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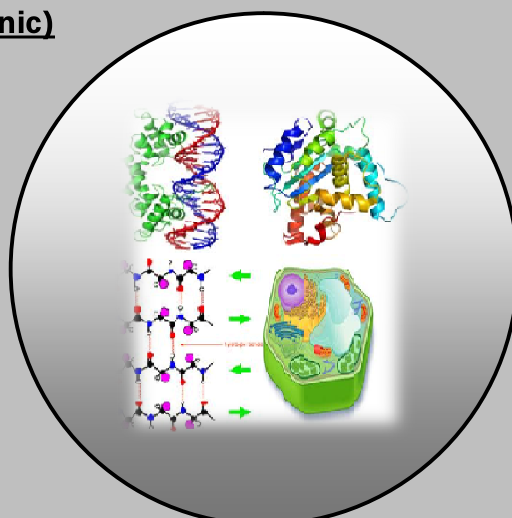

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RESEARCH PAPER

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Heavy Metal Contents of *Gambaya albida* (Linn.) Seedlings Grown in Soil Contaminated with Crude Oil

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ABSTRACT

The heavy metal contents of Gambaya albida seedlings grown in crude oil contaminated soil were investigated at the nursery site of the Department of Forestry and Wildlife, Delta State University, Asaba Campus, Nigeria. Five crude oil levels (0.00; 2.00, 4.00, 6.00 and 8.00% w/w) in soil constituted the treatments. The oil was applied to the soil before the seedlings of Gambaya albida were transplanted. The experiment was arranged in a complete randomized block design with four replicates. The results showed that crude oil contamination of soil had significant ($P \leq 0.05$) effects of increasing the contents of heavy metal of the test plant including lead, chromium, vanadium, zinc and cadmium when compared with values obtained for seedlings from the uncontaminated soil; the effect being oil-concentration dependent. This study has shown that crude oil contamination of soil can lead to a gradual build up of heavy metals which when absorbed are capable of making the Gambaya albida seedlings shoots and roots potentially toxic and harmful if consumed as food by man and his animals.
Keywords: Heavy metal concentration, Gambaya albida seedlings, soil contamination, crude oil

INTRODUCTION

Gambaya alibida commonly called African star apple, a member of the family Sapotaceae, is a small to medicine buttressed tree species up to 25 – 37m in height with a mature growth varying from 1.5 to 2m (Keay, 1989). The bark is pale brownish to green, slash exuding while gummy latex. The leaves are simple, dark green, pale tawny below; when young, are silver white below, when mature oblong elliptic to elongate obviate elliptic, 12 – 30cm broad, apex shortly acuminate (Centrad, 1999). The flowers are shortly pedicellate. Fruits almost spherical, slightly pointed at the tip, greenish-grey when immature, turning orange red, yellow brown or yellow when mature.

The fruit is a large berry containing two to five flattened seeds arranged in a star shaped form. *G. albida* is a dominant canopy tree of the low land mixed rainforest sometimes riverine and riparian forest in the Savannah regions. The fruits play an important role in food security in the humid lowlands and rainforest areas of Nigeria (Etukudo, 2000). The fresh pulp in the fruit is mostly eaten as snack as it is an excellent source of vitamins, irons, sugars, ascorbic acid, oil and it acts as a source of raw material for jams, alcohol, jellies, beverages (Keay, 1989, Agbogidi and Ejemete, 2005). 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 among others (Agbogidi *et al.*, 2007). Crude oil has a complex mixture of thousands of hydrocarbons and related compounds that are toxic to various life forms (Anoliefo and Osubor, 1998 and Agbogidi *et al.*, 2007). Some of these substances are heavy metals which are stable in the environment (Agbogidi, 2010). Heavy metals pollution of soil has been shown to be deleterious to plant germination, growth and yield (Alloway, 1995, Chee *et al.*, 2006, Vwioko *et al.*, 2006, Dauda *et al.*, 2008 and Nwite *et al.*, 2008). Although, studies exist on the heavy metal concentration of plants as affected by petroleum products, there is scarcity of documented materials on *Gambaya albida*. It is on this premise that a study as this has been embarked on to evaluated the heavy metal contents of *G. abida* seedlings, a multipurpose indigenous species with a view to establishing baseline information on this species.

MATERIAL AND METHODS

The study was carried out at the nursery site of the Department of Forestry and Wildlife, Delta State University, Asaba Campus (latitude: 6^{o}14'N; longitude: 6^{o}49'E) (Asaba Meteorological Station, 2009). Seedlings of *G. albida* (10 weeks of age) were obtained from the nursery of the Department of Forestry and Wildlife, Delta State University, Asaba Campus, Nigeria perforated and were transplanted into poly pots (30/60cm dimension), containing crude oil contaminated oil at 0.0, 2.0, 4.0, 6.0 and 8.0% (w/w) in a randomized complete block design (RCBD) with three replications. The seedlings were watered to field capacity immediately after transplanting them and afterwards every other day. The set up was monitored for 9 weeks after transplanting (WAT). At the ninth week, the seedlings were harvested and were separated into shoots and roots. These were even dried at 85^{o}C for 24 hours to get their dry weights following the procedure of Agbogidi and Eshegbeyi (2006). The plant tissues were ground to a powdered state. One gramme of each of the powder was weighted into a conical flask for wet ashing before subjecting them to analysis for heavy metals by atomic absorption spectrophotometer at the Nigeria Institute for Oil Palm Research (NIFOR) in Edo State. Composite soil samples were collected from 0-15cm depths prior to treatment application and after harvest. The samples were used to determine soil heavy metal concentrations. Data obtained were subjected to analysis of variance and at the significant means were separated with the Duncan's multiple range tests using SAS (2005).

RESULTS AND DISCUSSION

There was a build-up of heavy metals in soils treated with crude oil when compared with soils without crude oil treatment (Table 1). The levels of heavy metals viz: vanadium, cadmium, zinc, lead and chromium in soils of oil impact were significantly ($P \leq 0.05$) higher, as against the uncontaminated (Table 1).

Plant tissue analysis (Tables 2 and 3) also showed significantly higher amounts of heavy metals compared with tissues obtained from areas not contaminated with crude oil. Heavy metal building in soils polluted with crude oil and its various products has been previously reported by Chen *et al*. (2000), Agbogidi and Egbuchua (2010), Chukwuma *et al*. (2010), Nwaogu and Ujowundu (2010) noted that trace elements abound is soils polluted soils and they have a negative effect on the nutritional value of ripe guava fruits. Vwioko *et al.* (2006) also reported an elevated metal concentration in plant tissue of *Ricinus communis* (Castor oil) grown in soil contaminated with spent lubricating oil. Vihampa and Mwegoha (2010) also recorded accumulated metals in vegetables in Tanzania while Onwugbuta-Enyi *et al.* (2011) reported an elevated amount of lead on seedling growth in beans (*Phaseolus vulgaris*) The presence of metals in the uncontaminated soil indicates that heavy metals naturally occur in the environment and natural ecosystem (Salihi *et al.*, 2012). This further shows that they are natural components of the ecological system associated with one or more functions which may not be harmful at reduced concentrations but could become toxic at heightened doses. This funding is in harmony with prior reports of Hopkins (1996) and Benson and Ebong (2005). Heavy metals has also been shown to affect the soil physically, chemically, biologically and microbial properties of soils (Nabulo *et al*., 2008; Nwnchukwu *et al.*, 2010). Heavy metal and central nervous function, lower energy levels and damage to blood composition, lungs, kidneys, livers and other vital organs (Merrill *et al.*, 2001). Long term exposure may result in slowly progressing physical, muscular and neurological degenerative processes (Merrill *et al*., 2001). The presence of these heavy metals in soils when absorbed by plants is capable of making plants potentially toxic and harmful to man as well as his livestock if ingested or consumed as food (Ross, 2004; Agbogidi and Egbuchua, 2010). As trace elements, some of the heavy metals like zinc, copper selenium are essential for the maintenance of body metabolism. At higher concentration, they can lead to poisoning. Lead, chromium, nickel are known to have serious consequences on the brain cells (Laskowski, 1996; Edet *et al*., 2008). Benson and Ebong (2005) noted that poor growth of crop plants in higher levels of oil treatment was primarily due to the toxic effect of heavy metals or mineral uptake. Agbogidi and Ejemete (2005) also maintained that poor performance of plants in crude oil impacted soil could be due to either synergistic or antagonistic relations.

CONCLUSION

The present study investigated the heavy metal contents of *Gambaya albida* seedlings grown in soil contaminated with crude oil in Asaba, Delta State, Nigeria. The result indicated that crude oil contamination has a significant effect of increasing the concentrations of heavy metals including vanadium, cadmium, zinc, lead and chromium when compared with seedlings from the uncontaminated soils. This study has shown that tree species including *G. albida* can bio accumulate heavy metals which when ingested by man and his animals thereby constituting health risks.

Table 1. Heavy metal contents ($mgkg^{-1}$) of soil as affected by crude oil.

	Heavy metals in soil				
Oil in soil % (w/w)	**V**	**Cd**	**Zn**	**Pb**	**Cr**
0.014[e]	0.19[e]	0.98[e]	0.50[e]	1.30[d]	0.62[e]
2	0.020[d]	1.11[d]	1.49[d]	1.41[c]	1.08[d]
4	0.029[c]	2.38[c]	1.68[c]	1.41[c]	1.51c
6.3	0.034[b]	2.75[b]	2.30[b]	1.52[b]	2.10[b]
8	0.041[a]	4.59[a]	2.59[a]	1.63[a]	2.37[a]

Means with different letters are significantly different at ($P \leq 0.05$) level of significance using LSD.

Table 2. Heavy metal contents ($mgkg^{-1}$) in shoots of *Gambaya albida* **as affected by crude oil in soil.**

	Heavy metal contents				
Oil in soil % (w/w)	**V**	**Cd**	**Zn**	**Pb**	**Cr**
0	0.030[e]	1.33[e]	9.88[e]	6.05[e]	1.28[e]
2	0.042[d]	14.61[d]	15.88[d]	10.57[d]	4.67[d]
0.4	0.068[c]	19.97[c]	19.97[c]	13.18[c]	6.46[c]
6	0.086[b]	23.16[b]	25.50[b 1]	4.22[b]	8.79[b]
8	0.101[a]	25.44[a]	30.78[a]	16.25[a]	11.09[a]

Means with different letters are different at ($P \leq 0.05$) level of significance using LSD.

Table 3. Heavy contents ($mgkg^{-1}$) in roots of *Gambaya albida* **as affected by crude oil in soil.**

	Heavy metal contents				
Oil in soil % (w/w)	**V**	**Cd**	**Zn**	**Pb**	**Cr**
0	0.022[e]	1.07[e]	6.09[e]	4.22[e]	1.13[e]
2	0.030[d]	12.10[d]	9.22[d]	7.69[d]	3.90[d]
4	0.043[e]	18.27[c]	13.15[c]	8.86[c]	6.33[c]
6	0.067[b]	21.68[b]	19.84[b]	10.13[b]	8.64[b]
8	0.078[e]	24.67[a]	23.10[a]	12.07[a]	10.57[a]

Means with different letters are significantly different at ($P \leq 0.05$) level of significance using LSD.

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