit the growth of other weeds.

Adriano *et al.* (1998) considered the soil as an integral part of the natural ecosystem and suggest that environmental sustainability depends largely on it. Introduction of contaminants into the natural environment can cause adverse environmental change. Adedokun and Ataga (2007) reported that crude oil contamination alters soil microbial community and affect the growth of cowpea. Studies have shown that symptoms of oil pollution in soil were typical of extreme nutrient deficiency in plants (Agbogidi and Eshegbeyi, 2006) while nutrient deficiency symptoms could be directly proportional to water uptake (McKee, 1995). According to Onuoha *et al.* (2003), the hydrophobic characteristics of oil prevent normal oxygen exchange between soil and the atmosphere. For example Ogbohodo *et al.* (2001) reported that maize exposed to high pollution level inhibited its growth performance. Asuquo *et al.* (2001) also reported that increased crude oil concentration resulted in reduced seedling growth of *Abelmoschus* and *Telfairia.* Onuh *et al.* (2008) earlier reported that the adverse effect of crude oil pollution is a function of dosage and concentration of pollutant. Okonwu and Amakiri (2009) reported that crude oil equilibrate with water causes an increase in the lag phase preceding germination and also a decrease in germination percentage of IT84S-2246 variety of cowpea, *V. unguiculata*. Okonwu *et al*. (2010) also reported that the foliage of maize treated with crude oil caused reduction in the chlorophyll content leading to defoliation of leaves which amounted to retardation in growth. According to Okolo *et al*. (2005), oil pollution increases soil organic carbon but reduces its nitrate and phosphorus contents. White *et al*. (2000) reported that the process of remediating crude oil contaminated soils either by *ex situ* or *in situ* techniques can be costly. This study therefore, was conducted to examine growth of *C. mucunoides* in crude oil contaminated soil and possibly establish it as a phytoremediating agent.

MATERIALS AND METHODS

Seeds of *C. mucunoides* were collected from matured plants growing in the Biodiversity Conservation Area, University of Port Harcourt. These seeds were removed from the fruits, air dried and stored at room temperature. Crude oil was collected from Shell Petroleum Development Company of Nigeria Limited (SPDC) Oyigbo flow station. Soil samples were obtained from the upper soil surface layer (0-15 cm) and the field experiment was laid out in a Randomized Complete Block Design at the University of Port Harcourt Botanical Garden. In preparing the different concentrations of crude oil equilibrated with water, a known volume of distilled water was added to a known volume of crude oil. This was carried out with the aid of a measuring cylinder calibrated in milliliters. It was mixed thoroughly with the help of the shaker. Various mixtures, that is, 0, 5, 10, 20 and 30% concentrations were obtained. These treatments were applied to two weeks old seedlings of *C. mucunoides* using ring method and the plants were allowed to stand for eight weeks. The growth parameters assessed were plant height, leaf area and biomass of *C. mucunoides* in soil containing varying concentrations of crude oil equilibrated with water. Total chlorophyll of *C. mucunoides* was determined using the method of Stewart *et al*. (1984).

Statistical analysis: The data obtained from study were subjected to statistical analysis by Analysis of Variance (ANOVA) using 5% level of significance.

RESULTS

The result of the effect of varying crude oil application on plant height, leaf area and biomass of *C. mucunoides* are shown in Table 1. The plant height and leaf area obtained from the treatments are as follows: 0% (45 cm, 3.1 cm^2), 5% (76 cm, 3.0 cm^2), 10% (72 cm, 3.5 cm^2), 20% (53 cm, 2.1 cm^2), 30% (27 cm, 3.0 cm^2), respectively. The results indicated an appreciable increase in plant height from 0-5% treatment and then gradually decrease from 10-30% treatment. The plant height for 5% treatment was significantly different ($p<0.05$) when compared with other treatments except 10% treatment. Among the treatments, the leaf area did not show any trend. This result shows that *C. mucunoides* has some level of tolerance to crude oil applications. However, 10% treatment gave the highest value for leaf area. The resultant plant biomass showed that 5% treatment gave the highest value which was significantly different among treatments at $p = 0.05$. The highest value for total chlorophyll content of *C. mucunoides* was obtained at 10% concentration of crude oil equilibrated with water as shown in Fig. 1. The trend of data showed that as the volume of crude oil increases, the biomass content of *C. mucunoides* decreases.

Table 1: Effect of varying concentration of crude oil equilibrated with water on the plant height, leaf area and biomass of *C. mucunoides*

Crude oil treatment (v/v)	Plant height (cm)	Leaf area (cm^2)	Biomass (g)
0%	45.0	3.1	18.2
5%	76.0	3.0	46.0
10%	72.0	3.5	24.2
20%	53.0	2.1	21.8
30%	27.0	3.0	2.5
SE	8.992	0.229	6.979
SD	20.107	0.513	15.605

SE: Standard error, SD: Standard deviation

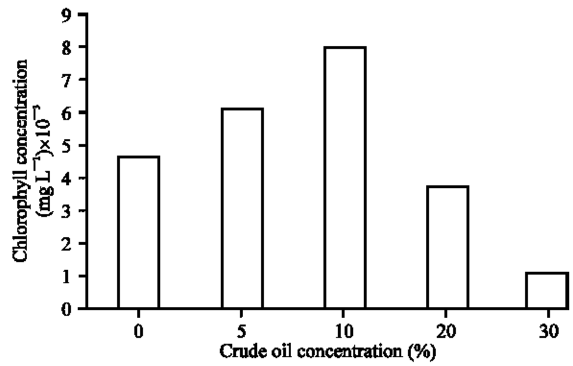

Fig. 1: Effect of varying crude oil concentration on the chlorophyll content

DISCUSSION

The results indicated an enhancement of plant height, leaf area, biomass and total chlorophyll content with the concentrations of 5-20% crude oil application when compared with the control (0%) treatment. However, further increase in the crude oil concentration to 30% decreased plant height, leaf area, biomass and total chlorophyll content. This result implied that *C. mucunoides* could tolerate crude oil levels within 5-20% concentrations, thus *C. mucunoides* has potential for phytoremediation of crude oil contaminated soils. Agbogidi *et al.* (2005) reported that differential changes in the rate of leaf growth may be associated with anatomical and morphological change caused by the oil treatment. Okonwu and Amakiri (2009) also reported that crude oil application increased the chlorophyll and lipid contents of *V. unguiculata*. The mechanism for thriving or growing in crude oil polluted soil may be attributed to its nitrogen fixing ability. It could also be that the development of extensive fibrous and deeper root system by *C. mucunoides* plant aids in its tolerance and survival strategies to cope with water stress imposed by the crude oil treatment. White *et al.* (2000) reported that microbial analysis of vegetated sites revealed a significantly higher population of total hydrocarbon, alkane and polynuclear aromatic hydrocarbon degraders to be present in soils vegetated with legumes.

CONCLUSION

The study has shown that *C. mucunoides* could be used to phytoremediate crude oil polluted site due its potential to tolerate some levels of crude oil. The increased in leaf area obtained showed a corresponding increase in the total chlorophyll of *C. mucunoides*.

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