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Full Length Research Paper

Effect of unspent and spent diesel fuel on two agricultural crop plants: *Arachis hypogea* and *Zea mays*

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The effect of five levels (1, 2, 3, 4 and 5%) of spent and unspent diesel fuel on two agricultural crop plants – *Zea mays* and *Arachis hypogaea* was investigated. Significant differences ($p < 0.05$) were observed between lower percentage levels and higher percentage levels of diesel fuel contamination. From the spent diesel fuel contamination- 4 and 5% levels of contamination had 40% seed germination for *Z. mays* and 22% for *A. hypogaea* respectively. In the unspent diesel fuel contamination, the values obtained were 10% for *Z. mays* and 0.5% for *A. hypogaea* in 5% level of contamination. The growth of plumule and radicle were negatively affected in all levels of contamination. The values obtained from the control were higher than those obtained from treatment, 100% seed germination was recorded for both species in control. There was no significant difference observed in 1 to 2% level of contamination in the treatment in spent and unspent diesel fuel contamination. However, seed germination, plumule and radicle growth were inhibited in comparison with the control, that test crops survived in all levels of contamination is suggestive of the test crop species being possible candidates for phytoremediation. Using the results from this study as indices, it is clear that the environment where oil spillage occurs suffer degradation. Agricultural crop producers in such areas equally suffer poor yield from their farms and poor income which indicates poor wellbeing. The study suggests that the relevant control agencies should protect petroleum products pipe lines from vandals and possible leakages. This is with a view to ensuring environmental protection and stability. National effective policy on fuel leakages and spillage backed by Legislation is suggested.

Key words: Zea mays, *Arachis hypogaea*, diesel fuel, agricultural crops, environmental stability.

INTRODUCTION

The two agricultural crops are annuals and belong to the family poaceae. They are cultivated by local farmers in Okada environment and generally in the rural communities in Nigeria. They serve as source of income to rural dwellers and the general public. Crude oil and refined petroleum product pipelines pass through these communities to their target destination. With the current high rate of pipeline vandalization in Nigeria, these communities and their environment suffer various degrees of damages arising from oil spillage. Furthermore, accident during transportation, pipeline leakages and ruptures has been made known in various media reports. In addition to these, the uncontrolled disposal of spent fuel by mechanics is the main source of discharge onto the environment.

The environmental consequences of fuel spillage are high, this causes adverse effect on the soil micro flora and reduces soil fertility (Torstenssen et al., 1998). Soil pollution arising from fuel contamination can kill plant roots and impair water and nutrient uptake and the general growth of plants (McCrown et al., 1972). Erute (2009) reported that petroleum derived fuel contains 75%

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saturated hydrocarbon paraffin and 25% aromatic carbons and further added that they can be degraded by a number of microorganisms, diesel fuel is phytotoxic to plants at low concentration. Seed germination and root enlongation have been used as indices of survival in environmental contaminants (Baud-Gasset et al., 1993). Degradation of land by petroleum derived products was reported by Sztompka (1999). Changes in biological composition of soil, water and oxygen deficits, shortage of available nitrogen and phosphorus may occur (Wyszkowska and Kuchariki, 2000). Diesel contamination of soil inhibits seed germination and plant growth (Hazel, 2005; Odjegba and Sadiz, 2002). Spent fuel was described by Wang et al. (2000), as a mixture of different chemicals including lubricative additives and heavy metals that come from engine parts as they wear away.

Spent fuel is a toxic environmental contaminant not usually or naturally found in the environment (Dominguez-Rosado and Pitchtel, 2004). Due to the different composition of diesel fuel, it affects the environment in different forms. Thus, the organic carbon and mineral component in soil are affected at different rates. The implication of this is that the growth and development of organisms depending on such soils are affected at different rates (Wyszkowiski and Ziolkowski, 2008). This study was undertaken to investigate the effect of unspent and spent diesel fuel on the selected agricultural crops and if they or any of them has phytoremediation capacity. Furthermore, to ascertain the extent, diesel fuel can affect plant growth and thus environmental stability.

MATERIALS AND METHODS

The choice of the selected agricultural crops for the study stems from their universal acceptance as food and industrial raw materials. *Arachis hypogaea* is used for the production of groundnut oil etc. *Zea mays* is an important food, fodder and industrial crop (Food and Agricultural Organization, 2007; Rouanent, 1992), they are widely cultivated, consumed and service a number of industries as raw materials in Nigeria (Miracle, 1996).

Test crop materials

Seeds of local varieties of *Z. mays and A. hypogae* were purchased locally in Okada market, the seeds were kept in perforated plastic buckets and kept in the laboratory till they were needed for the experiment. Plastic Petri dishes and Whatman No. 1 filter paper were purchased in Benin City, Edo State, Nigeria.

Viability test

Seeds were tested for viability going by the method described by .

Experiment

The experiment was conducted in plastic Petri dishes containing Whatman No.1 filter paper in Igbinedion University Microbiology laboratory Okada. A modification of the methods described by Erute (2009) was adopted. Five different levels of contamination were prepared with distilled water – 1, 2, 3, 4 and 5% respectively with respect to the spent and unspent diesel fuel. The preparation of the 5 levels of contamination was done by adding 0.8, 1.62, 2.43, 3.24 and 4.05 ml of diesel fuel to 10 ml of distilled water respectively. The control was only of distilled water. Each Petri dish had ten seeds in it. The contaminated water was used to moisten the filter paper in the Petri dishes. Seed germination was monitored and percentage germination recorded using the relationship:

$$\% \text{ Germination} = \frac{\text{Total number of emerged seed}}{\text{Total number of seeds sown}} \times 100$$

Seeds were regarded germinated with the emergence of radical. Germination was monitored till there was no more seed germination. Radicle and plumule length (cm) were recorded at the point (day) when there was no more seed germination. The experiment was a completely randomized block design with treatment replicated five times. The control was also replicated five (5) times. The data obtained were analyzed using (ANOVA) analysis of variance.

RESULTS

The results obtained from this study are presented as follows.

Viability test

One hundred percent (100%) viability was obtained from the seeds using floatation method.

Seed germination

Table 1 showed the result obtained from the effect of five (5) levels of spent diesel fuel contamination on seed germination. Significant difference ($p < 0.05$) was observed between the control and treatments. With the two agricultural test crop species, control had 100% seed germination while a decrease in the percentage seed germination was observed, as the percentage of diesel fuel contamination increases (Table 1). The significance of the results obtained is that spent diesel fuel contamination has negative effect on the test agricultural crop seed germination and possibly the soil, microorganism and thus the environment.

Seed germination results in five levels of contamination with respect to unspent diesel fuel are presented in Figure 1. The control had 100% seed germination and this agrees with what was obtained in control with respect to the spent diesel fuel contamination. This harmonious result confirms that the seeds used were viable and sown in uncontaminated environment (Table 1 and Figure 1). Comparatively, the results obtained in the level of

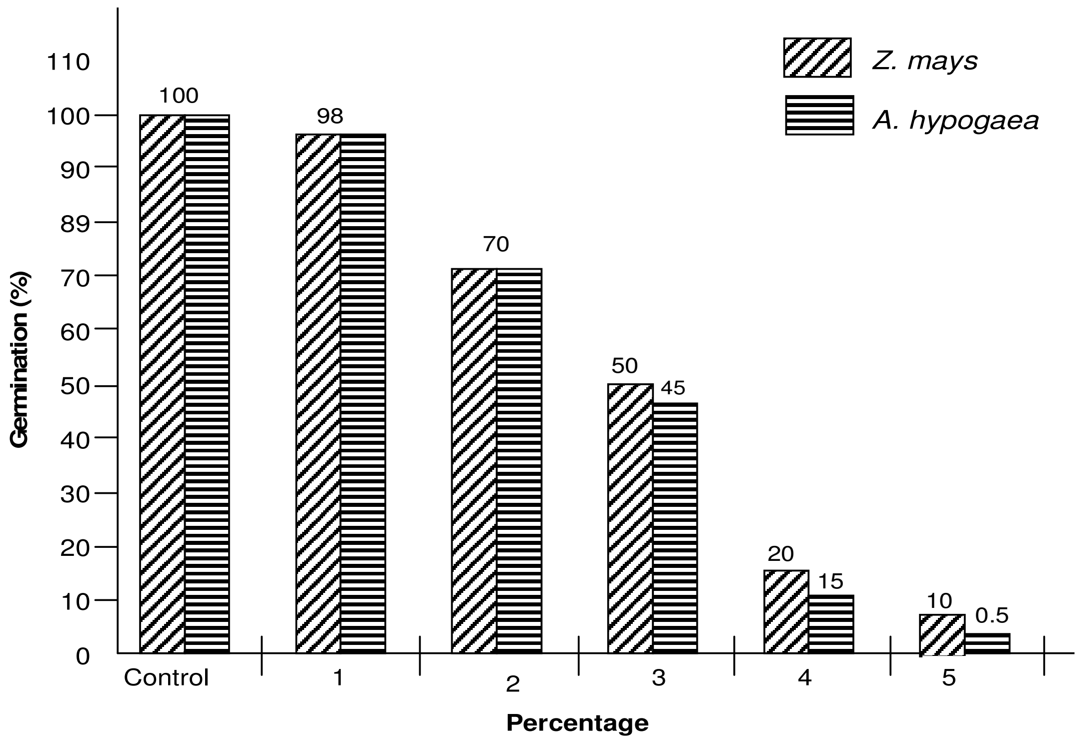

Figure 1. Germination of seeds of *Zea may* and *Arachis hypogaea* in 5 levels of unspent diesel fuel contamination.

Table 1. Percentage seed germination of two agricultural crop plants in five levels of spent diesel fuel contamination

	Agricultural crops	
	Zea mays	***Arachis hypogaea***
Control	100a	100a
Levels of contamination (%)		
1	90a	98a
2	55a	80a
3	40b	22b
4	40b	23b
5	10b	11c

Figures with same letters are not significantly different ($p < 0.05$)

contamination followed a similar pattern. Seed germination decreased with increased percentage (%) contamination. The study reached the conclusion that both the spent and unspent diesel fuel contamination have negative effect on the two test agricultural crops under study.

Effect of diesel contamination on plumule growth

The effect of spent and unspent diesel fuel contamination on plumule growth are presented in Table 2 and Figure 3, respectively. From the control*, Z. mays* had a length of 5.03 cm while *A. hypogaea* had 3.40 cm in spent diesel fuel contamination (Table 2). From the unspent diesel fuel contamination, the following values were obtained – 3 cm growth of plumule from *Z. mays* and *A. hyphogaea* 2.5 cm (Figure 3). The variation observed may be due to genetic variation. However, no significant difference ($p < 0.05$) was observed in the control of both treatments (Table 2 and Figure 3).

Effect of diesel contamination on radicle growth

The results are presented in Table 3 and Figure 2, respectively. The values obtained from the control in both levels of contamination types – in spent and unspent diesel fuel contamination were not significantly different ($p < 0.05$). The variations observed between species could possibly be the role of genetic variation establishing individuality of species. However, significant differences exist between various levels of contamination. The least values were observed in 5% level of contamination (Table 3 and Figure 2).

DISCUSSION

Evidence from the results showed that diesel fuel spent

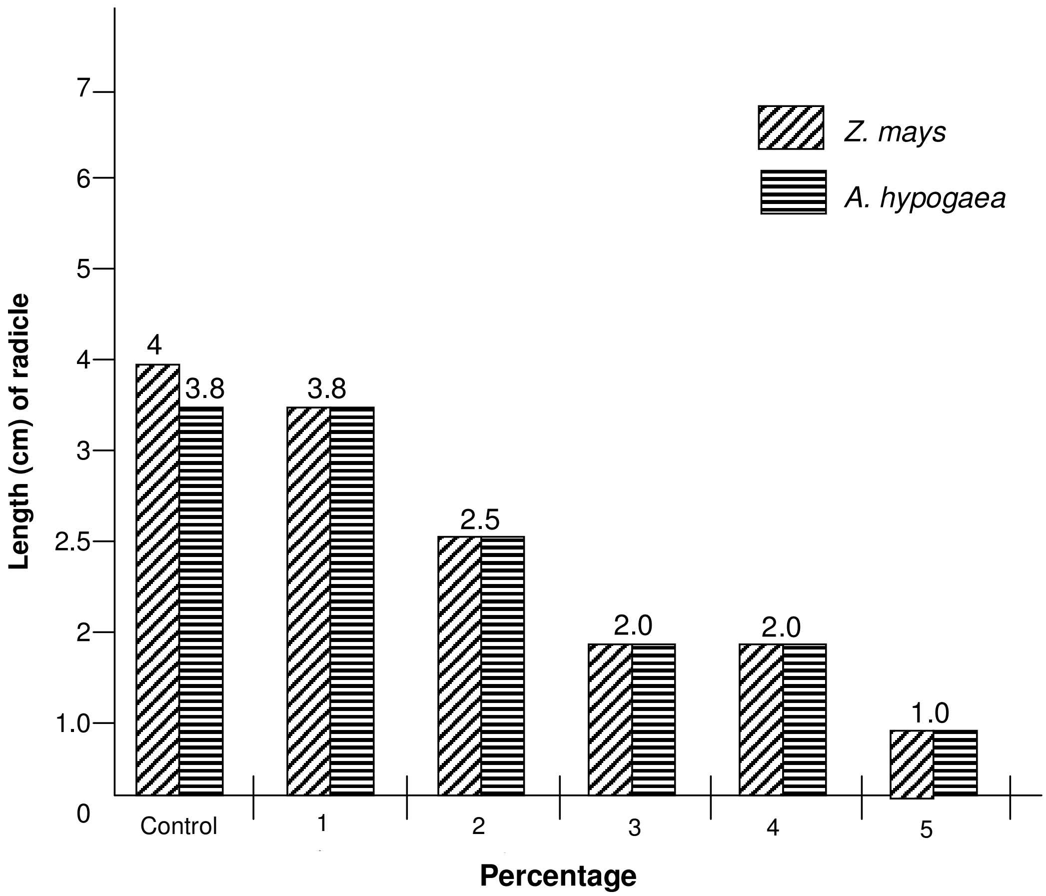

Figure 2. Length (cm) of radicle of *Zea mays* and *Arachis hypogaea* in 5 levels of unspent diesel fuel contamination.

Table 2. Length (cm) of plumule of two agricultural crop plants in five levels of spent diesel fuel contamination.

	Agricultural crop plants	
	Zea mays	***Arachis hypogaea***
Control	5.03a	3.40a
Levels of contamination (%)		
1	3.03a	3.10a
2	1.10a	2.20a
3	0.90b	1.30b
4	0.88b	1.20b
5	0.74b	0.64c

Figures with same letters are not significantly different ($p < 0.05$).

or unspent affected the test plants negatively. There was reduction in all the parameters measured in comparison with the control. However, germination was observed in all the levels of treatment. This is an indication that the test agricultural crops can tolerate diesel fuel contamination. This evidence is harmonious with the findings of Kirk et al. (2002). They recommended that such crops that germinate in diesel fuel contamination soil, are possible candidates for phytoremediation of petroleum hydrocarbon contaminated soil. A decrease in seed germination percentage was also observed by them in treatments with increased level of contamination.

Adam and Duncan (2002) are also in agreement with the findings of this study. When they evaluated the effect of petroleum contaminants on commercial crops, they reported decreased seed germination. Although decreased seed germination was reported by several researchers with respect to diesel fuel contamination, Salanitro et al. (1997) observed that the toxicity effect may not just be that arising from the diesel fuel contamination but other factors like soil properties, hydrocarbon type, microbial load and genetic diversity in plant communities. The level of damage as evident from this study showed that in the higher levels of contamination, 4 to 5% were most damaging to seed germination, plumule and radicle growth (Tables 1, 2, 3, and Figures 1, 2, 3). This observation is in consonance with that of Issuofi et al. (2006). They reported reduced seed germination as the level of contamination increased for agricultural crops like corn, wheat, soya bean, etc.

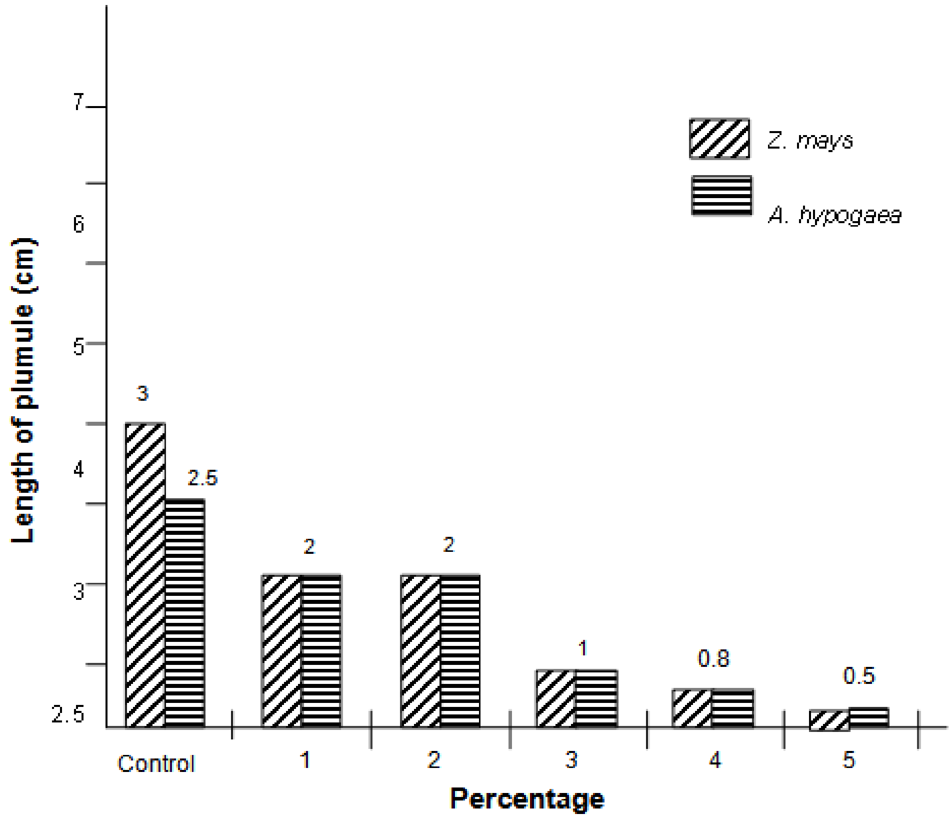

Figure 3. Plumule length (cm) of zea mays and Arachis hypogaea is 5 levels of unspent diesel fuel contamination

Table 3. Length (cm) of radicle of two agricultural crop plants in five levels of spent diesel fuel contamination.

	Agricultural crop plants	
	Zea mays	***Arachis hypogaea***
Control	3.01a	2.02a
Levels of contamination (%)		
1	1.22b	1.11b
2	1.20b	1.10b
3	1.10b	1.00b
4	0.97c	0.54c
5	0.97c	0.44c

Figures with same letters are not significantly different ($p < 0.05$).

However, the result obtained from this study is at variance with Anoliefo and Vwioko (1995) and Anoliefo and Edegbai (2000). They reported that petroleum hydrocarbons can inhibit the growth of plants like okro and that *Solanun incanum* failed to germinate in 6% level of contamination. This study observed that the degree and variability of response to petroleum hydrocarbon is genetic. In this study, the least values in the parameters measured was in 5% level of contamination, failure to germinate was not recorded in this study. The report of Amadi (1992) that increasing concentration of diesel fuel beyond 3% in the soil affects seed germination, the physiological processes or function of the plant and growth, was corroborated in this study.

Molina-Barahoma et al. (2005), Wang and Bertha (1990), Trap et al. (2001) and Erute (2009) agreed that diesel fuel contamination reduced plumule, radicle growth and seed germination. Their observations agree with the outcome of this study. Issoufi et al. (2006) recommended *Z. mays* as candidate species for phytoremediation in petroleum contaminated soil, as the species had highest values in the parameters evaluated in their study. They did not however point out which variety – local or improved variety. That *Z. mays and A. hypogaea* standout in all levels of diesel fuel contamination in this study, makes them choice species for possible phytoremediation. Thus, the view of this study is in agreement with that of Issoufi et al. (2006).

Conclusion

Evidence from this study showed that the agricultural test crops were negatively affected by diesel fuel contamination. The results served as pointers to the fact that farming population suffers some economic losses whenever there is diesel fuel spillage. Their soils, plants, economic crops are possibly negatively affected to the extent that their well being is jeopardised.

Furthermore, the implication of this in Nigeria is that the claim by the Niger Delta agricultural producers, that their means of livelihood is destroyed each time there was spillage of petroleum product, is supported from the evidence of this study. It is therefore right to suggest that the soil that supports plant growth and other organisms is negatively affected thus bringing about imbalance in the environment. Arising from the results of this study, it is recommended that government and government control agencies, etc should pay adequate attention to the protection of petroleum product pipelines, promulgate effective policies backed by effective legislation.

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