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GROWTH TOLERANCE OF GRASSES GROWN ON WASTE ENGINE OIL CONTAMINATED SOIL

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ABSTRACT: *The growth tolerance of Digitaria horizontalis, Eluecine indica and Setaria barbata grass species grown on waste engine contaminated soil was investigated in this study. Waste engine oil was added to soil to obtain different concentrations on weight basis: 0 % (control), 2 %, 4 %, 7 % and 10 % v/w oil- in-soil. The mixing was gradually done to ensure thorough and even mixing. After the mixing, the soil was left under shade for a period of seven days without planting. At the end of the seventh day, the plant materials collected from the wild were transplanted into the buckets. The growth parameters measured at 2, 4, 6, 8 weeks after planting were plant height, leaf number, lea area and shoot girth. The result obtained showed that the increased concentration of waste engine oil in the soil caused reduced growth of the three grass species studied as was evident in the growth parameters studied. In conclusion, the D. horizontalis, E. indica and S. barbata grass species studied responded differently to waste engine oil contaminated soil and their sensitivity were determined by the five different concentrations of waste engine oil used.*

KEYWORDS: Concentration, Grass, Soil, Transplanted, Tolerance, Waste Engine Oil.

INTRODUCTION

Pollution from waste engine oil is one of the major problems of the environment in the world and is more widespread than crude oil pollution (Odjegba and Sadiq, 2002). Spent lubricant or waste engine oil, is gotten from automobile and generator engines servicing and subsequent draining (Anoliefo and Vwioko, 2001) and much of this oil is spilled on the ground. In countries like Nigeria that do not enforce strict compliance to environmental laws, the unchecked discharge of waste engine oil by motor mechanics is a common source of soil pollution (Ogbo et al., 2009). The presence of oil in the soil has effects on the chemical, biological, physical and microbiological components of the soil in various ways (Agbogidi, 2010), hence, affecting the growth, development, productivity and yield of plants. Waste engine oil can have a number of significant, short-term and long-term impacts on the environment if disposed in an uncontrolled manner (UNEP/MAP, 2006). It has been reported that oil pollution result in slow germination rate in plants. Adam and Duncan (2002) observed that this could be attributed to the fact that the oil acted as a blockage preventing or reducing the access of water and oxygen to the seeds. Additionally, the commonest soil contaminant in the rural areas where agriculture/farming forms the mainstay of the inhabitants is the waste engine oil (Agbogidi, 2011). The waste engine oil contains some toxic materials including heavy metals that could affect growth, yield and general performance of plants (Agbogidi and Egbuchua, 2010). Several methods can be used for the rehabilitation of oil-contaminated soils. Traditionally, engineering techniques based on physical, chemical and thermal processes are used (Ekundayo, 1978). Enhancing of rehabilitation of an impacted ecosystem by micro-organisms is also known as bioremediation which (April and Sims, 1990) described as our unseen allies in fight against pollution. Another form of bioremediation is phytoremediation, which is the use of biological processes (plants) to detoxify contaminated environment (Frick et al., 1990). Using this technology lowers the total cost of the clean-up project and minimizes the disturbance the remediation will cause in the environment (Oyibo, 2013). Some weeds of the grass family are considered to be particularly suitable for phytoremediation since they offer an increased rhizosphere zone because of their multiple ramified root systems. This gives room for more microbial activity and growth around the root zone (Aprill and Sims, 1990). Criteria for choosing plant candidates for phytoremediation of organic contaminants found in soil include the growth of plants under specific climatic conditions (Gudin and Syratt, 1975; Banks *et al*., 2003), their tolerance to contaminant toxicity (Kirk *et al*., 2002), the presence of phytochemical in the root exudates of plant (Hegde and Fletcher, 1996; Liste and Alexander, 1999) or their ability to render the concentration of the contaminants in soil inactive (Kumar *et al*., 2017). There is paucity of information on tropical species that could serve in the cleanup of waste engine oil contaminated soils. The objective of this study was therefore to screen *D. horizontalis, E. indica, and S. barbata,* for waste engine oil contaminated soil tolerance.

MATERIAL AND METHODS

This study was conducted within the Research Farm of Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Nigeria in 2015. The experimental design was Completely Randomized Design (CRD). Soil samples used in this study were collected from the Research Farm. Top soils (0-10 cm) were collected from the marked area. The soil samples were air dried and sieved through a 2-mm mesh gauze (Ogedegbe *et al*., 2013). Thereafter, 4 kg of soil was introduced into 4 litre perforated plastic buckets. The different percentages of the waste engine oil were calculated. The different ml of waste engine oil was added to the plastic buckets containing the soil to obtain different concentrations 2%, 4%, 7% and 10% of waste engine oil; identified as T_1, T_2, T_3, and T_4. The mixing was gradually done to ensure thorough and even mixing. The untreated soil with 0% waste engine oil was used as control (T_c) (Adenipekun *et al*., 2009). Treatments were replicated in 3. After the mixing, the soil was left under the shade for a period of seven days without planting. This was done for uniformity of oil, moisture content, air content, temperature and effective activities of soil micro-organism (Oyibo, 2013). The plant materials; *D. horizontalis, E. indica and S. barbata* were collected from the wild by the roadsides and bush fallows within Umuahia, Nigeria. The three grass species were identified as *D. horizontalis* (P_1), *E. indica* (P_2) and *S. barbata* (P_3). The waste engine oil was obtained from pooled waste engine oil from two different motor mechanic workshops at the mechanic village, Umuahia, Nigeria.

Tillers that are of the same height (shoot: 15 cm) were selected and immersed in water for 2 days to improve their rooting ability (Brandt, 2003). Three (3) tillers of each of the grass species were transplanted into each of the buckets with soils contaminated with different percentages of waste engine oil. The control tillers were transplanted into buckets with uncontaminated soils (0%). Growth parameters - plant height, leaf area, leaf number and shoot girth were measured and recorded forthrightly from 2 weeks after transplanting till the eighth week. The plant height (cm) was measured with a metre rule from the top soil level to the terminal bud. Leaf area was determined by measuring the length and width (at the widest point) of each leaf using a meter rule. The product was multiplied by a correction factor of 0.75 to take care the leaf shape (Agbogidi and Eshegbeyi, 2006). The number of leaves was determined by visual counting of the number of leaves per grass stand per bucket per treatment. Shoot girth diameters at 3 cm plant height were measured using Vernier Calipers. The data collected were summarized with Microsoft Excel while one-way ANOVA was used to test for significant differences with PAST statistical package.

RESULTS

The result of the effect of various percentages of waste engine oil on the plant height of *D. Horizontalis* is shown in Fig 1a. The increasing concentrations of waste engine oil had significant ($P<0.05$) adverse effect on the height of *D. horizontalis.* It was observed that at 10 % and 7 % waste engine oil concentrations there were significant reductions in the height when compared with 4 % and 2 % and the control at 2 WK, 4 WK, 6 WK and 8 WK respectively. The results of the effect of various percentages of waste engine oil on the plant height of *E. indica* are shown in Fig 1b. The increasing concentrations of waste engine oil also had significant ($P<0.05$) adverse effect on the height of *E. indica.* It was observed that at 10 % and 7 %, 4%, 2 % concentrations there were significant reductions in the height when compared with the control at WK2, WK4, WK6 and WK8 respectively. The results of the effect of various percentages of waste engine oil on the plant height of *S. barbata* are shown in Fig 1c. The increasing concentrations of waste engine oil also had significant ($P<0.05$) adverse effect on the height of *S. barbata.* It was observed as in *D. Horizontalis that* at 10 % and 7 % waste engine oil concentrations; there were significant reductions in the height when compared with 4 %, 2 % and control at WK2, WK4, WK6 and WK8 respectively.

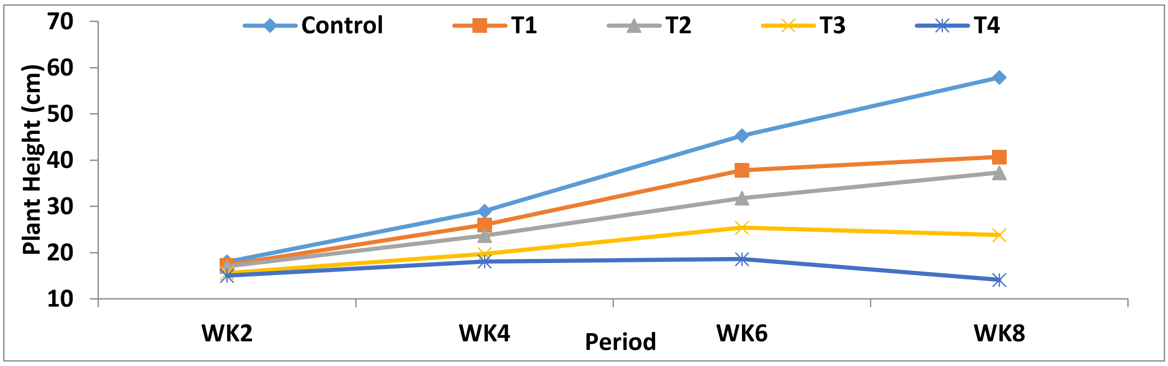

Fig. 1a: The Effect of Different Concentrations of Waste Engine Oil on the Height of *D. Horinzontalis.*

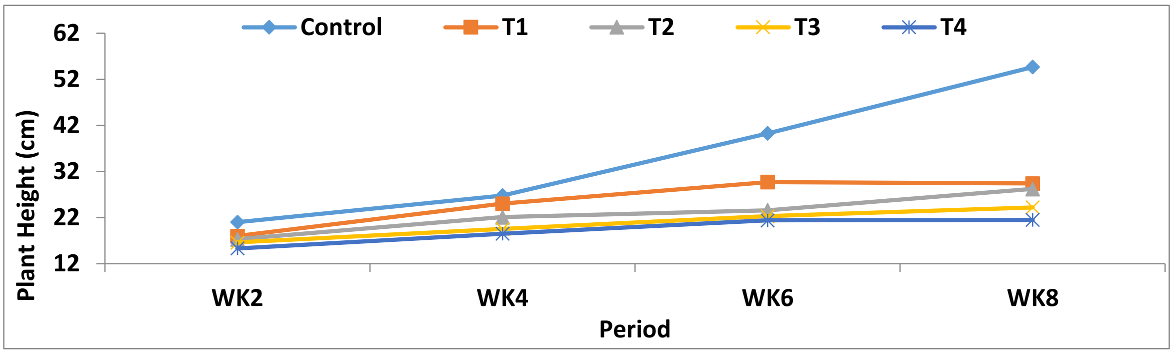

Fig. 1b: The Effect of Different Concentrations of Waste Engine Oil on the Height of *E. Indica.*

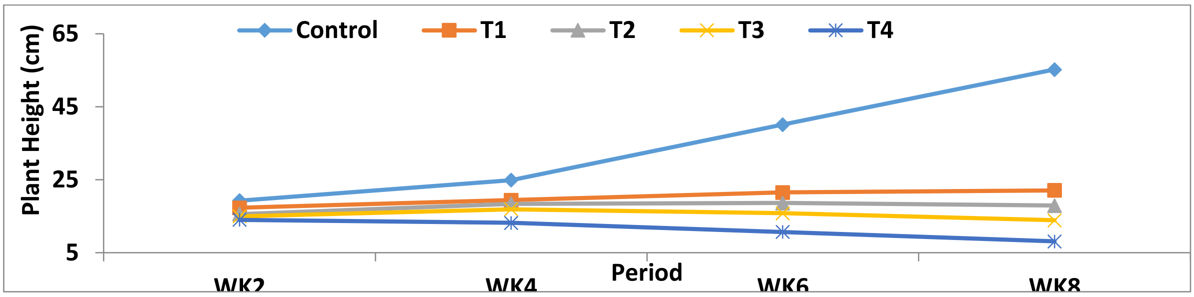

Fig. 1c: The Effect of Different Concentrations of Waste Engine Oil on the Height of *S. Barbata.*

The result of the effect of various percentages of waste engine oil on the leaf area of *D. horizontalis* is shown in Fig 2a. The leaf area was significantly (P<0.001) affected by waste engine oil. It was observed that at 10 % and 7 % concentrations there were significant reductions in the leaf area when compared with 4 %, 2 % concentrations and control at WK2, WK4, WK6 and WK8 respectively. The result of the effect of various percentages of waste engine oil on the leaf area of *E. indica* is shown in Fig 2b. The leaf area was also significantly (P<0.01) affected by waste engine oil contamination. It was also observed that at 10 % and 7 % concentrations; there were significant reductions in the leaf area when compared with 4 %, 2 % concentrations and control at WK2, WK4, WK6 and WK8 respectively. The result of the effect of various percentages of waste engine oil on the leaf area of *S. barbata* is shown in Fig 2c. The leaf area was also highly significantly (P<0.001) affected by waste engine oil contamination. It was observed that at 10 %, 7 %, 4 %, 2 % concentrations there were significant reductions in the leaf area when compared with the control at WK2, WK4, WK6 and WK8 respectively.

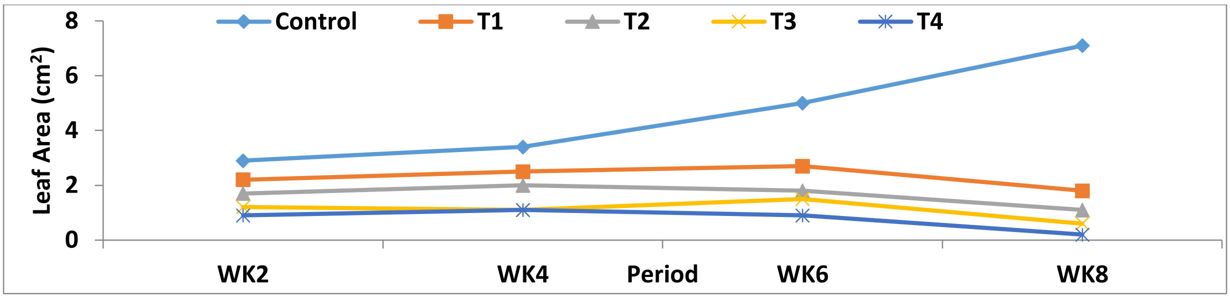

Fig. 2a: The Effect of Different Concentrations of Waste Engine Oil on the Leaf Area of *D. Horinzontalis.*

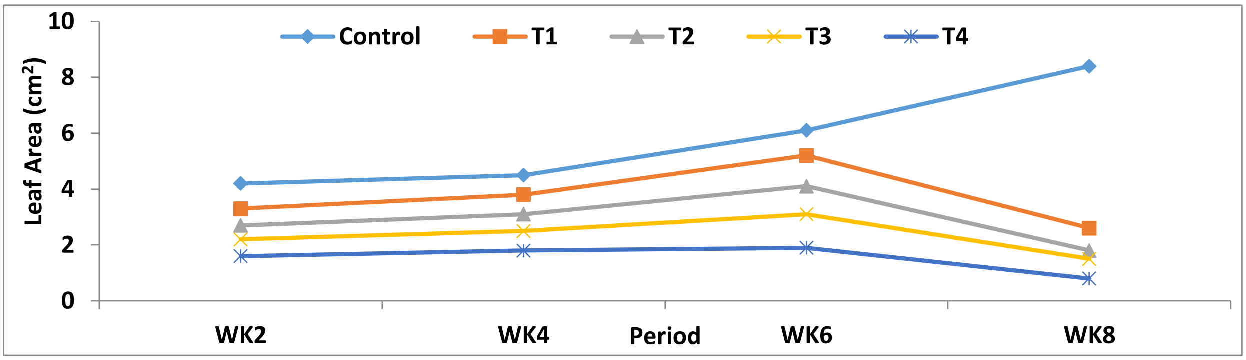

Fig. 2b: The Effect of Different Concentrations of Waste Engine Oil on the Leaf Area of *E. Indica.*

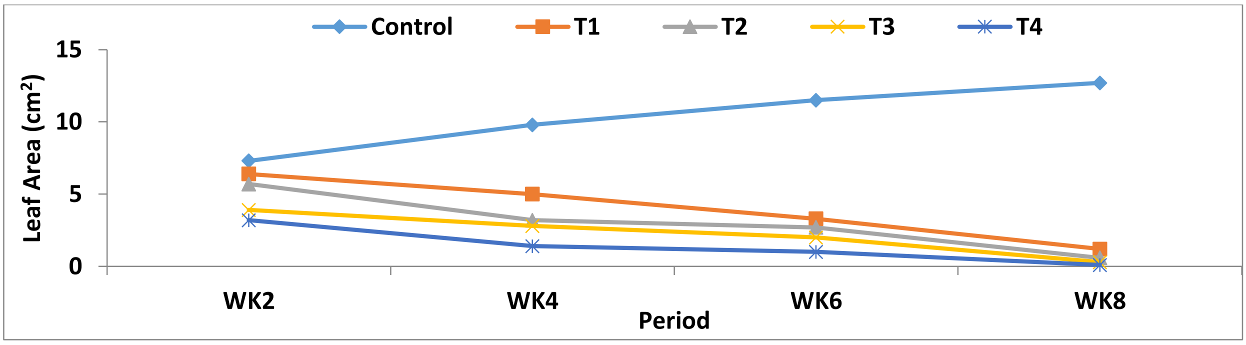

Fig. 2c: The Effect of Different Concentrations of Waste Engine Oil on the Leaf Area of *S. Barbata.*

The result of the effect of various percentages of waste engine oil on the leaf number of *D. Horizontalis* is shown in Fig 3a. The waste engine oil pollution exerted significant (P<0.01) influence on the leaf number. It was observed that at 10 %, 7 % concentrations there were significant reductions in the leaf number when compared with 4 %, 2 % concentrations and control at WK2, WK4, WK6 and WK8 respectively. The result of the effect of various percentages of waste engine oil on the leaf number of *E. indica* is shown in Fig 3b. The waste engine oil exerted significant (P<0.01) influence on the leaf number. It was observed that at 10 %, 7 % concentrations there were significant reductions in the leaf number when compared with 4 %, 2 % concentrations and control at WK2, WK4, WK6 and WK8 respectively. The result of the effect of various percentages of waste engine oil on the leaf number of *S. barbata* is shown in Fig 3c. The waste engine oil exerted highly significant (P<0.001) influence on the leaf number. It was observed that at 10%, 7% concentrations there were significant reductions in the leaf number when compared with 4 %, 2 % concentrations control at WK2, WK4, WK6 and WK8 respectively.

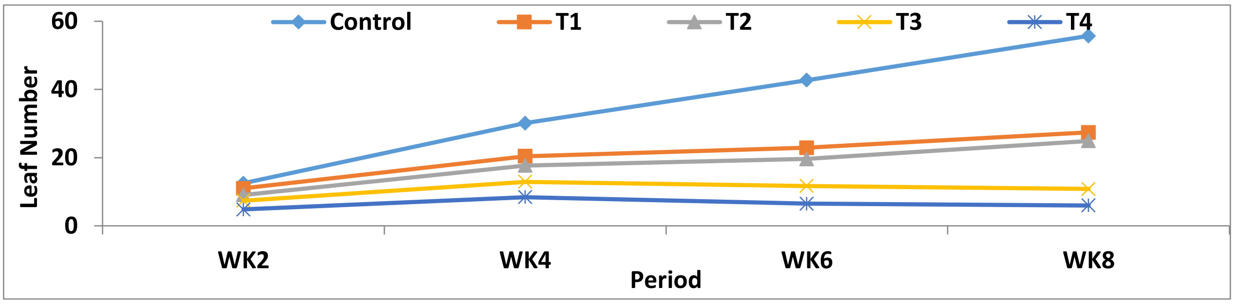

Fig. 3a: The Effect of Different Concentrations of Waste Engine Oil on the Leaf Number of *D. Horizontalis.*

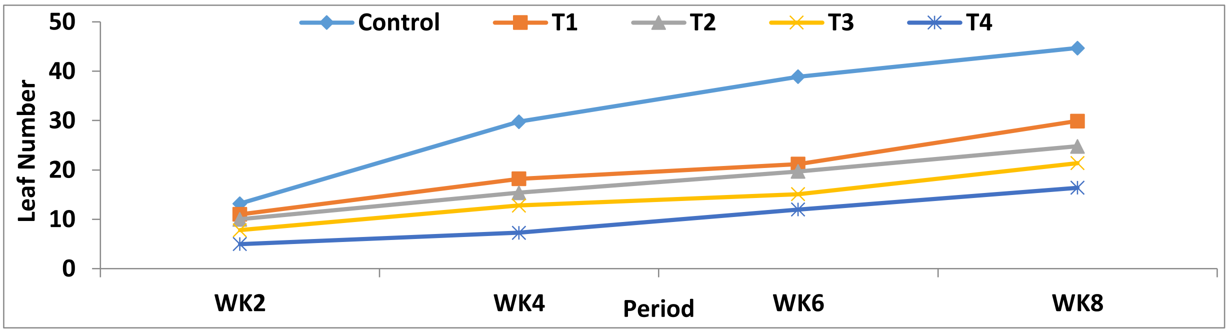

Fig. 3b: The Effect of Different Concentrations of Waste Engine Oil on the Leaf Number of *E. Indica.*

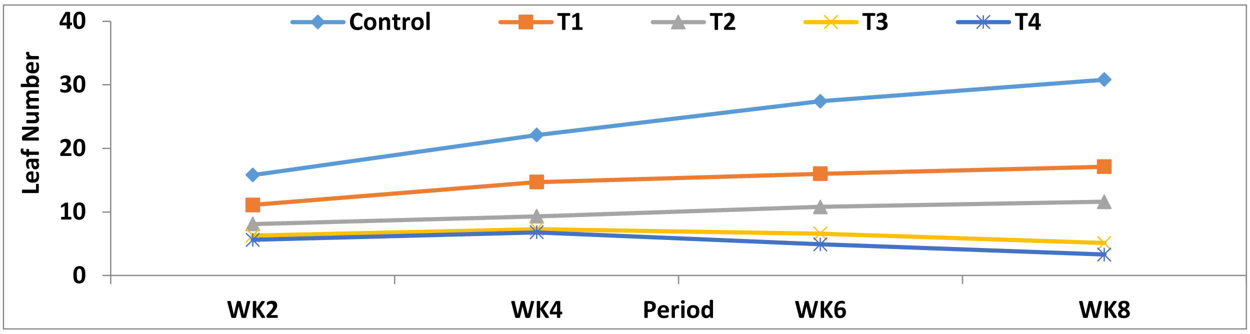

Fig. 3c: The Effect of Different Concentrations of Waste Engine Oil on the leaf Number of *S. Barbata.*

The waste engine oil significantly ($P<0.05$) affected the development of shoot girths in relation to their thickness. The result of the effect of various percentages of waste engine oil pollution on the shoot girth of *D. Horizontalis* is shown in Fig 4a. It was observed that at 10 %, 7 % concentrations there were significant reductions in the shoot girth when compared with 4 %, 2 % concentrations and control at WK2, WK4, WK6 and WK8 respectively. The result of the effect of various percentages of waste engine oil on the shoot girth of *E. indica* is shown in Fig 4b. It was observed that at 10 %, 7 % concentrations there were significant reductions in the shoot girth when compared with 4%, 2% concentrations and control at WK2, WK4, WK6 and WK8 respectively. The result of the effect of various percentages of waste engine oil on the shoot girth of *S. barbata* is shown in Fig 4c. It was observed that at 10 %, 7 % concentrations there were significant reductions in the shoot girth when compared with 4%, 2% concentrations and control at WK2, WK4, WK6 and WK8 respectively.

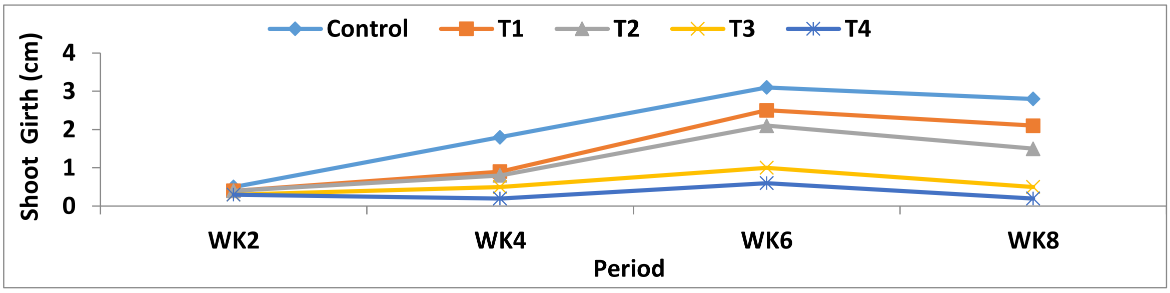

Fig. 4a: The Effect of Different Concentrations of Waste Engine Oil on the Shoot Girth of *D. Horizontalis.*

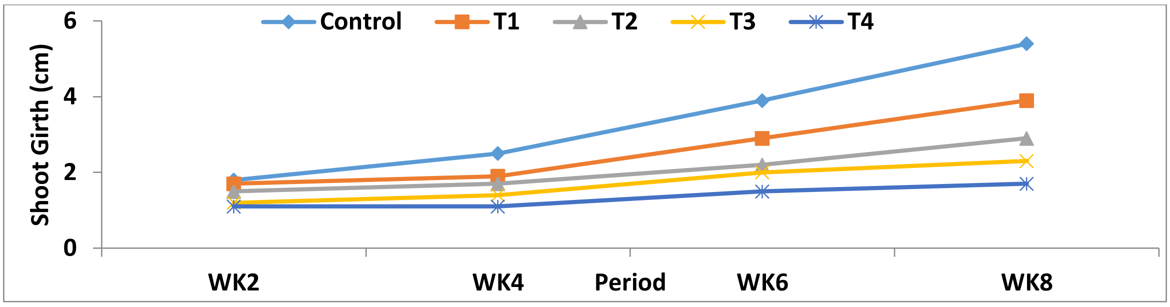

Fig. 4b: The effect of Different Concentrations of Waste Engine Oil on the Shoot Girth of *E. Indica.*

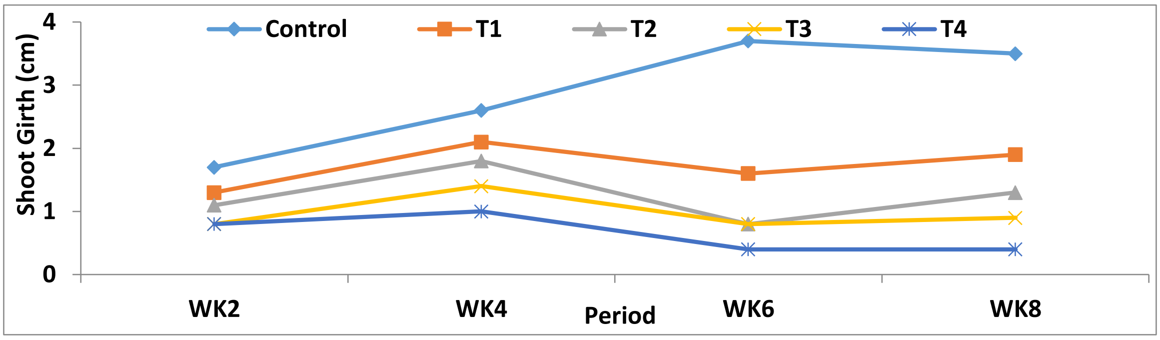

Fig. 4c: The Effect of Different Concentrations of Waste Engine Oil on the Shoot Girth of *S. Barbata.*

DISCUSSION

Decrease in plant heights was observed among the three grass species studied as the concentrations of waste engine oil increased. Plants growth rates were higher in the soil with lower concentrations of waste engine oil. This decrease in plant heights with increase in waste engine oil concentrations was observed by Ogedegbe *et al* (2013). The study reported that the growth rate of the plants grown on waste engine oil contaminated soils was profoundly affected. Aprill and Sims (1990) and Ikhajiagbe and Anoliefo (2012) reported that the vegetative growth of plants grown in waste engine oil-contaminated soil was reduced. This could be attributed to the presence of the pollutants in waste engine oil polluted soil which contains polycyclic aromatic hydrocarbons and heavy metals (Ogedegbe *et al.*, 2013). The significant reduction in leaf area was also observed in the leaves of the three grass species studied as the concentrations of waste engine oil increased. This was confirmed by Ogbo *et al* (2009) that also reported significant reduction in the leaf area of *P. scrobiculatum* that was grown on crude oil contamination soil. Udo and Fayemi (1975) observed that the plant leaves affected by oil are dehydrated and showed general sign of chlorosis; indicating deficiency of water. The reduction in leaf area may be due to dehydration. The progressive loss in leaf number observed in the leaves of the three grass species as the concentrations of waste engine oil increased was also observed by Lale *et al* (2014). The study reported that the plant growth parameters such as plant height, leaf area and number of leaves declined progressively with increase in spent lubricating oil (SLO) concentration. This could be as a result of changes in the soil parameters which imposed stressful conditions. Interference with water uptake and gaseous exchange resulting in a condition of physiological drought could have resulted through the stress conditions (Lale *et al.*, 2014). Furthermore, reduction in the diameter of the shoot girth of the three grass species was observed as the concentrations of waste engine oil increased. This finding is in line with that of Agbogidi and Ilondu (2013). There was significant difference ($P \leq 0.05$) between the plant height, number of leaves, leaf area, stem diameter and dry weight production of seedlings of *M. oleifera* in the control plots and those planted on spent oil contaminated soils respectively. The hydrocarbons and associated compounds which are toxic to biological organisms could be responsible for the negative interaction in the growth parameters (plant height, number of leaves, leaf area, stem diameter and biomass production) measured (Agbogidi and Ilondu, 2013). The three grass species studied were sensitive to waste engine oil pollution, despite the fact that the plants were also able to withstand the pollution to varying degrees. However, the growth parameters of *S. barbata* were the most affected followed by *D. horizontalis* which were tolerant to low percentages of waste engine oil concentrations in the soil only when compared with *E. indica.* This showed that the tolerance of *S. barbata* to waste engine oil is low and *D. horizontalis* had low tolerance to high percentages of waste engine oil concentrations. *E. indica* could be a potential candidate for phytoremediation of waste engine oil contaminated sites. This study has contributed to the knowledge of phytoremediation of waste engine oil contaminated sites using the three grass species studied.

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