Short Communication

Effects of amendments and bioaugmentation of soil polluted with crude oil, automotive gasoline oil, and spent engine oil on the growth of cowpea (*Vigna ungingculata* L. Walp)

Adedokun, Olutayo M. and Ataga, A. E.*

Department of Plant Science and Biotechnology, University of Port Harcourt, P. M. B. 5323, Port Harcourt, Rivers State, Nigeria.

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The effects of sawdust and waste cotton as soil amendment and bioaugmentation with *Pleurotus pulmonarius* (pp) on soil polluted with crude oil (COIL), automotive gasoline oil (AGO), and spent engine oil (SEO) on the growth of cowpea (*Vigna ungingculata* L. Walp) was investigated. There was a significant improvement (*P* = 0.05) on the growth of cowpea when polluted soil was amended and bioaugmented with *P. pulmonarius* (pp) after one month of incubation when compared with the result of planting on polluted soil with no amendments and bioaugmentation. Addition of waste cotton as an amendment and *P. pulmonarius* as bioaugmentation agents to crude oil polluted soil significantly reduced time of seed germination from 8 to 3 days, increased seed germination from 60 to 96%, plant height from 10.3 to 22 cm, leaf number from 3 to 5 and biomass from 0.5 to 1.5 g dry wt. Similar reductions in time of germination, increases in percentage germination, plant height, leaf number and total biomass in cowpea plants grown in automotive gasoline oil and spent engine oil polluted soils, amended with waste cotton or saw dust and bioaugmented with *P. pulmonarius* were observed in this study.

**Key words:** Amendments, bioaugmentation, *Pleurotus pulmonarius*, *Vigna* and growth.

**INTRODUCTION**

The soil is a key component of natural ecosystems because environmental sustainability depends largely on a sustainable soil ecosystem (Adriano et al., 1998). When soil is polluted, the ecosystem is altered and agricultural activities are affected.

Crude oil and petroleum products such as gasoline, fuel oils and diesel fuels are complex mixtures of organic compounds and have been shown to be toxic to plants (Anon, 2003). Oil pollution prevents normal oxygen exchange between soil and atmosphere due to hydrophobic properties of oil (Atlas, 1977). It also inhibits seed germination and plant growth (Ojiegba and Sadiq, 2002; Hazel, 2005).

In Nigeria, most of the terrestrial ecosystem and shorelines in oil producing communities are important agricultural land under continuous cultivation. Any contact with crude oil results in damage to soil condition of these agricultural lands, microorganisms and plants (Onuoha et al., 2003). They also reported that beyond 3% concentration in an environment, crude oil becomes increasingly deleterious to soil biota and crop growth. As a means of remediation of soil polluted with these substances, various technologies have been employed among which is bioremediation. For efficient bioremediation, soil amendment or additives, such as sawdust, peat, waste cotton, manure, fertilizers etc. are added to increase microorganisms activities. A soil amendment is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure (Davis and Wilson, 2005).

This study investigates the effects of waste cotton and saw dust as amendments and bioaugmentation with *Pleurotus pulmonarius* on the growth of cowpea cultivated on soil polluted with crude oil (COIL), automotive gasoline oil (AGO), and spent engine oil (SEO).
Table 1. Performance of cowpea on soil treated with crude oil (COIL) after a month of pollution with incorporation of amendments and bioaugmentation

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Germination/day</th>
<th>Germination (%)</th>
<th>Plant height (cm)</th>
<th>Leaf number</th>
<th>Biomass (g/ dry wt.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2±0.4</td>
<td>100±0</td>
<td>33.0±2.5</td>
<td>7.0±0.9</td>
<td>4.1±0.6</td>
</tr>
<tr>
<td>Soil+cotton +COIL +pp</td>
<td>3±0.6</td>
<td>96±2.9</td>
<td>22.1±2.1</td>
<td>5.0±0.4</td>
<td>1.5±0.3</td>
</tr>
<tr>
<td>Soil+cotton +COIL</td>
<td>3±0.4</td>
<td>76±3.4</td>
<td>15.8±4.5</td>
<td>5.0±0.3</td>
<td>1.4±0.2</td>
</tr>
<tr>
<td>Soil+cotton +COIL +pp</td>
<td>3±0.4</td>
<td>76±2.9</td>
<td>16.5±1.2</td>
<td>5.0±0.4</td>
<td>1.1±0.3</td>
</tr>
<tr>
<td>Soil+COIL +pp</td>
<td>3±0.4</td>
<td>76±3.4</td>
<td>12.9±3.7</td>
<td>3±2.1</td>
<td>0.8±0.4</td>
</tr>
<tr>
<td>Soil +sawdust + COIL</td>
<td>3±0.4</td>
<td>76±6.7</td>
<td>13±3.5</td>
<td>4.0±0.9</td>
<td>0.8±0.2</td>
</tr>
</tbody>
</table>

MATERIALS AND METHODS

Sample and sample collection

Soil sample (sandy loam) was collected randomly with a shovel at a depth of about 15 cm from a site in the University of Port-Harcourt, Nigeria. Samples were homogenized, sieved and stored in polythene bags at room temperature (28±2°C) in the laboratory. Seeds of cowpea were purchased from a local market in Port Harcourt. The crude oil was a Nigerian Bonny light blend obtained from Shell Petroleum Development Company (SPDC) Limited Port-Harcourt, Nigeria. Automotive Gasoline oil (AGO) was purchased from a filling station in Port Harcourt and spent engine oil was collected from a mechanic workshop in Port Harcourt.

Sawdust and waste cotton (secondary wastes from the mechanical processing of raw cotton prior to spinning) which were used as amendments in this study, were collected from a sawmill in Port Harcourt and Atlantic Textile Mills (ATM), Lagos, Nigeria respectively. Sawdust was mixture of wood of Khaya species and Heleia ciliata and 5-month-old when used for the study. P. pulmonarius used was obtained from the Federal Institute of Industrial Research Oshodi (FIIRO).

Soil treatment and planting

One kilogram of soil was weighed into transparent polythene bags. The soil, was treated, with 5% crude oil, AGO and spent engine oil, respectively. Ten percent sawdust and waste cotton were added to the polluted samples and thoroughly mixed with it. The samples were sterilized in an autoclave at 121°C for 15 min. After cooling, some of the samples were inoculated with 10% spawn of P. pulmonarius and incubated at room temperature (28±2°C) for one month. A set of samples was not inoculated, but also incubated at room temperature. After incubation, the soil samples together with mycelial mat was homogenized and distributed into planting bags of 26 x 23 cm dimension. Five cowpea seeds were planted per bag. Each treatment was replicated 5 times. The experiment was watered daily and observation was made on the growth of the plant. Germination, % germination, plant height, number of leaves and biomass of plant were recorded. Plant height was measured from the soil level to the terminal bud using a transparent meter rule. This was done at an interval of seven days. Number of leaves was by visual counting of the leaves as the plant grew. Biomass was by carefully uprooting the plants and cleaning up the root to remove sand particles. These were then weighed and kept in the oven at 80°C for 24 h to obtain dry weight (Odjegba and Sadiq, 2002).

RESULTS AND DISCUSSION

The results of the effects of amendments incorporated into soil polluted with COIL, AGO and SEO are presented in Tables 1, 2 and 3. Soil polluted with crude oil (COIL), automotive gasoline oil (AGO) and spent engine oil (SEO) significantly affected the time of germination, percentage germination, plant height, leaf production and biomass. There was delay in germination of seeds sown in COIL-polluted soil (8 days), AGO-polluted soil (5 days) and SEO-polluted soil (4 days) when compared with 2 days in the unpolluted controls. The growth parameters: plant height, leaves and biomass were comparatively low in all the polluted soils compared to the control, with no pollutant. This is in line with the work of Atlas (1977) that oil pollution prevents normal oxygen exchange between soil and atmosphere due to hydrophobic properties of oil, thus inhibiting plant growth. Odjegba and Sadiq (2002) and Hazel (2005) also reported that oil pollution inhibits seed germination and plant growth.

Amendments of polluted soil with cotton waste and saw dust significantly enhanced (P = 0.05) time of germination, percentage germination of seeds and the growth of the seedling. In COIL-polluted soil, amendment with cotton waste reduced time of seed germination from 8 to 3 days, improved seed germination from 60 to 76%, plant height from 10.3 to 15.8 cm and leaf number from 3 to 5. Similar improvement in growth was also recorded in amendments of AGO and SEO polluted soils with cotton and saw dust when compared with non-amended polluted soils (Tables 2 and 3).

The addition of amendments and bioaugmentation of polluted soil with P. pulmonarius further improved the growth performance of cowpea when compared with non-amended soil after one month. Amendment of COIL-polluted soil with cotton waste and bioaugmentation with pp significantly improved germination from 60 to 96%, plant height from 10.3 to 22 cm, leaf number from 3 to 5 and biomass from 0.5 to 1.5 g/dry wt. Similar enhancement in growth parameters were also obtained in the amendment and bioaugmentation of AGO AND SEO polluted soils (Tables 2 and 3).

The improvement in plant growth could be attributed to the addition of soil amendments and bioaugmentation. A probable explanation for this is that soil amendments and bioaugmentation improved the soil physical properties otherwise damaged by pollution of the soil (Davis and Wilson, 2005). Soil amendments may be described as materials added to a soil to improve its physical proper-
ties, such as water retention, permeability, water infiltration, drainage, aeration and structure. When cotton was used as a soil amendment, it was found to increase soil concentrations of most soil nutrients above that of commercial fertilizers (Evanylo, 1998). Sawdust has been found to be a good soil amendment because of its ability to improve soil properties. (Davis and Wilson, 2005; Starbuck, 1994). The efficiency of bioaugmentation in soil remediation has also been recorded (Dave et al., 1994; Adenipekun and Fasidi, 2005).

**REFERENCES**


