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Preliminary Test of Hydrocarbon Exposure on *Eleocharis Ochrostachys* in Phytoremediation Process

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ABSTRACT

In this study, the aim was to determine the maximum concentration of diesel which *Eleocharis ochrostachys* plant that can survive and degrade the hydrocarbon. This investigation adopted two systems, free surface flow (FSF) and sub-surface flow (SSF) to select which system is more suitable for this plant to be applied in future study of phytotoxicity test. The preliminary test for plant was conducted in a greenhouse for 15 days. The plants were planted in six pails with 3 kg sand and different diesel concentration for every SSF and FSF system. The diesel concentrations used in this experiment were 0, 5, 10, 20, 30 and 40 mL diesel/L water for both systems. At the end of exposure period to diesel contaminants, the plant had shown that it could grow and survive with concentrations of 5, 10 and 20 mL diesel/L water in the SFS system. The withered plant percentage was 66.7 % at 20 mL/L in SFS system, 33% occurring at 10 mL/L and 100% withered at other concentrations. Whereas, in the FSF system, all plants died in all concentrations except 5 mL diesel/L water. In the FSF system, 66.7% of plants were withered at lower concentration of 5mL/L and 100% withered with the rest of the concentrations. As a conclusion, the findings from the preliminary test, indicates that *Eleocharis ochrostachys* is able to grow and survive in the subsurface flow system better than the free flow system.

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INTRODUCTION

Petroleum hydrocarbons are the most widespread of organic contaminants and some of these compounds are toxic due to mutagenic and carcinogenic properties (Cook, R.L. and D. Hesterberg, 2013). Diesel oil is one of these major contaminants in soil and groundwater (Qing, L.Y., 2008; Al-Baldawi, I.A., 2012). It contains Polycyclic Aromatic Hydrocarbons (PAHs) which are considered great threat to the environment and human being due to their toxicity to the higher organisms and resistance to microbial attack (Arulazhagan, P., 2010). Phytoremediation is one of methods which can be applied to remediate the contaminated environment (Tangahu, B.V., 2013). There are plants that have the ability to concentrate elements and compounds from the environment and to metabolize various molecules in their tissues (Nouri, J., 2009). Some microorganisms can degrade the PAHs to carbon dioxide and water or transform to other nontoxic or low- toxic substance to get energy (Ye, J.S., 2011). The use of plants for the phytodegradation of hydrocarbons becomes widely applied for treatment of wastewater. They are used to treat different pollutants such as agricultural, petroleum and petrochemical industry wastewaters, various runoff waters and landfill leachates (Al-Baldawi, I.A., *et al*., 2013). Phytoremediation is considered to be the most sustainable wastewater treatment option but its application is often limited by unavailability of suitable candidate species (Anning, A.K., 2013). Like other remedial system, phytoremediation also requires monitoring system to determine progress towards its objectives (Rathod, P.H., *et al*., 2013).

Therefore, the preliminary test in phytoremediation is important and is required before a full-scale system can be installed. This is to ensure that the remedy is effective by selected plants and the suitable system. There are two type of systems normally used in phytotechnology, which are subsurface flow system (SSF) or free flow surface system (FSF). The difference between SSF and FSF is the position of water layer. FSF has a thin layer of water above the media whereas the water level of the SSF is kept just below the top of the media (Lim, P.E., *et al*., 2001). Constructed SSF and FSF wetlands are being increasingly implemented worldwide into wastewater treatments (Graczyk, T.K., *et al*., 2009). Wetlands are among the most important components in

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natural ecosystems. They can effectively remove organic matter, suspended solids, metals and other pollutants (Jing, S.R., 2001). Wetland can be divided into natural and constructed wetlands and it can be considered more efficient and flexible than conventional wastewater treatment. Wetland uses plants and microorganisms to transform pollutant in the wastewater into biological cell or inorganic substances (Chiang, H.C., *et al*., 2010).

E. ochrostachys is one type of grasses with heights of 35 to 75 cm and has basal and lack leaves. The leaves are linear and have parallel venation. The flowers of *E. ochrostachys* are arranged in spikes. The Family for this plant is Cyperaceae and common name is Spike rush. *E. ochrostachys* is distributed in Malaysia, China, Cambodia, Indonesia, Japan, Laos, Myanmar, Philippines, Sri Lanka, Thailand, Vietnam and Pacific islands and other countries. This plant is a common species in wetlands and in the understory along lowland rivers and shallow water, in marshes and along irrigation canals, sometimes found in floating islands and also on grasslands, paddy fields and pond margins (Catford, J.A. and B.J. Downes, 2010). This study aims to determine the maximum concentration of diesel to which the plant of this plant can survive and degrade the hydrocarbon and which system (SSF or FSF) is better to adopt in phytotoxicity test.

MATERIALS AND METHOD

Synthetic wastewater was prepared by mixing water with different diesel concentrations (0, 5, 10, 20, 30 and 40 mL diesel/L water). Three healthy bulrush plants of *E. ochrostachys* were planted in six pails each filled with 3 kg of sand both types of each system (SSF and FSF). Next, synthetic wastewater was poured into the sand for both SSF and FSF systems which required 0.8 and 2 L of wastewater respectively. Throughout the exposure, addition of some water to the plants was done occasionally to ensure the plants having sufficient water to grow (Sanusi, S.N.A., *et al*., 2012).

The plant growth was observed physically for 15 days in the two systems SSF and FSF to investigate the ability of the plant to survive and resist the hydrocarbon contaminant. At the end of exposure period, the percentage of withered plants was determined by using following equation:

$$\%\text{The percentage of withered plants} = \frac{\text{No. of withered plants}}{\text{No. of total plants}} \times 100 \qquad (1)$$

RESULTS AND DISCUSSION

After 15 days of exposure to diesel contaminants, the plant had shown that it could grow and survive in concentrations of 5, 10 and 20 mL diesel/L water in the SSF system. As shown in Figure 1 and Table 1, all bulrush plants were still green in 5 mL/L, one bulrush withered with 10 mL/L and two bulrushes withered in 20 mL/L while all bulrush withered in 30 and 40 mL/L diesel concentrations. In the FSF system, all plants were withered and died in all concentrations except 5 mL diesel/L water as shown in Figure 2.

By using Equation (1), the withered plant percentage for the SSF system was 0% at 5 mL/L, 33% at 10 mL/L, 66.7% at 20 mL /L and 100% at other concentrations. While, in the FSF system 66.7% of plants were withered at lower concentration of 5 mL/L and 100% withered with the rest of the concentrations as illustrated in Figure 3.

Table 1: Number of bulrushes withered in SSF and FSF systems at different concentrations.

Concentration of diesel (mL/L)	Number of bulrush withered in SSF system	Number of bulrush withered in FSF system
Control plant (0 mL diesel/L water)	0	0
5	0	2
10	1	3
20	2	3
30	3	3
40	3	3

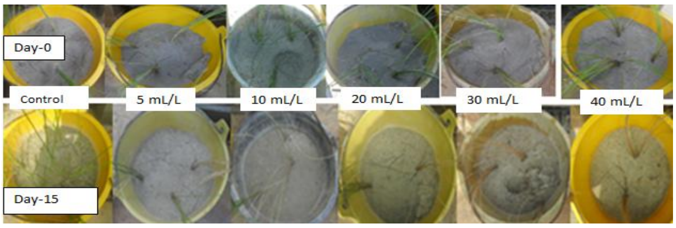

Fig. 1: Growth of *E. ochrostachys* in different diesel concentrations on day 0 and15 in SSF system.

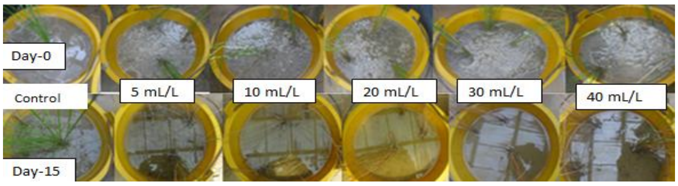

Fig. 2: Growth of *E. ochrostachys* in different diesel concentrations on day 0 and15 in FSF system.

Conclusions:

Laboratory culture of preliminary experiments was conducted to assess the ability of *E. ochrostachys* to survive with different diesel concentrations in two systems of SSF and FSF. The results clearly showed that whenever the concentration increased, the number of withered plants also increased. The plant resistance to hydrocarbon contaminant in the SSF system was better compared to the FSF system, in which the plant can grow and survive in diesel concentration in SSF until 20 mL/L while in FSF the plant cannot survive in diesel concentration more than 5 mL/L.

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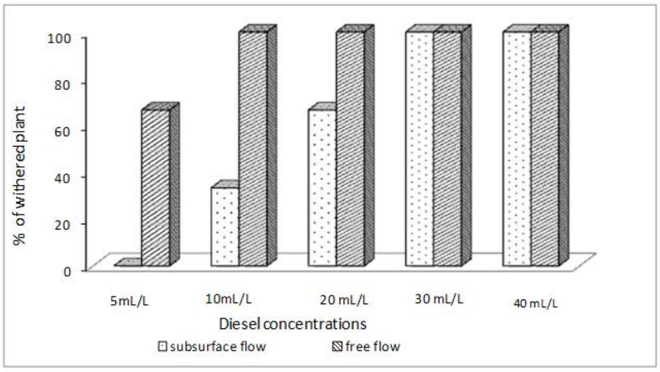

Fig. 3: Percentages of withered plants for SSF and FSF systems.

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