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Effects of Crude Oil Contaminated Soil on Biomass Accumulation in *Jatropha curcas L*. Seedlings

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Abstract

A study was conducted in 2010 to investigate the effects of crude oil contaminated soil on biomass accumulation in *Jatropha curcas* seedlings in Asaba, Delta State, Nigeria. Oil levels used were 0.0, 2.0, 4.0, 6.0, 8.0 and 10.0% w/w. The trial was arranged in a randomized complete block design with four replications and monitored for 12 weeks after transplanting. Results showed that contamination of soil with crude oil significantly reduced ($P \leq 0.05$) biomass accumulation when compared with seedlings grown in the uncontaminated subplots. A negative interaction was observed between the soil crude oil level and weight gained in *J. curcas* seedlings. For instance, while the fresh weight of seedlings grown in 0.0% w/w of oil was 3.0g, as low as 2.1g was recorded for seedling exposed to 10.0g w/w of the oil. This study has demonstrated that crude oil contamination of soil has a significant effect of reducing the biomass accumulation in the seedlings of *Jatropha crucas.*

Keywords: Biomass accumulation, Contaminated soil, Crude oil, *Jatropha curcas* seedlings.

INTRODUCTION

Jatropha curcas commonly called physic nut is a bush or small tree (up to 5m high). The genus name Jatropha is derived from the Greek word jatros (doctor), trophe (food), which implies medicinal uses. The plant is planted as a hedge (living fence) by farmers all over the world because it is not browsed by animals (Sukarin *et al.,* 1987, Achten *et al.,* 2007).

The plant has thick glabrous branchlets and the leaves are arranged alternately. The branches contain whitish latex, which causes brown stains that are very difficult to remove (Wini *et al.,* 2006). Although, native to the Caribbean, *J. curcas* today, is cultivated in almost all tropical and subtropical countries including Africa and Asia as protection hedges around gardens and fields. Other uses of this plant include potential for biodiesel production. It improves rural development through the promotion of women (local soap production), poverty reduction (protecting crops and selling seeds, oil and soap), erosion control and energy supply for the household and stationary engines in the rural area (Tigere *et al.,* 2006). *J. curcas* also has a great potentiality in the rehabilitation of degraded land (Achten *et al.,* 2007; Kumar *et al.,* 2008). *J. curcas* is a drought resistant plant that has wide adaptability to varied climate and soils. With the reviewed interest in the extraction of biodiesel from *J. curcas* plant due mainly to the fact that oil (28-38%) from the plant is converted to biodiesel which could be used as a good substitute for fossil fuel, there is an increase in the establishment of both plantations and normal cultivation of this multipurpose plant species in the Niger Delta area where oil activities are predominant. Crude oil pollution is an inevitable consequence of oil exploration and exploitation activities both in oil producing and consuming areas due mainly to accidental discharge human error, sabotage, transportation, natural causes etc (Agbogidi, 2005). Although studies have been conducted on oil pollution effects on crop plants and tree species (Terge, 1984; Anoliefo and Vwioko, 1995; Agbogidi, 2003; Smith *et al.,* 2006; Agbogidi and Dolor, 2007; Bamidele *et al.,* 2007; Agbogidi, 2009a; Agbogidi, 2009b), there is paucity of documented information on the effects of crude oil on the performance of *J. curcas.* It is against this background that a study as this was embanked upon. The present study has the aim of investigating the effects of crude oil contamination of soil on the biomass accumulation in *Jatropha curcas.*

MATERIALS AND METHODS

The study was conducted in 2010 at latitude $6^0$14'N and longitude $6^0$49'E (Asaba Meteorological Office, 2010) at the nursery site of the Department of Forestry and Wildlife, Delta State University, Asaba Campus, Nigeria. Matured fruits were harvested from the parent plants in Asaba, Delta State. The fruits were depulped mechanically to extract the seeds. Healthy seeds were selected and sorted out. Viability tests were carried out on the seeds using floatation technique. The depulped seeds (600) in number were sown in the Departmental nursery and the basic nursery techniques were observed. The soil treatment was thoroughly mixed with appropriate crude oil levels before the polypots (10/15cm in dimension) were each filled up with the oil-soil mixture. Oil concentrations used were 0.0, 2.0, 4.0, 6.0, 8.0 and 10.0% w/w. The soil sample was obtained as a pooled sample from the Gmelina plantation behind the Departmental office. The soil was air-dried and passed through a 2mm sieve. The crude oil was obtained from the Nigeria National Petroleum Corporation (NNPC), Warri, Delta State.

The seedlings (6 weeks of age) were transplanted into the oil–contaminated soil and the uncontaminated soil (control) in the polypots and watered immediately to field capacity and after wards, every other day till the end of the experiment. There were therefore six treatments, replicated four times and arranged in randomized complete block design. One seedling was transplanted into each polypot and each treatment comprised 10 polypots indicating a total of 180 seedlings of relatively the same height were transplanted. The set-up was monitored for 12 weeks after trans planting (WAT). At the end of the trial, the plants were harvested and separated into roots, stems and leaves. The various parts were weighed (Fresh weights) and then over dried at 85^{0}C for 22 hours following the procedure of Anon (1966) and Agbogidi and Eshegbeyi (2006) until a constant weight (Dry weight) was achieved. Data collected were subjected to analysis of variance (ANOVA) and the significant means were separated with the Duncan's multiple range tests using SAS (2005).

RESULTS AND DISCUSSION

The biomass yield of *J. curcas* seedling grown in the unpolluted soil (0.0%) significantly differed ($P \leq 0.05$) from the weights of seedlings grown in other treatments (Tables 1 and 2). The reduction in the weights is oil–concentration dependent i.e. the leaf, stem and root biomass decreased with an increase in crude oil level in soil. The results of the present study where a negative interaction existed between the soil crude oil content and biomass accumulation in *J. curcas* confirmed the reports of Agbogidi and Eshegbeyi (2006), Agbogidi *et al*., (2007) and Agbogidi (2009c) who noted that as hydrocarbons from oil polluted soil accumulate in the chloroplasts of leaves, photosynthetic ability of the leaves becomes reduced affecting translocation in affected plants probably due to obstruction of the xylem and phloem vessels hence reduction in photosynthate and matter content. Various contaminates including crude oil, spent engine oil and heavy metals have been found to significantly affect the growth and performances of various plant species.

The yield of a crop is a complex trait affected by genetically controlled physiological components (Agbogidi *et al.,* 2006; Agbogidi, 2009c), crude oil contamination of soil has been reported to cause reduction in the germination, growth and their performance and even yield (Anoliefo *et al.,* 2006; Vwioko *et al.,* 2006; Agbogidi *et al.,* 2007). Oil contamination of soil has also been shown to limit normal diffusion processes thereby reducing the availability of the level of some nutrients in the soil (Agbogidi and Egbuchua, 2010). The unavailability of mineral nutrients in soils following crude oil application to soil has been reported to cause such harmful effects as leaf chlorosis, necrosis, growth stunting in shoots and roots thereby leading to a reduction in biomass accumulation.

The observed significant reduction in the biomass accumulation in *J. curcas* seedlings grown in soils with higher oil levels could be attributed to the adulterated soil, which could have caused nutrient immobilization as the oil could here created some conditions in the soil, which make same vital nutrients unavailable to plants. Similar case of nutrient immobilization in soils treated with petroleum hydrocarbons have been reported by Benka-Coker and Ekundayo (1995), Benka-Coker and Ekundayo (1997), Ekundayo and Obuekwe (1977) and Agbogidi and Ejemete (2005). Agbogidi (2009c) maintained that in most cases, a reduction in shoot growth is a direct result a reduction in root growth as roots are important organs for the absorption and translocation of water and mineral nutrients. Similar reports have been made by Sharma *et al.,* (1989), Gill *et al.,* (1992), Bamidele and Agbogidi (2000). This study has demonstrated that crude oil contamination of soil has a highly significant effect of a reducing the biomass accumulation in *Jatropha curcas* seedlings. This study has implication on sustainability of using *Jatropha curcas* as a biodiesel species.

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Tables

Table 1. Fresh weight (g/plant) of Jatrophas curcas as affected by various levels of crude oil contamination of soil

	Plant Parts			
Oil in soil % (w/w)	**Leaf**	**Stem**	**Root**	**Means**
0.0	**28.6**	**30.5**	**10.6**	**23.2a**
2.0	**24.3**	**27.8**	**9.0**	**20.3b**
4.0	**16.7**	**21.9**	**7.8**	**15.4c**
6.0	**9.8**	**12.3**	**3.3**	**8.4d**
8.0	**5.4**	**7.7**	**2.4**	**5.1e**
10.0	**3.2**	**4.2**	**1.8**	**3.0f**
Means	**14.66**	**17.4a**	**5.6c**	

Means with different letters are significantly different at P≤0.05 here by Duncan's multiple range tests

Table 2. Dry biomass (g/plant) of Jatrophas curcas as influenced by various levels of crude oil contamination of soil

	Plant Parts			
Oil in soil % (w/w)	**Leaf**	**Stem**	**Root**	**Means**
0.0	**9.7**	**10.8**	**3.6**	**8.0a**
2.0	**9.2**	**10.6**	**3.0**	**7.6a**
4.0	**8.0**	**9.1**	**2.2**	**6.4b**
6.0	**5.3**	**7.3**	**1.4**	**4.6c**
8.0	**4.2**	**5.0**	**0.8**	**3.3d**
10.0	**3.1**	**2.9**	**0.4**	**2.1e**
Means	**6.5**	**7.6**	**1.9**	**5.3**

Means with different letters are significantly different at P≤0.05 here by Duncan's multiple range tests