JASEM ISSN 1119-8362

Full-text Available Online at www.ajol.info and www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *March,* 2012
Vol. 16 (1) 17 - 20

Growth response of Taro (*Colocasia esculenta* L.) in soil polluted with Abura petroleum oil

BAMIDELE, J F; SIJUADE ESAN

Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria

ABSTRACT: Field experiment was conducted to evaluate the effect of crude petroleum oil on cocoyam (*Colocasia esculenta* L.). Plants were grown in substrates exposed to 0, 1, 2 and 3 L/m^2 of Abura crude petroleum oil. There was significant growth stimulation ($p \leq 0.05$) in terms of number of leaves, petiole length, leaf area, plant dry weight, and chlorophyll content in plants subjected to 1-2 L/m^2 oil. The dry biomass as well as other plant growth attributes showed significant reductions in plants grown in soil polluted with 3 L/m^2 oil. The highest applied oil dosage also adversely affected the leaf chlorophyll content. The experiment demonstrated that cocoyam is sensitive to crude petroleum oil pollution. @JASEM

Keywords: Crude oil; pollution; cocoyam; petroleum; hydrocarbon; crop

Crude petroleum oil is presently the mainstay of the Nigerian economy. Over 90% of the country's revenue is generated from oil export. A high percentage of the oil is drilled in very sensitive ecosystems such as freshwater and mangrove swamps as well as lowland rain forest zones. Oil spills in Nigeria occur due to a number of causes that include corrosion of pipelines and storage tanks, sabotage, and accidents in oil production operations. Kotangora (1991) reported that between 1976 and 1990, an estimated 2.1 million barrels of oil was spilled on land, coastal and offshore marine environments in Nigeria. The trend has continued up to the present time.

Most of the stable food crops consumed in the Southern part of the country are grown in the rain forest belt. It is a generally held view that oil production has over the last forty years impacted negatively on the socio-physical environment of the Niger Delta oil bearing communities, massively threatening the subsistent peasant economy, the environment and hence the entire livelihood and basic survival of the people. Systematic data on the effects of crude petroleum oil and its refined products on the flora in Nigeria are scarce.

A few workers have reported on the adverse effects of crude oil as well as refined products such as diesel and spent lubricating oil on soils (Ekundayo and Obuekwe, 1997) and the flora (Amakiri and Onofegara, 1984; Anoliefo and Vwioko, 1994; Odjegba, and Sadiq, 2002) of the Niger Delta. They showed that soil contamination with petroleum hydrocarbon leads to the suppression of seed germination, as well as growth reduction in diverse food crops. Reliable baseline data is essential for a good quality Environmental Impact Assessment (EIA). Ecotoxicity of hydrocarbons is highly variable, depending on their type and concentration, exposure time, state, environmental conditions and the sensitivity of affected species (Lin and Mendelssohn, 1996; Ogboghodo et al., 2004; Daniel-Kalio and Pepple, 2006; Anyawu and Tanee, 2008).

Cocoyam (*Colocasia saggitifolia*) Araceae , is widely grown and consumed in Southern part of Nigeria. *C esculenta* and *C saggitifolia* are both grown but the former prefers wet terrain. This aim of this work is to contribute to this debate and examines the effect of crude oil pollution on the growth of cocoyam.

MATERIALS AND METHODS

Secondary corms (suckers) of *Colocasia esculenta* were collected from a farm near Ikpoba River, Benin City. Crude petroleum oil was obtained from NPDC Abura field at Ologbo, near, Benin City. Cocoyam suckers were planted on 1m x 1m ridges using a randomized block design. The experimental area was hand weeded as necessary. The plants were allowed to establish. NPK fertilizer was applied to the ridges.

This treatments allowed the plants to grow under non-limiting conditions. One week after fertilizer application, crude oil was introduced to the soil

Email: fdele2001@yahoo.com

surface slowly from a beaker. The treatments applied were 1 L/m^2, 2 L/m^2 and 3 L/m^2 respectively. A control plot was set up without any oil application. Each treatment was replicated four times. After three weeks of treatments, 5 successive harvests were carried out at three weeks interval [equivalent to 51, 72, 93, 114, and 135 days after planting, (DAP)]. The following parameters were determined: leaf area was determined using the method of Eze (1965) while the number of leaves produced was determined by counting.

The biomass was determined by carefully uprooting the plants and separating them into leaves, corms, suckers, roots and cormels. The plant organs were dried to constant weight using a ventilated oven set at 80 ^{o} C. The dry weights of the plant organs were determined using a Metler E 200 electronic balance.

The leaf chlorophyll was extracted from 1.0g of leaf sample with aqueous acetone. 25 ml extract was transferred to ether and the optical density at 660 nm and 643 nm in 1cm cells was measured using ether as a reference. Chlorophyll content was measured using a spectrophotometer. The data obtained was subjected to statistical analysis (ANOVA) using the method outlined by Field (2005).

RESULTS AND DISCISSION

Pollution of the substrate with crude petroleum oil resulted in significant ($p \leq 0.05$) stimulation of growth of cocoyam in terms of leaf number, petiole length and leaf area. at 1 L/m^2 and 2 L/m^2 respectively (Figs 1-2; Table 1). Ninety- three days after planting, the number of leaves of plants treated with 2 L/m^2 crude petroleum oil was twice that of the untreated control .

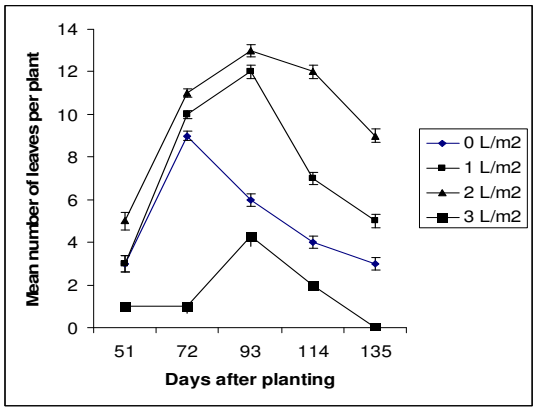

Fig 1. Effect of crude petroleum oil on number of leaves in cocoyam. Results are means of 4 replicates. ± standard error

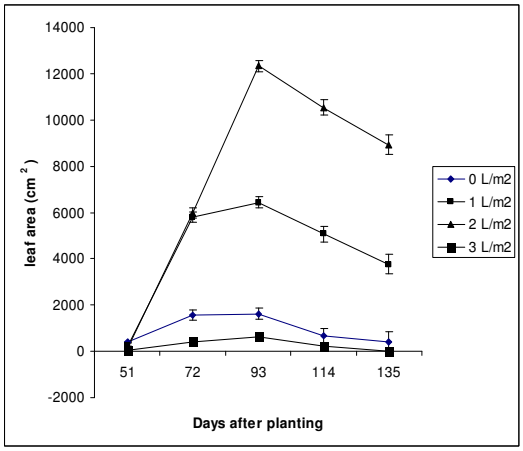

Fig. 2 Effect of crude petroleum oil on leaf area of cocoyam. Results are means of 4 replicates. ± standard error.

There was also a significant increase in leaf area at low oil concentrations. Chlorophyll, which is vital to plant growth and development also showed a parallel increase at low oil dosage when compared with the untreated control. The chlorophyll content of plants subjected to 2 L/m^2 was 4.49 mg/g while the value obtained for control plants was 1.66 mg/g. The total dry weight of cocoyam was significantly ($p \leq 0.05$) increased in plants grown at 1 - 2 L/m^2 when compared with the plants grown in unpolluted soil.

Previous reports have shown different growth responses of plants to petroleum hydrocarbon pollution (Bamidele and Agbogidi, 2000; Bamidele and Agbogidi, 2006; Otitoloju and Bamidele, 2006; Tanee and Anyanwu, 2007). Many of these have shown dose dependent relationship (Bamidele *et al*., 2007; Agbogidi and Ofoku, 2005; Agbogidi and Dolor, 2007). There have also been reports of stimulatory effect of petroleum hydrocarbon at low concentrations (Baker, 1979). Possible reasons responsible for this effect may include growth soil fertilization by soil killed organisms and potential stimulatory effect of growth enhancing compounds present in the crude oil (Baker, 1997).

Table 1. Effects of crude petroleum oil pollution on petiole length and chlorophyll content in *Colocasia esculenta*

Intensity of oil applied(L/m^2)	Petiole length (cm)	Chlorophyll content (mg/g)
0	31.7±2	1.66
1	49.5±4	2.46
2	53.2±15	4.49
3	6.7±20	0.96

There was significant reduction ($p \leq 0.05$) in plant performance in terms of the growth attributes such as leaf area and number of leaves at the highest applied concentration (3 L/m^2).

Higher concentration of petroleum oil in the soil led to significant decline ($p \leq 0.05$) in plant biomass. Similar patterns were obtained in other attributes measured such as root, cormel and total plant dry weights (Figs. 3-6). Significant growth reductions obtained at the highest applied dosage could be due to impairment of the photosynthetic apparatus or disruption of soil water relation. Reported adverse effects of oil on plants range from depressions of photosynthesis to mortality.

Soil pollution by hydrocarbon can disrupt nutrient uptake, metabolism and cause cell death (Wyszkowski *et al*., 2004). Reduction in the chlorophyll content can also contribute to lower plant performance under stress.

The results in this experiment corroborate the view of Lin and Mendelssohn (1996) that oil impact on plants depends on a number of abiotic and biotic factors including type and amount of oil, the plant species and extent of oil coverage, the season of spill, the weather condition, and soil composition. Variations in these factors have resulted in conflicting results.

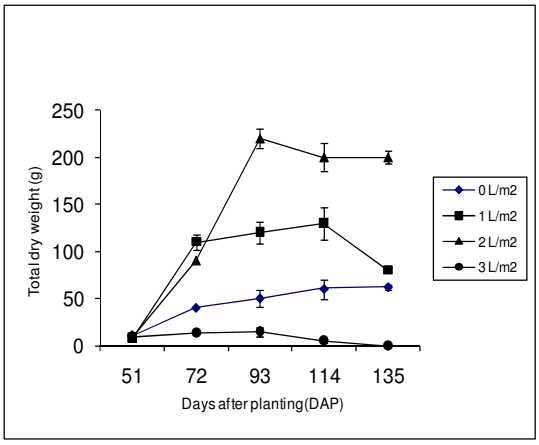

Fig. 3 Effect of crude oil on total dry weight of *Colocasia esculenta.* Results are means of 4 replicates. ± standard error.

REFERENCES

Agbogidi, OM; Ofoku, AU (2005). Response of sour sop (*Annona muricata*) to crude oil levels. *J. Sustain. Tropic. Agric. Res*. 16,98-102.

Anoliefo, GO; Vwioko DF (1994) Effects of spent lubricating oil on the growth of *Capsicum annum.*

Anyanwu, DI; Tanee, FBG (2008). Tolerance of cassava (var. TMS 30572) to different concentrations of post-planting crude oil pollution. *Nigerian Journal of Botany*. 21(1): 203-207.

L. *and Lycopersicon esculetum* Miller". Environmental Pollution, 88: 361 – 384.

Agbogidi, OM; Dolor, DE (2007). Assessment of the growth of *Irvingia gabonensis* (Aubry-Lecomte.) seedlings as influenced by crude oil contamination. *Asian Journal of Plant Sciences*. 6 (8): 1287-1292.

Amakiri, JO; Onofeghara, FA (1984). Effect of crude oil pollution on the growth of *Zea mays, Abelmoschus esculentus* and *Capsicum frutescans. Oil Petroleum and Pollution* 1: (3): 199- 206.

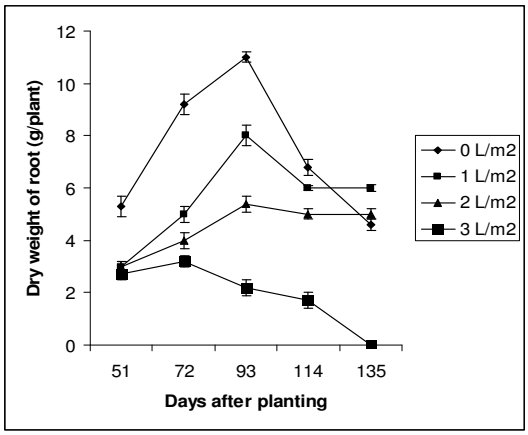

Fig. 4 Effect of crude petroleum oil pollution on root dry weight in cocoyam. Results are means of 4 replicates. ± standard error.

Many staple food crops such as cocoyams, plantain, cassava ,yams, sweet potatoes, vegetable and spices are commonly produced in terrestrial environment in Nigeria. Information on the sensitivity of these to various crude oil is essential for proper environmental management. The present work contributes to this essential database and demonstrates that Abura crude petroleum oil has adverse impact on the growth of Taro (*Colocasia esculenta*) although there was growth stimulation at low oil concentration.

ACKNOWLEDGEMENT: We thank Prof. O.T. Okusanya for his suggestions and interest.

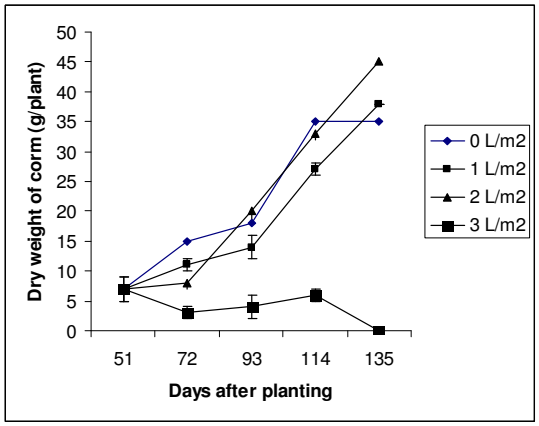

Fig 5. Effect of crude petroleum oil on dry weight of corm in cocoyam. Results are means of 4 replicates. ± standard error.

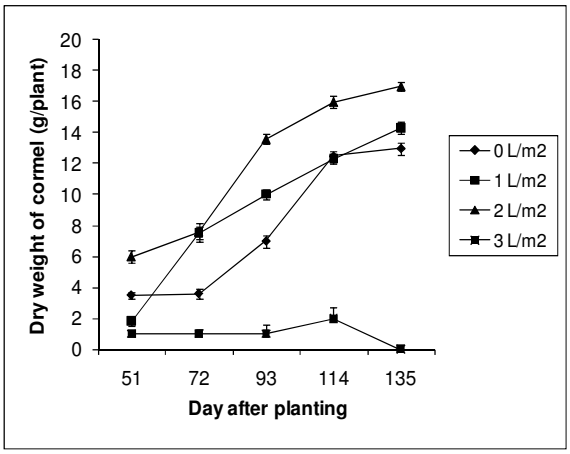

Fig 6. Effect of crude petroleum oil on dry weight of cormels in cocoyam. Results are means of 4 replicates. ± standard error.

Baker. JM (1979). Responses of salt marsh vegetation to oil spills and refinery effluents. In. Ecological processes in coastal environments, edited by R.L. Jefferies & A.J. Davy, Blackwell Scientific Publications. Oxford, pp. 529-542.

Bamidele, JF; Agbogidi, OM (2000). Toxicity of Odidi petroleum oil and its water soluble fraction on three aquatic macrophytes. *Nig. J. Sci. Environ*., 2:113-121.

Bamidele, JF; Agbogidi, MO ((2006). Effects of crude petroleum oil on *Machearium lunatus. Discovery and Innovation*. 18(2) 104-108.

Bamidele, JF; Agbogidi,M; Ohienbor, MO (2007). Phytotoxic effects of gasoline on *Ischaemum rugosum* (Salisb), a wetland species. *American Journal of Plant Physiology* 2: 276-281.

Daniel-Kalio, LA; Pepple, SF (2006). Effect of Bonny light crude oil pollution of soil on the growth of dayflower (*Commelina benghalensis* L.) in the Niger Delta, Nigeria. *J. Appl. Sci. Environ. Mgt.* 10 (2) 111-114.

Ekundayo, EO ; Obuekwe, CO (1997). Effects of an oil spill on soil physico-chemical properties of a spill site in a typic paleudult of Mid Western Nigeria. Env. Mon. Assess. 45 209-221

Eze, JMO (1965). Studies on growth regulation, salt uptake and translocation. PhD. Thesis, University of Durham, England. pp.31-33.

Field, A (2005). Discovering statistics using SPSS.Sage Publications London.

Kotangora, M (1991). Address at an International symposium on the National Oil Spill Contigency Plan for Nigeria. Badagri. pp.1-3.

Lin, Q. & Mendelssohn, I.A. (1996) A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and salt marshes. *Marine Pollution Bulletin*, **32**, 202–209.

Odjegba, VJ; Sadiq, AO (2002). Effect of spent engine oil on the growth parameters, chlorophyll and protein levels of *Amaranthus hybridus* L. *The Environmentalist*. 22: 23 –28.

Ogboghodo, A; Iruaga, EK; Osemwota, IO; Chokor, JU (2004). An assessment of the effects of crude oil pollution on soil properties, germination and growth and maize (*Zea may*).Using two crude types-Forcados Light and Escravos Light. *Environmental Monitoring and Assessment*, 96:142-152.

Otitoloju, K; Bamidele, JF. (2006) 'Growth, productivity and heavy metal content of TMS6 cultivar of cassava (*Manihot esculenta* Crantz.) polluted with Oredo crude petroleum oil at early and late growth stages' *Science Research Annals 2, 59-71.*

Tanee, FBG; Anyanwu, DI (2007). Comparative studies of the growth and yield of two cassava lines (TMS 30572 and TMS 30555) in a crude oil polluted habitat. *Scientia Africana.* 6(1): 81-84.