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Research Paper

EVALUATION OF *Gmelina arborea* AND *Tectona grandis* LEAVES FOR IMMOBILIZATION OF HEAVY METALS IN EGGPLANT RAISED IN OIL POLLUTED SOIL

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ABSTRACT

This study measured the vegetative performance of garden egg on polluted soil as affected by Gmelina arborea and Tectona grandis in immobilizing heavy metals. The experiment consists of three treatments including a control and replicated three times. Nine pots of 10 litres capacity were arranged in which the application of polluted soil was done by filling each with 5kg of soil. The leaves of Gmelina arborea and Tectona grandis were chopped and 200g of chopped sample leaves were thoroughly mixed with the contaminated soil. The pots were arranged in completely randomized design using analysis of variance (ANOVA) for analysis and means was separated using Duncan Multiple Range Test (DMRT). Parameters taken were Internodes length, number of leaves, plant height, stem girth, number of aborted flowers and number of fruits of eggplant as part of vegetative performance. The three treatments had significant ($p<0.05$) differences in the height of eggplant, number of leaves, number of flowers aborted and stem girth while there was no significant difference in number of fruits and internodes length of egg plant.

Key words: Evaluation, *Gmelina arborea, Tectona grandis* Immobilization, Heavy Metals.

Introduction

Our planet Earth has large reserves of oil and gas trapped deep beneath its surface. Occasionally, these reserves develop cracks and some of the oil or gas seeps out. However, this is a part of nature and rarely causes any major damage. On the other hand, there are times when the same problem is caused because of human interference and it can cause a great deal of damage to marine ecosystems. In the last thirty odd years, the issue of oil spills and their effects has taken on much importance. This is because when an oil spill occurs, it causes a multitude of problems for the environment and humans.

An oil spill happens when liquid petroleum is released into the environment by vehicle, vessel or pipeline. It happens on a large scale and is mostly seen in water bodies. It happens due to human negligence and is a major form of pollution. Crude oil can be released by tankers on land. In water bodies, the spill occurs due to drilling rigs, offshore oil platforms and wells. Oil spills and their effects can also be experienced with refined petroleum or even waste oil from large scale industries. What is common in all of them is that the damage caused by them is permanent and takes a long time to clean up (Abii and Nwosu, 2009).

Oil spillage has been reported to negatively affect both timber and non-timber products such as food and other important components of traditional agro-forestry systems. It is also an important factor that adversely affects economic, social and cultural roles in Nigeria. The Niger delta area for example, as a result of oil spills developed low timber harvest, low land development, poor land use and land destruction of nest trees.

Oil spills from tankers also are likely to result in more than those from residential and recreational land development and timber harvesting. Oil spill have negative influences which involves pollution, food poisoning and other kinds of environmental hazards. Oil spillage in definition means the release of crude oil and its corresponding compounds into the natural environment either through disasters, deliberate acts, or human error. The ways through which spillage itself gets into the natural environment ranges from land disposal of waste, leakage from storage tanks and pipeline during distribution process as well as by car and railway transport, besides, petrol stations are rapidly increasing.

Many researchers have studied the effects of crude oil spillage and gas pollution on crop farms in Nigeria and other parts of the world (Ekundayo *et al*., 2001; Achuba, 2006; Aade- Ademilua and Mbamalu, 2008; Ibemesim, 2010; Al- Qahtani, 2011). Ekundayo *et al*. (2001) studied the effects of crude oil spillage on growth and yield of crops using maize (Zea mays L.) as the test crop in soil of Midwestern Nigeria. Their results showed that in crude oil polluted soils, germination was delayed and the germination percentage was significantly affected by oil pollution.

Al-Qahtani (2011) carried out an experiment to determine the effects of oil refinery sludge on plant growth and soil properties. The results of the effect of oil refinery sludge on Vinca rosea (*Catharonthus roseus*) and soil chemical composition showed that the dry matter yield decreased significantly with increasing application of sludge and the decrease in yield was significant. Soil salinity showed slight increases with the application of oil refinery sludge.

This study is therefore designed to determine the effect of oil spillage on the germination and fruitivity of crops using *Gmelina* arborea and *Tectona grandis* as treatment samples with special emphasis on African Garden egg (*Solanium marcrocarpon*) as the test crop.

G. arborea is a fast growing tree which occur almost all over the world; it occurs naturally throughout the part of India at altitude up to 1500meters, it occurs extensively from the Ravi eastwards in the sub- Himalayan tracts, common throughout Assam and adjoining areas of Northern West and Southern Indian. It occurs naturally in Myanmar, Thailand, Laos, Cambodia, Vietnaam and in Southern provinces of China and has been planted extensively in Sierra Leone, Nigeria and Malaysia.

Gmelina most common occurs in West Bengal forests in mixed forest. Estimated to range from Tropical Very Dry to Wet through Subtropical Very Dry to Wet Forest Life Zones, *Gmelina* is reported to tolerate annual precipitation of 7 to 45 dm, annual temperature of 20 to 26°C, and pH of 6 to 8. It can tolerate a 6–7-month dry season. Grows on many soils, acidic laterites to calcareous loams, doing poorly on thin or poor soils with hardpan, dry sands, or heavily leached acidic soils.

Tectona grandis is one of three species in the genus *Tectona*. The other two species, *T. hamiltoniana* and *T. philippinensis*, are endemics with relatively small native distributions in Myanmar and the Philippines, respectively. *Tectona grandis* is native to India, Indonesia, Myanmar, northern Thailand, and northwestern Laos. *Tectona grandis* is found in a variety of habitats and climatic conditions from arid areas with only 500 mm of rain per year to very moist forests with up to 5,000 mm of rain per year. Typically, though, the annual rainfall in areas where teak grows averages 1,250-1,650 mm with a 3-5 month dry season.

S. macrocarpon has a large cultivar variety. It grows in areas of high rainfall found in the tropical and humid regions of West and Central Africa, South-East Asia, South America and the Caribbean. Some cultivars can be found in the savanna and semi-arid region of Northern Ghana, Burkina Faso and their neighboring countries. The cultivars grown there consist of plants with small leaves and fruit. The fruit cultivars are only able to grow in humid coastal areas. *S. macrocarpon* can occasionally be found at higher altitudes but have a slower growth rate and are more robust. *S. macrocarpon* reproduces mostly by self-pollination.

Materials and Methods

The experiment was sited at the Teaching and Research Farms of Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria, which falls within the Southern Guinea Savannah Agro-ecological zone of Nigeria. Ogbomoso lies between Longitude 4^0 10'E and Latitude 8^0 10N. This location is found to be cold and dry from November to March and then warm and moist from April to October. It is characterized by bimodal rainfall distribution whereby the early rainy season starts in late March and ends in late July/early August, followed by a short dry spell in August and finally the late rainy season from August to November. The annual mean rainfall is between 1150 mm and 1250 (Olaniyi*,* 2006)**.**

The test crop, Eggplant (*Solanum macrocarpon*) was obtained from National Horticultural Research Institute (NIHORT) Ibadan. The tree crop species for amelioration are the leaves of *Gmelina arborea* and *Tectona grandis* was used as treatment in the course of the experimentation. The test soil was an oil polluted sample which was collected from Burutu Local Government, Warri, Nigeria. The collected soil sample was filled into the plastic pots with 5kg of soil after a thorough mixture of 200g of the chopped treatment sample leaves.

All together, there were three treatments (soil+*Tectona grandis* leaves, soil+*Gmelina arborea* leaves) and control replicated three times. The seeds of the crops were sown simultaneously, at three seeds/pot and later thinned into one/pot after germination. Regular watering was maintained when there was no rainfall. Plots were manually weeded by careful hand pulling of all the emerging weeds from the pots.

Data were collected on seedling growth parameters, included plant height using measuring tape, stem girth with veneer calipers which gave the diameter value and was later converted to circumference using a formula of π D (i.e. 3.142) multiplied by the obtained diameter (D) value, number of fruits per plant, internodes' length and number of leaves. These were measured at 2, 4, 6, 8 and 10 weeks after sowing (WAS). The results obtained from the plants treated with two treatments were compared statistically to those obtained from the control experiments following the procedure of analysis of variance (ANOVA) where differences were observed. Duncan's Multiple Range Test (DMRT), at 5% level of probability, was used to compare differences between the treatment means.

Results

Effects of *Gmelina Arborea* and *Tectona grandis* on the height of egg plant, at different weeks after transplanting are shown in table 1. At 2 WAT, it was observed that there were no significant different among the treated pot when compared with the control. At 4 WAT it was observed that there were significant ($p < 0.05$) differences among the treated pot *Gmelina arborea* (6.8b) and *Tectona grandis* when compare with untreated pot control (11.0a).

At 10 WAT to 14 WAT significant ($p < 0.05$) differences were observed among the treatments, it was observed that egg plant treated with *Tectona grandis* was significantly taller than *Gmelina arborea* and control excepts at 6 WAT and 8 WAT that no significant different was observed but *Tectona grandis* recorded higher value (13.3 and 14.1) respectively than *Gmelina aborea* and control (Table 1).

As with the plant height, the treatments had effect on the number of leaves, number of fruits, number of fruit aborted, stem girt and lent of internodes. The result obtained from the treated plants on the number of leaves, number of fruits, number of fruit aborted, stem girt and lent of internodes were similar over the periods of monitoring except at 10 WAT to 14 WAT where the two treatment were significantly ($p < 0.05$) different with respect to number of leaves (Table 2). However, *Tectona grandis* also significantly ($p < 0.05$) different 10 WAt, and 12 WAT to 14 WAT in respect to number of fruit aborted and stem girt respectively (Table 3, 4, 5 and 6).

In the uptake of heavy metals, uptake of cadmium, lead and zinc were determined. The treatments however had detrimental effects on the uptake of heavy metals both in the egg-plant leaves and fruits as these treatments had reduced values but lead and zinc is more pronounced in the leaves of egg-plant treated with both treatments but cadmium was more pronounced in the fruits of egg-plant treated with *Tectona grandis* leaves and zinc was more pronounced in the egg-plant fruits treated with *Gmeina arborea* leaves (Table 7).

Discussion and Conclusion

Polluted soils are toxic to egg plant at higher concentration while it favours plant at developmental stage at lower or minute concentration. Rate of polluted soil cannot be eradicated totally but can be checked and reduced to a minimal level if proper check and controls are put in place. Some historical disasters from oil spill are more informative than others in making predictions and amelioration of the effects of spill on the soil (Stephanie *et al*., 2014). Polluted soils have a highly damaging effect on the microbes in the soil which are supposed to increase the germination process and the enzymatic process in the soil for the enhancement of the growth and development. Farmers in the area of Niger Delta can ameliorate the effect of pollution by immobilizing heavy metals in the soil with the use of leaves of *Gmelina arborea.* This study is a precursor that can be employed by vegetable farmers in polluted soils. Reducing heavy metal intake will help in cleansing the soil as well as making the farm products safe for consumption. Natural processes such as oil-eating bacteria and wave action can help to disperse and degrade oil and may be more effective than human efforts. From an ecological point of view, cleanup intervention is advisable only in situations when the continued persistence of oil on the shoreline poses a greater threat than the adverse effect of the cleanup technique on the environment (American Petroleum Institute, 1985)

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Table 1: Effect of *Gmelina arborea* and *Tectona grandis* on the height of egg plant at different weeks after transplanting.

	Week after transplanting (WAT)						
	2	4	6	8	10	12	14
Gmelina arborea	6.0a	6.8b	9.0a	10.8a	15.3b	17.7b	19.0b
Tectona grandis	7.7a	10.0ab	13.3a	14.1a	24.8a	32.3a	34.6a
Control	7.2a	11.0a	12.8a	13.5a	18.2b	20.3ab	21.5ab

Means with the same letter are not significantly different from each other by DMRT at 5%

Table 2: Effect of *Gmelina arborea* and *Tectona grandis* on the number of leaves of egg plant at different weeks after transplanting.

	Week after transplanting (WAT)						
	2	4	6	8	10	12	14
Gmelina arborea	3.7a	5.0a	6.7a	8.3a	10.7b	13.3b	16.0b
Tectona grandis	5.0a	5.3a	6.7a	8.7a	39.0a	41.0a	47.7a
Control	4.0a	6.3a	7.0a	8.7a	14.3b	15.7b	17.7b

Means with the same letter are not significantly different from each other by DMRT at 5%

Table 3: Effect of *Gmelina arborea* and *Tectona grandis* on the number of fruits of egg plant at different weeks after transplanting

	Week after transplanting (WAT)						
	2	4	6	8	10	12	14
Gmelina arborea	0.0a	0.0a	0.0a	0.0a	0.0a	0.3a	0.3a
Tectona grandis	0.0a	0.0a	0.0a	0.0a	0.0a	1.3a	3.3a
Control	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a

Means with the same letter are not significantly different from each other by DMRT at 5%.

Table 4: Effect of *Gmelina arborea* and *Tectona grandis* on the number of flower aborted of egg plant at different weeks after transplanting

	Week after transplanting (WAT)						
	2	4	6	8	10	12	14
Gmelina arborea	0.0a	0.0a	0.0a	0.0a	0.3b	0.3a	0.3a
Tectona grandis	0.0a	0.0a	0.0a	0.0a	4.7a	4.3a	1.0a
Control	0.0a	0.0a	0.0a	0.0a	0.0b	0.0a	0.0a

Mean of the same letter are not significantly different from each other by DMRT at 5%

Table 5: Effect of *Gmelina arborea* and *Tectona grandis* on stem girth of egg plant at different weeks after transplanting

	Week after transplanting (WAT)						
	2	4	6	8	10	12	14
Gmelina arborea	0.0a	0.0a	0.0a	0.0a	0.0a	0.3ab	0.3b
Tectona grandis	0.0a	0.0a	0.0a	0.0a	0.0a	0.7a	0.9a
Control	0.0a	0.0a	0.0a	0.0a	0.0a	0.2b	0.5b

Means with the same letter are not significantly different from each other by DMRT at 5%

Table 6: Effect of *Gmelina arborea* and *Tectona grandis* on the length of internodes of egg plant at different weeks after transplanting

	Week after transplanting (WAT)						
	2	4	6	8	10	12	14
Gmelina arborea	0.7a	0.8a	1.0a	1.0a	1.5a	1.9a	1.8a
Tectona grandis	1.0a	1.0a	1.0a	1.3a	2.8a	2.9a	2.9a
Control	0.7a	0.9a	1.2a	1.2a	1.8a	1.7a	1.9a

Means with the same letter are not significantly different from each other by DMRT at 5%

Table 7: The Table Below Shows The Determination Of Heavy Metals Lead, Cadmium And Zinc.

S/N	ID	SAMPLE WEIGHT (g)	Cd (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
1	Leaf from *Gmelina arborea*	0.15	0.15	10.25	14.00
2	Leaf from *Tectona grandis*	0.17	2.50	77.21	24.85
3	Fruit from *Gmelina arborea*	0.50	0.15	7.35	24.40
4	Fruit from *Tectona grandis*	0.50	0.30	3.60	11.50
5	Polluted Soil	0.50	0.17	18.35	17.30
6	Control leaf	0.43	0.35	2.73	13.20
7	Control fruit	0.29	0.78	20.69	16.38