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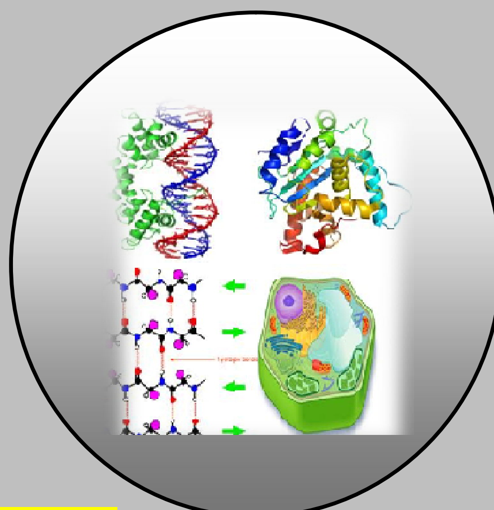

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Seedling Emergence in *Senna siamea* (Larnk) Irwin and Bameby as Affected by Crude Oil in Soil

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ABSTRACT

A study was carried out in 2011 at the Nursery site of the Department of Forestry and Wildlife, Faculty of Agriculture, Delta State University, Asaba Campus, Nigeria to evaluate the seedling emergence of Senna siamea as influenced by crude oil in soil. 0.0, 2.0, 4.0, 6.0, 8.0 and 10.0% (w/w) of the oil constituted treatments 10 seeds were sown in the soil crude oil mixture. The experiment was laid out in a randomized complete block design with four replicates. The results showed that contamination of soil with crude oil significantly (P≥0.05) reduced percentage germination, delayed germination by increasing the days to 50% germination and reducing the rate of germination in S siamea when compared with the uncontaminated plots. The effects were generally oil level-dependent. Only two seeds planted in 10.0% (w/w) of soil contaminated germinated while the majority did not sprout. This study has shown that oil in soil has a significant effect of reducing seedling emergence in Senna siamea. This study has a great ecological significance especially in the Niger Delta.
Keywords: Seedling emergence, Senna siamea, crude oil and contaminated soil.

INTRODUCTION

Senna siamea belongs to the plant family Fabaceae and order Fabales. It is commonly called black wood cassia, Bombay black cassia, iron wood, kassod tree. It is a medium sized, evergreen tree growing up to 18m fall with a straight trunk of up to 30cm in diameter. The bole is short, crown usually dense and rounded at first later becoming irregular and spreading with dropping branches (Okafor, 1980).

The root system consists of a few thick roots, growing to a considerable depth and a dense mat of rootlets in the top 10 – 20cm of soil, which may reach a distance of 7m from the stem in one year and eventually a distance up to 15m (Keay *et al*., 1989). The leaflets 6-12 pairs are on short stalks of 3mm. The pods are numerous, long; narrow, between 5 – 25cm long, 12 – 20mm broad with many bright yellow flowers (Dalziel, 1987). The seeds are bean – shaped, shining, dark brown, 8mm long with distinct areole (small clearly defined space) (Opeke, 1992).*S. siamea* is a native to South and Southern Asia but it has been cultivated for so long in other places. Okafor (1980) reported that plantations of *S. siamea* were established in the 1920s in Ghana, Nigeria and Sierraleane mainly for fuel wood. Ecologically, *S. siamea* will grow in a range of climatic condition but is particularly suited to lowland tropics with a monsoon climate. The plant grows only when its roots have access to groundwater and the maximum length of dry period should not exceed 4 – 8 months. It is susceptible to cold and frost and does not do well at altitudes above 1:300m. The plant starts flowering and fruiting at the age of 2 – 3 years (Dalziel, 1987). Once established, it flowers precociously and abundantly throughout the year. The seeds remain viable for 2–3 years under Sahel conditions. Seeds germinate readily without treatment but older seeds may receive some forms of pre-treatments.

Economically, *S. siamea* is a rather fast growing species for the production of pole timber and fuel wood in sudanian ecozones. It regenerates vigorously by coppicing, rotation of 4–7 years for pole production. Throughout the Sahel, it is used as fuel wood. The wood is fairly heavy with a specific gravity of 0.6 – 0.8 which makes it appropriate size suitable for furniture, turnery and cabinet work. The use of poles-posts in variousendeavours cannot be over emphasized. Leaves and pods are widely browsed by ruminants but highly toxic to pigs, poultry and possibly to other monogastrics (Gutteridge, 1997). The young leaves and flowers of *S. siamea* are used in curry dishes. The species is also used for the production of honey and tannins. It is suitable for windbreaks, shelterbelt plantation but not as shade tree in agro forestry because of root competition. It can be used as shade tree in cocoa, coffee and tea plantations roadside and court yard planting in the south planting erosion control, villages and squares laxative properties and used for a variety of ailments, of blood forming organs, genitourinary tract, also for herpes and rhinitis (F/FRED, 1994). Petroleum and its refined products account for over 90% of Nigeria source of income and during its exploration and exploitation, crude oil is inevitably discharged into the environment through transportation, oil well blowouts, rupture/leakages of oil storage tanks and pipelines terminal loading, operational discharge and accidental discharge (Terge, 1984; Ogri, 2001; Agbogidi and Dolor, 2007). Oil pollution effects vary from growth reduction, yield reduction, growth stagnation wilting of plant and total death. Oil pollution effects depends on the type of oil, plant types, oil level, time of application, adequacy of plant responses and other environmental factors (Agbogidi *et al*., 2007). Studies have been conducted on the effects of oil pollutions using various plant species including African star apple (Agbogidi and Ejemete, 2005), castor oil (Vwioko and Fashemi, 2005), native pear (Agbogidi and Eshegbeyi, 2006), dikanut (Agbogidi and Dolor, 2007), information on soil contamination and *Senna siamea* is however,scarce.

The aim of this study was to evaluate the seedling emergence in *Senna siamea* as affected by crude oil in soil with a view to recommending the critical level of crude oil to this multi-purpose tree species.

MATERIAL AND METHODS

The experiment was conducted in 2011 at the Forestry and Wildlife Research Farm of the Department of Forestry and Wildlife, Faculty of Agriculture, Delta State University, Asaba Campus, Delta State, Nigeria (Asaba Meteorological Station, 2010). The seeds of *S. siamea* were collected from a *S. siamea* tree behind Hall B in Delsu, Asaba Campus. Crude oil was with specific gravity 0.8334cm^{-3} wassourced from NNPC, Warri, Delta State. The soil samples collected was dir-dried and passed through a 2mm sieve. The oil was applied at 0.0, 2.0, 4.0, 8.0 and 10.0% w/w (based on weights of oil and soil). The soil/oil samples were thoroughly mixed together by hand. The mixtures were poured into bottom perforated polypots (15 x 10cm in dimension). The seeds (10) were later planted in the polypots, watered to field capacity immediately after planting and later, once in two days. The composite soil samples were collected from 0–20cm depth prior to treatment application and at the end of experiment and used to determine soil physico-chemical properties such as soil pH, texture, nutrients water holding capacity, moisture, bulk density and structure. Similarly, the characteristics of the crude oil used weredetermined in NNPC laboratory, Warri prior to experimentation. The set up was arranged in randomized complete block design withfour replications. The polypots were kept in the nursery for subsequent examination. Parameters measured were germination percentage, days to germination and rate of germination. Data collected were subjected to analysis of variance while significant means were separated with the Duncan's multiple range tests using SAS (2005).

RESULTS AND DISCUSSION

Table 1 shows the soil physico–chemical properties before experimentation. The soil is sandy loam in texture with characteristics of 94.5% (sand), 2.1% (silt) and 3.4% (clay). The pH 5.60 indicated that the experimental site is slightly acidic. Both the organic matter (2.64gkg) total nitrogen (0.06%) is relatively low. The characteristics of the crude oil used are presented in Table 2. The oil contains the major nutrients including carbon, nitrogen, sulphur, hydrogen, and oxygen and trace metals in varying quantities.

The germination characteristics of *Senna siamea* as influenced by crude oil in soil are presented in Table 3. Over 98% of the seeds of *S. siamea* planted in the uncontaminated soils germinated as from the 3rd day after sowing. The percentage germination of seeds sown in soils with 2.0%w/w crude oil contamination was 94.87. No significant ($P \leq 0.05$) differences existed in the seeds sown in the control plots and those exposed to 2.0%w/w oil treatment. Significant reductions ($P \geq 0.05$) were however, observed as the level of oil in soils increased. As low as 22.67% germination was recorded for *S. siamea*seeds planted in soils that received 6.00%w/w crude oil treatment (Table 3).

In the same vein, it took 3.4 days for *S. siamea* seeds sown in the control plots to sprout when compared to seeds exposed to 8.0%w/w of crude oil that sprouted at about 7 days after sowing indicatinggrowthreduction and stagnation. The observed reductionin growth of crops in crude oil contaminated soils may be attributed to one or a combination of the following factors: poor wetability and aeration of the soil, loss of seed viability, penetration of the oil components into the embryo and effect of the oil on the metabolic activities of the seeds.

Table 1. Physico-chemical properties of soil before experimentation.

Parameters	**Asaba**
Sand (%)	94.5
Silt (%)	2.1
Clay (%)	3.4
Soil pH	5.60
Textural class	Sandy loam
Organic carbon (%)	0.91
Organic matter (gkg^{-1})	2.64
Total N (%)	0.06
Available P (mg/kg)	30.00
Ca^{2+} (cmol/kg)	1.31
Mg^{2+} (cmol/kg)	0.16
Na^{+} (cmol/kg)	0.25
K^{+} (cmol/kg)	0.17
H^{+} (cmol/kg)	0.45
$Al3^{+}$ (cmol/kg)	0.08
ECEC (cmol/kg)	2.42
Base saturation (%)	78.10

The radicle could have emerged and the oil affected subsequent events relating to seedling growth. If a seed is dehydrated at the phase of seedling growth, such a seed is killed (Agbogidi *et al.,* 2006). Since increasing respiratory activities are associated with germination, there could be a correlation between any treatments that affects respiration in the soil. The physical surface characteristics of the oil which make it function as a physical barrier to water and oxygen uptake thus adversely affecting gaseous exchange as well as a delay in days to seedling emergence with increasing oil level. The rate at which the seeds of the test plant germinated were also, significantly ($P \geq 0.05$) affected. Almost all the seeds (9.8) in the soil without crude oil treatment germinated but only 3.4 of the 10 seeds subjected to 10.0% w/w of the oil germinated showing a significant reduction with increasing oil level in soil.

These observations are in agreement with prior reports of oil and other crops including *Leucaena leucocephala* (Agbogidi *et al.,* 2005), *Ricinus cummunis* (Vwioko and Fashemi, 2005), and Sharfi *et al*. (2007) on six plant species.

Table 2. Characteristics of the crude oil used.

Parameters	**Asaba**
Specific gravity (cm^{-3})	0.8334
API gravity	34.2897
Bottom temperature (^0C)	98.0
Viscosity (cp)	0.27
Gas oil ratio	881
Reservious depth (m)	2556
Carbon (%)	84.8
Hydrogen (%)	12.61
Sulphur (%)	1.48
Nitrogen (%)	0.48
Oxygen	0.50
Trace metals (%)	0.13

According to Agbogidi and Ejemete (2005), Ogbo (2009), Vwioko *et al.* (2006) and Agbogidi and Egbuchua (2010), reduced germination percentage, delayed germination, growth reduction couldbe due tooxygen tension that has beencreated following the high biological oxygen demand (BOD) as a result of the crude oil addition to soil. The presence of heavy metals and other toxic oil components could have also endangered the life and growth activities of plant. Reduction in seedling emergence of plants grown in crude oil contaminated soils had been reported by Anoliefo and Edegbai (2000), Anoliefo and Vwioko (2001) and Agbogidi and Dolor (2007).

Table 3. Germination characteristics of *Senna siamea* as influenced by crude oil in soil.

Oil in soil (% w/w)	**% germination**	**Days to germination**	**Rate of germination**
0.01	98.42	5.4	9.8
2.0	94.87	2.8	8.6
4.0	63.58	5.7	6.7
8.0	38.70	6.9	5.1
16.0	22.67	7.5	3.4

CONCLUSION

This study has shown that soil contamination with crude oil has highly significant effects of reducing the seedling emergence in *Senna siamea*. This study has importNT ecology relevance especially in the Niger Delta areas of Nigeria.

Means with same letters within the same column are not significantly different from each other at P ≥ 0.05 using the Fisher's least significant Difference (LSD)

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