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Growth Response of *Jatropha curcas* (linn.) Seedlings Grown in Spent Engine Oil Contaminated Soil

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Abstract

This study was conducted at the research farm of Department of Forestry and Wildlife, Delta State University Asaba campus, Delta State, Nigeria to evaluate the effects of spent engine oil contaminated soil on the growth parameters of *Jatropha curcas* seedlings. The levels of oil used were 0.00, 3.45, 6.92, 10.39 and 13.86 (%w/w). The results showed that the performance of seedlings grown in the contaminated soil in terms of plant height, number of leaves, leaf area and collar diameter when compared with seedlings in control were significantly ($p \leq 0.05$) reduced. For example at four weeks after transplanting (WAT), plant height, leaf area, number of leaves and collar diameter had the values of 13.27cm, 4.67, 67.72cm^2, and 2.43 in control as against 10.27cm, 2.33, 12.56cm^2 and 1.99 in soil contaminated with 13.86(%w/W) level of oil respectively, while at 12 WAT, plant height, number of leaves, leaf area and collar diameter had 15.60cm, 7,40,102.65cm^2, and 3.87 in control against 10.87cm, 1.80, 9.10cm^2 and 2.11 in 13.86(%w/w) level of oil respectively. The reductions observed in the parameters were spent engine oil concentration dependent. No death was recorded indicating that the plant tolerated all the levels of spent oil used, although, the rate of tolerance decreased as the levels of oil increased. Thus study has shown that 3.45 (%w/w) level of the oil present in a soil is the critical level for *Jatropha curcas*, above which significant reduction in growth parameters of *Jatropha curcas* was recorded

Key words: *spent engine oil, Jatropha curcas, contamination, soil.*

Introduction

Jatropha curcas L. (physic nut) is a species of flowering plant in the spurge family Euphorbiaceae, which is native to the American tropics most likely Mexico and Central America (Janick and Robert, 2008). It is cultivated in tropical and sub – tropical regions around the world becoming naturalized in some areas. The specific name "curcas" was first used by a Portuguese doctor Garcia de orta, more than 4,000 years ago and is of uncertain origin. Their common name includes Barbados nut, purging nut, physic nut or JCL (Sukarin *et al.*, 1987). *Jatropha curcas* is a poisonous semi-evergreen shrub or small tree reaching a height of 6m i.e. (20 feet) with a smooth grey bark (Agbogidi *et al.*, 2011a; Agbogidi *et al.*, 2012). The leaves are large and usually pale green. The plant produces flowers and fruits throughout the year; the fruit contain 37.5% shell and 62.5% seed (Singh *et al.*, 2007). Seeds are said to resemble castor in seed shape and black in colour, they have 42% husk and 58% kernel (Singh *et al.*, 2007). The seeds are encased within green capsule in the plant's fruits. Seeds are matured when the capsule changes from green to yellow (Openshaw, 2000).

Jatropha curcas can be grown from either seeds or cuttings, for plants started as seeds germination is achieved within 9 days and yielding begins between 9 and 12 months. The seed become matured when the capsule changes from green to yellow, after two to four months. The seed is black and in the average 18mm long (11-30) and 10mm wide (7-11) (Henning, 2008). The seed contains 27 – 40% oil (average of 34.4%) that can be processed to produce a high quality biodiesel fuel usable in a sound diesel engine (Achten *et al*., 2008). It is traditionally used as hedging plants in part of India to protect agriculture and livestock. It was used in some areas in Africa as a grave marker. *Jatropha curcas* as biodiesel tree and countries like Nigeria to reducing emission from fossil fuel and reduce deforestation, improving energy efficiency and transforming urban transport. Such an approach can simultaneously support economic recovery and encourages growth in areas that mitigate the impact of climate change. The rapid development of the global biodiesel industries has been closely observed by countries that are interested in stimulating economic growth, improving the environment and reducing dependency on imported oil (Agbogidi and Ekeke, 2011).

The seeds have been used as insecticides (Adebowale and Adedire, 2006; Ampitan *et al*., 2011) once de-shelled the glycerin with the almond of the seed can be used to make soap, the pressed cakes that remains after oil has been extracted are often used as organic fertilizer because of their high concentration of nitrogen. The wood and the seed cake both can be used as fire wood or charcoal (Kumar *et al.,* 2008). Spent engine oil, which is also known as used mineral based crankcase oil, is a brown to black liquid produced when new mineral–base crankcase oil is subjected to high temperature and high mechanical strain (Agency for Toxic Substances and Disease Registry (ATSDR), 1997). spent engine oil is a mixture of several different chemicals (Wang *et al.*, 2000) including low and high molecular weight (C_{15} – C_{20}) aliphatic hydrocarbons, aromatic hydrocarbons, polychlorinated biphenyls, chlorodibenzofurans, lubricating additives, decomposition products, heavy metal contaminants such as aluminum, chromium, tin, lead, manganese, nickel and silicon that comes from engine parts as they wear down (ATSDR, 1997). Spent engine oil is a common and toxic environmental contaminant not naturally found in the environment (Dominguez *et al.*, 2004). Large amount of spent engine oil are liberated into the environment when the motor oil is changed and disposed into gutters, water drains, open vacant plots and farm lands, a common practice by motor mechanics and generator mechanics (Odjegba and Sadiq, 2002). In addition, the oil is also released into the environment from the exhaust system during engine use and due to engine leaks (Anoliefo and Edegbai, 2000). Spent engine oil, when present in the soil, creates an unsatisfactory condition for life in the soil which is due to the poor aeration it causes in the soil, immobilization of soil nutrients and lowering of soil pH (Atuanya, 1987). Soil enzymes are biologically produced substance which bind with substrate in stereoscopic position that causes changes in the electronic configuration around certain susceptible bonds that culminates in biochemical reactions (Zahir *et al*., 2001). The activities of soil enzymes provide an integrated measure of the biological status of the soil (Li *et al*., 2005).Spent lubricating oil (waste engine oil), has been reported as one of the major and most common soil contaminants (Anoliefo and Edegbai, 2000). The spent lubricating oil is usually obtained after servicing and subsequently draining used oil from automobiles and generator engines. The disposal of spent oil into gutters, water drains, open vacant plots and farmlands in Nigeria is a common occurrence and is mostly done by auto-mechanics and allied artisans with workshops on the roadside and open places. Disposal of used oil indiscriminately to the soil according to Atuanya (1987) affects its physical, biological and chemical properties, therefore making life uncomfortable for both plants and animals that live and feed in the soil including *Jatropha curcas*. There has been general awareness about the dangers of loosing economic tree species form our tropical high forest ecosystem including *Jatropha curcas;* this is due to low concerted efforts being made to cultivate the species (Omolaiyi *et al*., 2005; Agbogidi, 2011). The indiscriminate disposal of spent engine oil has led to the disappearance of most economic tree species, the environmental impact of indiscriminate disposal of spent oil is one of the inevitable consequences of economic development. The effects of oil in the soil include depression and inhibition of plant growth by interfering with the soil water plant interrelationship (Agbogidi and Dolor, 2007). Oil in the soil has been reported to cause alteration in soil physico-chemical properties as well as the performance and yield of crop plants (Anoliefo and Vwioko, 1995; Anoliefo and Edegbai, 2000; Agbogidi and Nweke, 2005; Vwioko *et al*., 2005; Agbogidi *et al*., 2006a). Agbogidi *et al*. (2006b) maintained that pollution of soil by spent lubricating oil has been shown to cause growth reduction in plants attributed mainly to the presence of heavy metals at toxic concentration in soil. Although, research has been conducted on forest species using spent oil, information on *Jatropha curcas* is however, scarce. It is against this background that a study as this has been embanked on. This study has the objective of evaluating the growth performance of *Jatropha curcas* grown in spent engine oil contaminated soil.

Materials and Methods

Study area

The experiment was carried out at the research farm of the department of forestry and wildlife, Delta State University, Asaba Campus. Asaba is located within the tropical rain forest zone at latitude 6^o 14'N and longitude 6^o 49'E of the equator. The area is characterized with a total annual rainfall of 1,955mm, mean monthly rainfall of 1586 mm; mean monthly soil temperature at 100cm depth is 31.4^{o}C and means monthly sunshine of 4.7 hours (Asaba meteorological station, 2010).

Source of soil sample: Soil sample was collected from the *Gmelina aborea* plantation behind the department of forestry and wildlife, Delta State University Asaba Campus.

Source of seeds: The seeds were obtained from the parent plant in Delta State University Asaba Campus

Source of spent engine oil: Spent engine oil was collected from one of the mechanic workshops in Asaba, Delta State.

Experimental design: Randomized Complete Block Design (RCBD) was used with three replicates for each treatment.

Procedure: The top soil used was thoroughly mixed with the appropriate spent oil level before the poly pot was filled up with 1.3kg weight of the contaminated soil. The levels of spent engine oil used are 0, 50,100, 150 and 200ml. thus by calculating the equivalent concentration of spent oil in the soil was 0.00, 3.45, 6.92, 10.39 and 13.86% of the oil per 1.3kg weight of the soil respectively. Seedlings of two weeks old were transplanted into the contaminated soil in the perforated poly pot and were watered immediately and afterward every other day to field capacity. The experiment was replicated three times with five treatments. The set up was monitored for 12 weeks after transplanting, while parameters was measured fortnightly with effect from the second week after transplanting.

Data collected: The parameters considered were plant height (cm): This was measured using measuring tape from soil level to terminal bud at two weeks interval after transplanting, number of leaves: This was done by visual counting of the number of leaves for each seedling per treatment, leaf area (cm^2)**:** This was done by tracing the leaves on a graph paper and the total area per plant was obtained by measuring the maximum leaf and the length and breadth of the leaf was multiplied by the correction factor 0.75 following the formula of (Agbogidi and Ofuoku., 2005), collar diameter: This was measured using veneer caliper every two weeks and Tolerance index:**-** This was measured using the formula below

$$T.I\ (\%) = \frac{NEO}{NEC} \times \frac{100}{1}$$

Where

T.I = Tolerance index

NEO = number of emerged leaves/leaf of seedlings in oil contaminated soil

NEC = number of emerged leaves/leaf in control.

Data analysis: Data collected was subjected to analysis of variance (ANOVA) at 0.05 probability level while the significant means was separated using the Fisher's least significant difference (L.S.D) method.

Results and Discussion

The performance (plant height, number of leaves, leaf area and collar diameter) of *Jatropha curcas* seedlings as influenced by various levels of spent engine oil in soil are presented in Tables 1, 2, 3 and 4 respectively. The results showed that spent engine oil contaminated soil had significant effects ($p \geq 0.05$) on *Jatropha curcas* seedlings in terms of plant height, number of leaves, leaf area and collar diameter. The effect being spent engine oil- concentration dependent. For example at 0.00 level of oil contamination 8 WAT, the plant height was 14.40cm, 13..03cm at 3.45 (%w/w) level of oil application to soil and 10.32cm at 13.86 (%w/w) level of oil in soil (Table 1). Significant reduction ($p \geq 0.05$) was observed in the parameters (plant height, number of leaves, leaf area and collar diameter) measured with increasing levels of spent engine oil (Tables 1-4). No death was recorded in all the seedlings, which indicates that *Jatropha curcas* seedlings tolerated all the oil levels used. Tolerance index of the seedlings exposed to oil contaminated soil decreased as oil levels increased (Table 5).It was observed that there was a complete leaf fall (defoliation) of *Jatropha curcas* seedlings both in control and contaminated soil one WAT, this could be seen as a result of shock. However, the seedlings grown in the contaminated soils experienced leaf fall subsequently unlike those in control. This is responsible for the reduction in the number of leaves and leaf area (Table 2 and 3). For example the mean values of number of leaves at 12 WAT were 7.40 and 1.80 in 0.00 and 13.86 (%w/w) levels of oil respectively. While for leaf area the mean values were 102.65 and 9.10 in 0.00 and 13.86 (%w/w) levels of oil respectively at 12 WAT (Table 3).The reductions in the number of leaves and leaf area were also spent engine oil concentrations dependent.

The reduction in the growth parameters of *Jatropha curcas* seedlings is in agreement with the findings of Oyin and Kassim (2006) who reported that the heights of *Celosia agentea* decreased as the concentration spent engine oil increased. For number of leaves, leaf area and collar diameter, similar results were obtained with the control having the highest mean value of 5.59, 82.99 and 3.11 respectively which also confirm the report of Oyin and Kassim (2006) who reported that number of leaves, leaf area and collar diameter of the plant decreased as spent engine oil concentration in the soil increased. The analyses of variance also showed that there were significant differences ($p \geq 0.05$) in the tolerance index. The highest mean value 71.92 was recorded for 3.45% level of oil concentration which is the lowest level of contamination. This indicates that tolerance index decreased as concentration of spent engine oil increased. This result is in agreement with the work of Anoliefo and Vwioko (2001) who reported that *Chromolaena odorata* grown in control 0.00% and 3.45% levels oil contaminated soil showed high level of tolerance than the others. The result from this investigation showed that the highest level of oil (13.86%) in the soil has the greatest effect on the seedling of *Jatropha curcas.* It was also observed that the plant grown in the contaminated soil experienced chlorosis of leaf unlike those grown in control.

Conclusion

This study has demonstrated that spent engine oil has a highly significant effect of reducing the growth characteristics of *Jatropha curcas* seedlings and their effects are oil level dependent.

Table 1. Plant height (cm) of *Jatropha curcas as* influenced by different spent engine oil levels in soil

Oil in soil (%w/w)				WAT/plant height			
0	2	4	6	8	10	12	Mean
0.00	12.77	13.27	14.20	14.40	14.80	15.60	14.17a
0.45	13.05	13.01	12.93	13.03	13.10	13.87	13.17b
6.92	11.45	11.43	11.17	11.21	11.75	11.84	11.48c
10.39	10.60	10.50	10.51	10.54	11.12	11.15	10.74d
13.86	10.37	10.27	10.04	10.32	10.30	10.87	10.36e
Means	11.65	11.70	11.77	11.90	12.21	12.67	

Means with different letters are significantly different at (p ≤ 0.05) level of significance using Fisher's least significant difference (LSD).

Table 2. Effect of spent engine oil on number of leaves of *Jatropha curcas* seedling

Oil in soil (%w/w)			WAT/number of leaves				
0	2	4	6	8	10	12	Mean
0.00	4.20	4.67	5.27	5.60	6.40	7.40	5.599a
3.45	3.73	3.20	3.20	2.87	3.13	3.40	3.28b
6.92	2.93	3.13	3.13	2.67	2.40	5.53	2.80c
10.39	2.80	2.67	3.00	2.53	1.93	2.20	2.52d
13.86	1.93	2.33	2.07	1.93	1.27	1.80	1.89e

Means with different letters are significantly at (p ≤0.05) level of significant using Fishers least significant (LSD).

Table 3. Leaf area (cm^2) of *Jatropha curcas* as affected various levels of spent engine oil contamination in soil

Oil in soil (%w/w)			WAT/leaf area				
0	2	4	6	8	10	12	Mean
0.00	59.09	67.72	79.39	89.88	99.22	102.65	82.99a
3.45	48.48	57.12	46.88	46.11	42.68	44.45	47.62b
6.92	34.77	43.24	36.68	36.04	30.83	31.84	35.58c
10.39	21.57	28.12	21.47	20.82	17.25	17.98	21.20d
13.86	9.00	12.56	9.80	9.59	6.88	9.10	9.49e

Means with different letters are significantly different at (p ≤ 0.05) level of significance using Fisher's least significant difference (LSD).

Table 4. Collar diameter (cm) of *Jatropha curcas* as influenced by different spent engine oil level in soil

Oil in soil (%w/w)			**WAT/collar diameter**				
0	2	4	6	8	10	12	Mean
0.00	2.21	2.43	2.99	3.47	3.66	3,87	3.11a
3.45	2.25	2.43	2.73	2.97	3.08	3.22	2.78b
6.92	2.11	2.33	2.65	2.71	2.75	2.91	2.58c
10.39	2.11	2.22	2.29	2.43	2.45	2.50	2.33d
13.86	1.94	1.99	2.08	2.04	2.05	2.11	2.04e
Means	2.12	2.28	2.55	2.72	2.80	2.92	

Means with different letters are significantly different at (p ≤ 0.05) level of significance using Fisher's least significant difference (LSD)

Table 5. Effects of spent engine oil on tolerance index (%) of *Jatropha curcas* seedlings

Oil in soil (%w/w)			**WAT/Tolerance index**				
0	2	4	6	8	10	12	Mean
0.00	4.20	4.67	5.33	5.67	5.47	7.40	5.46a
3.45	111	79.67	71.89	57.54	63.20	48.22	71.92b
6.92	81.22	72.89	65.77	54.76	49.28	34.49	59.24c
10.39	67.39	59.56	63.66	50.46	39.90	31.90	52.15d
13.86	57.78	54.11	43.11	38.12	31.79	26.12	41.89e
Means	64.32	54.1	50.01	40.71	37.93	29.63	

Means with different letters are significantly different at ($p \leq 0.05$) level of significance using Fisher's least significant difference (LSD)

References

Achten, W.M.J., Mathijs, E., Verchot, L., Singh, V.P., Aerts. R. and Muys, B. (2007). *Jatropha b*iodiesel fueling sustainability, *Biofuels, Bioproducts and Biorefining* 1 (4): 283-291.

Achten, W.M.J., Verchot, L., Franken, Y.J., Mathijs, E., Singh, V.P., Aerts, R. and Muys, B. (2008). Jatropha biodiesel production and uses: a literature review. *Biomass and Bioenergy* 32 (12): 1063-1084.

Adebowale, K.O. and Adedire, C.O. (2006). Chemical composition and insecticidal properties of the underutilized *Jatropha curcas* seed oil. *African Journal of Biotechnology*5:16-22.

Agbogidi, O.M. and Dolor, D.E. (2007). An assessment of the growth of *Irvingia gabonensis* (Aubry-Lecomte Ex O' Rorte) Bail seedlings as influenced by crude oil contamination of soil. *Asian Journal of Plant Sciences* 2: 1287-1292.

Agbogidi, O.M. and Ejemeta, O.R. (2005). An assessment of the effect of crude oil pollution on soil properties, germination and growth of *Gambaya albida* (L). *Uniswa Research Journal of Agriculture. Science and Technology* 8(2): 148-155.

Agbogidi, O.M., Eruotor, P.G. and Akparobi, S.O. (2006a). Effect of soil contaminated with crude oil on the germination of maize (*Zea mays* L). *Nigerian Journal Science and Environment.* 5:1-10

Agbogidi, O.M., Onosode, A.T. and Okonta, B. C. (2006b).Susceptibility of *Dennettia tripetala* (Bak.) F. seeds to crude oil. *Journal of Food and Agricultural Environment* 4(2): 350 – 352.

Agbogidi, O.M. and Ofuoku, A.U. (2005). Response of sour sop (*Annona muricata* Linn) to crude oil levels. *Journal of Sustainable Tropical Agricultural Research.* 16:98-102.

Agbogidi, O.M., Okonta, B.C. and Dolor, D.E. (2005). Social economic and environmental impact of crude oil exploration and production on agricultural production: a case study of Edjeba and Kokori communities in Delta State Nigeria. *Global Journal of environmental Sciences* 4(2): 171-176.

Agbogidi, O.M. and Nweke, F.U. (2005). Effect of crude oil polluted soil on the performance of okra (*Abelmoschus esculentus*) Moench in Delta State. *African Journal of Natural Science*: 8:31-35.

Agbogidi, O.M., Eruotor, P.G.and Ohwo, O.A. (2011). Germination response of *Jatropha curcas* L seeds as influenced by crude oil in soil .*Journal of Agriculture and Biological Sciences* 2(5): 114-117.

Agbogidi, O.M. (2011). Effects of crude oil contaminated soil on biomass accumulation in *Jatropha curcas* L seedlings. *Journal of Ornamental and Horticultural Plants*1 (1): 39-45.

Agbogidi, O.M. and Ekeke, B.A. (2011). *Jatropha curcas* L.; an important but neglected plant in Nigeria. *Journal of Biological and Chemical Research 28(1 and 2):53-63.*

Agbogidi, O.M., Mariere, A.E. and Ohwo, O.A.(2012). Metal concentration in plant tissues of *Jatropha curcas* L. grown in crude oil contaminated soil. *Journal of Sustainable Forestry* (in press).

Ampitan, T.A., Adekanmbi, D. I. and Chineme, C.B.(2011). The effects of *Jatropha curcas* L.seed oil as preservative against termites on *Gmelina arborea* wood. *Biological and Environmental Sciences Journal for the Tropics* 8(4):46-49.

Anoliefo, G.O. and Edegbai, B.O. (2000). Effect of spent engine oil as a soil contaminant on the growth of two egg plant species, S*olanum melongena* L. and *S.incanum*. *Journal of Agriculture and Fishery* 1:21-25.

Anoliefo, G.O. and Vwioko, D.E. (1995). Effect of spent lubrication oil on the growth of *Capsicum annum* L. *Lycopersicon esculentum* Miller. *Environmental Pollution.* 88:361-364.

Anoliefo, G.O.and Vwioko, D.E. (2001). Tolerance of *Chromolaena odorata* (L) K. and R. grown in soil contaminated with spent lubricating oil. *Journal Tropical Bioscience:* 1 (1): 20 – 24.

Asaba Meteorological Station (2010): National Meteorological Report on Meteorological Bulletin, 20010.

ATSDR (Agency for Toxic Substances and Disease Registry), (1997). Toxicology profile for used mineral base crankcase oil department of health and human services, public health services press, Atlanta, GA, USA.

Atuanya, E.J. (1987). Effect of oil pollution on physical and chemical properties of soil, a case study of waste oil contaminated Delta Soil in Bendel State, Nigeria. *Journal Applied Science* 55:155-176.

Becker, E. (1999). Studies on propagation of non toxic variety of *Jatropha curcas,* Stuttgart Germany.

Bhojvaid, P.P. (2006). Biofuels towards a greener and secure energy future. Tata Energy Research Institute, New Delhi pp. 281.

Dominguez-Rosad, R.E. and Pichtel, J. (2004). Phytoremediation of soil contaminated with used motor oil. Enhanced microbial activities from laboratory and growth chamber studies. *Environ Eng Sci,* 2:157-168.

Henning, R.K. (2008). *Jatropha curcas* L. in Africa: an evaluation global facilitation unit for under utilized species (GFUUS), Weossensberg, Germany.

Jahasz, A.C.P., Primenta, S., Soares, B.O., Batista Morais de Lourdes., Rabell, D.and Oliveira, D. H. (2009). Floral biology and artificial pollination in physic nut in the north of minas Gercus State Brazil (Biologic Florala Polinizacao artificial de pin)

Janick, J. and Robert, E. P. (2008). The Encyclopedia of fruit and nuts. CABI. Pp: 371-372.

Kumar, G.P., Yadav, S.K., Thawale, P.R., Singh, S.K., Juwarka, A.A. (2008). Growth of *Jatropha curcas* on heavy metal contaminated soil amended with industrial wastes and Azotobacter- a green houses study. *Bioresource Technology* 99:2078-2082.

Li, H., Zhang, Y., Zhang, C.G., Chen, G.X., (2005). Effect of petroleum containing waste water irrigation on bacterial diversities and enzymatic activities in a paddy: soil irrigation area. *Journal of Environment Quality* 34:1073-1080.

Makker, H.P., Becker, K. and Schmook, B. (2001). Edible provenance of *Jatropha curcas* from Quintana Rood State of Mexico and effect of roasting on ant nutrient and toxic factors in seeds. Institute for Animal Production in the Tropics and Subtropics (480), University of Hohenheim, Stuttgart, Germany.

Odjegba, V.J. and Sadiq, A.O. (2002). Effect of spent engine oil on the growth parameters, chlorophyll and protein levels of *Amaranthus hybridus* L. *The Environmentalist*, 22:23-28.

Omolaiye, J.A., Soyemi, D., Ogunbanijo, O.R. and Odubela, A.O. (2005). Estimation of some essential vitamins in *Jatropha curcas* L seeds. *Journal of Forestry Research and Management* 2:14-22.

Openshaw, K., (2000). A review of Jatropha curcas: an oil plant of unfulfilled promise. *Biomass and Bioenergy* 19:1-5.

Oyema, M.C., Osuagwu, N.C. and Igbokwe, B.I. (2008).The development and use of biofuels as alternative energy sources: issues, prospects and challenges for Africa. *In*: Popoola, L., (ed.). Proceedings of the 32nd Annual Conference of the Forestry Association of Nigeria (FAN) held in Umuahia, Abia State, between 20th and 24th October, 2008.pp 675 – 681.

Oyin, C.A. and Kassim, L.Q. (2006). Effect of spent engine oil on some growth parameters and moisture content of *Celosia argentea*. L. Department of botany and Microbiology, University of Ibadan, *Nigeria Journal of Botany*. 19(2):318-324.

Sharifi, M., Sadeghi, Y. and Akharpour, M., (2007). Germination and growth of six plant species on contaminated soil with spent oil. *International Journal Environmental Science Technology* 4 (4): 463-470.

Singh, R.A., Munish, K. and Haider, E. (2007). Synergistic Cropping of summer groundnut with *Jatropha curcas*. A new two tie cropping system for Uttar Pradesh. *ICRISAT Journal* 5(1):1-2.

Sukarin, W., Yamada, Y.M. and Sakaguchi, S. (1987). Characteristics of physic nut, *Jatropha curcas* L. as a new biomass crop in the tropics. *Japanese Agricultural Resources* 20(4): 302-303

Tigere, T.A., Gatsi, T.C., Mudita, I.I., Chikuvire, T.J., Thamangani, S., and Mavunganidze, Z. (2006). Potentials of *Jatropha curcas* in improving smallholder farmers' livelihoods in Zimbabwe: an explanatory study of Makosa ward, Mutoko District *Journal of Sustaininable Development* in Africa 7:11-16.

Van Eijck, J., and Romijn, H. (2008). Prospects of Jatropha biofuels in Tanzania. an analysis with strategic niche management. *Energy Policy* 36:311-325.

Vwioko, D.E., and Fashemi, D.S., (2005). Growth response of *Ricinus cummunis* L. (castor oil) in spent lubricating oil polluted soil. *Journal of Applied Sciences and Environmental Management* 9 (2): 73-79.

Wang, J., Jia, C.R., Wong, C.K., and Wong, P.K. (2000). Characterization of polycyclic aromatic hydrocarbon created in lubricating oils, *Water, Air, and Soil Pollut.* 120:381-396.

Wini, S.P., Osman, M., Emmanuel, D.S., and Sreedevi, T.K. (2006). Improved livelihoods and environmental protection through biodiesel plantations in Asia. *Asian Biotechnology and Development Review* 8(2): 11-29.

Zahir, A.Z., Malik, M.A.R., and Arshad, M.J., (2001). Soil enzymes research: a review. *Journal Biological Science* 1:299-301.