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Susceptibility of *Dennettia tripetala* (Bak.) F. seeds to crude oil

O. Mary Agbogidi*, A.T. Onosode and B. C. Okonta

Department of Forestry and Wildlife, Faculty of Agriculture, Delta State University, Asaba Campus, Nigeria.
**e-mail:omagbogidi@yahoo.com*

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Abstract

The effects of crude oil levels (0.00, 2.65, 5.31, 7.96 and 10.61%) on germination and seedling growth of *Dennettia tripetala* were studied in 2004 in Asaba, Delta State, Nigeria. The soil mixture used was a 2:1 ratio of topsoil to well decomposed organic manure. The experimental design adopted was a randomized complete block design (RCBD) with three replications. The results showed that oil concentrations of 5.31 and 7.96% significantly ($p<0.05$) affected percentage germination of this indigenous forest fruit tree species (59.14 and 34.01%, respectively) compared to the control (100%). No germination was recorded in *D. tripetala* seeds grown in soil treated with 10.61% (w/w) oil. A negative interaction was observed between the performance of *D. tripetala* seedlings (in terms of plant height, number of leaves, leaf area and collar girth) and the concentration of crude oil applied to the soil. The present study demonstrated that soil pollution by crude oil has a highly significant effect on the growth of *D. tripetala*. The study also indicate that *D. tripetala* has a remediation potential in crude oil- contaminated sites.

Key words: Crude oil, *Dennettia tripetala,* seeds and seedlings, susceptibility.

Introduction

Dennettia tripetala (Bak.) F., also known as pepper fruit, is an indigenous fruit tree [18]. It is a medium-sized or small tree, which extends throughout the rainforests and sometimes occurs in forests in savanna areas [23]. Young leaves and fruits have a distinctive spicy taste [23]. On the high forest, *D. tripetala* is a lower storey. The plant is widely domesticated [25].

The tree grows up to 50 ft height and 2 ft in girth, with a dense compact crown [18]. The leaves are 3–6 inches long by 1.5–2.5 inches broad, elliptic to ovate, shortly acuminate broadly connate to rounded at the base. The plant flowers between October and November and fruits between April and May [23]. The flowers are light brown outside, reddish inside and usually in small clusters on the young or older wood. The fruits are green at first but eventually red with finger-like carpel constricted between the seeds. The wood is white and soft which yields a good fuel wood [1, 14].

The fruits are used as masticatories [12, 19]. The fruits of *D. tripetala* when chewed drive away sleep and may raise the body temperature slightly because the fruits are peppery and spicy [18]. The roots together with other components of the plant are medicinal [21]. *D. tripetala* is also used as carminative and antiseptic [18]. The fruits contain minerals, vitamins, oils, iron and flavours [16, 18, 20, 24, 26, 28].

Oil pollution effects on crop plants and trees including mangroves result in the reduction of plant growth [4, 7, 10, 27]. Although oil pollution has been reported to have a direct herbicidal and phytotoxic effect on some tree species [2, 11, 15, 17, 30], no systematic investigation on the effects of crude oil on the germination and subsequent growth of this indigenous fruit tree has been documented. The objective of this study was to investigate the susceptibility of *Dennettia tripetala* seeds to crude oil.

Materials and Methods

The experiment was conducted in the Teaching and Research Farm of the Delta State University, Asaba Campus, Delta State, Nigeria. Asaba (latitude 6°14'N, longitude 6°49'E, temperature 28±6°C, rainfall 1505 mm, relative humidity 69-80% and sunshine 4.6 hours) is located in the rainforest agro-ecological zone [6].

The seeds of *Dennettia tripetala* were purchased as a single batch from Ogbeogonogo market in Asaba, Delta State, Nigeria. The crude oil used (with a specific gravity of 0.8848 g cm^{-3}) was obtained from the Nigerian National Petroleum Corporation (NNPC), Warri, Delta State.

The soil mixture used for the soil treatment was a 2:1 ratio of the topsoil to well decomposed organic manure. The mixture was air-dried and passed through 2 mm sieve. The soil mixture 1.00 kg set aside for each treatment was thoroughly mixed with the appropriate volume of crude oil before the polypots were each filled with 1.00 kg of the oil contaminated soil. The crude oil pollution levels used were 0.00 (control), 2.65, 5.31, 7.96 and 10.61% of the oil per weight (%w/w), respectively.

The viable seeds of *D. tripetala,* determined by simple flotation technique, were sown in the soils amended with crude oil in different polypots (15cm/10 cm) at different pollution levels and left in the nursery beds for germination. Polypots were watered to field capacity immediately and afterwards every other day until the end of the experiment. The experimental set-up thus comprised five treatments; each consisted of 15 polypots with three replications. The experimental design adopted was a randomized complete block design.

Seed sprouting began 10–14 days after planting (DAP) and when seedlings were 21 days old, germination counts were recorded per treatment. Percentage germination was calculated by the method of Amadi *et al.* [3]. Seeds, which failed to sprout after this time, were regarded as having not germinated [4].

Seedlings were allowed to grow and establish themselves. The set-up was monitored for 13 weeks after planting. Growth variables were measured fortnightly with effect from the 5th week after planting. Parameters measured included plant height, number of leaves, leaf area and collar girth. Data collected were subjectws to analysis of variance (ANOVA) and the treatment means separated with DmRT Using SAS [29].

Results

Germination of the control seeds was 100% for *D. tripetala* seeds twenty-one days after sowing (Table 1). A significant reduction in percentage germination of seeds was observed in soil amended with 5.31 and 7.96% oil at the 5% probability level. No germination was recorded for seeds sown in soils treated with 10.61% throughout the test period, indicating acute effect of oil on the seeds planted.

The height measurements of seedlings, weeks after planting, are presented in Table 2. The performance of the seedlings sown in the unpolluted soils in terms of height was significantly ($p<0.05$) higher than that of seedlings sown in crude oil-treated soils. There was a negative interaction between the soil crude oil content and the height of *D. tripetala* seedlings. The seedlings treated with 7.96% oil died about 6 weeks after germination. The rate of growth was also higher in the control plants than in seedlings grown in oil treated soils.

Table 1. Germination percent of *Dennettia tripetala* seeds 21 days after sowing in a crude oil contaminated soil.

Oil pollution level % (w/w)	Germination percent (%)
0.00 (control)	100.00a
2.65	96.72a
5.31	59.14b
7.96	34.01c
10.61	0.00d

Means with different superscripts are significantly different at P = 0.05 using Duncan's multiple range test (DMRT).

Table 2. Height (cm) measurements of *Dennettia tripetala* seedlings as affected by five levels of crude oil in soil.

Oil pollution	Plant height / weeks after planting (WAP)					
level % (w/w)	5	7	9	11	13	Mean
0.00 (control)	3.40	3.62	3.88	4.32	4.73	4.00a
2.65	3.00	3.21	3.42	3.48	3.82	3.39b
5.31	2.61	2.70	2.76	3.01	3.04	2.82c
7.96	2.50	-	-	-	-	2.50d
10.61	-	-	-	-	-	-

Means with different superscripts are significantly different at P = 0.05 using DMRT.

Table 3. Number of leaves of *Dennettia tripetala* seedlings as affected by five levels of crude oil in soil.

Oil pollution	Number of leaves/ WAP					
level % (w/w)	5	7	9	11	13	Mean
0.00 (control)	3.01	3.46	3.85	4.62	5.04	4.00a
2.65	2.00	2.02	2.41	2.44	3.40	2.45b
5.31	1.86	1.88	1.87	1.60	1.40	1.72c
7.96	1.01	-	-	-	-	1.01d
10.61	-	-	-	-	-	-

Means with different superscripts are significantly different at P = 0.05 using DMRT.

Table 4. Leaf area (cm^2) values of *Dennettia tripetala* seedlings as affected by five levels of crude oil contamination of soil.

Oil pollution	Leaf area/ WAP					
level % (w/w)	5	7	9	11	13	Mean
0.00 (control)	7.42	10.03	14.74	16.81	18.08	13.42a
2.65	5.20	8.84	8.96	13.41	14.02	10.09b
5.31	4.00	4.01	4.00	3.42	3.40	3.77c
7.96	3.21	-	-	-	-	3.21d
10.61	-	-	-	-	-	-

Means with different superscripts are significantly different at P = 0.05 using DMRT.

Table 5. Collar girth (cm) values of *Dennettia tripetala* seedlings as affected by five levels of crude oil contamination in soil.

Oil pollution	Collar girth / WAP					
level % (w/w)	5	7	9	11	13	Mean
0.00 (control)	1.01	1.04	1.07	1.09	1.12	1.07a
2.65	0.90	0.92	0.93	0.94	0.96	0.93b
5.31	0.74	0.75	0.73	0.71	0.70	0.73c
7.96	0.69	-	-	-	-	0.69d
10.61	-	-	-	-	-	-

Means with different superscripts are significantly different at P = 0.05 using DMRT.

The number of leaves of *D. tripetala* as influenced by crude oil contamination of soil is given in Table 3. Seedlings grown in the unpolluted soil had the highest number of leaves. Seedlings subjected to 2.65% oil contamination also had an appreciable number of leaves. Significant ($p<0.05$) reductions were, however, observed in the number of leaves of seedlings exposed to 5.31% and 7.96%of the crude oil.

The leaf area of seedlings grown in the unpolluted soil was significantly greater than that subjected to 2.65% oil treated soils, respectively at $P<0.05$ (Table 4). There was a progressive and uninterrupted increase in the collar girth of seedlings grown in the control soils and in soils treated with 2.65% of crude oil (Table 5). At 5.31% oil pollution level, the collar girth decreased from the 9th week after planting.

Discussion

The reduction in the percentage germination of *D. tripetala* seeds with increasing concentration of crude oil, as observed in the present study, could be attributed to the oxygen tension in the soil contaminated with crude oil. The oxygen stress encountered by the seeds could have affected the respiratory system of the embryo and hence, its viability [13]. The results of the present study, where significant reductions were recorded for *D. tripetala* seeds sown in soils amended with crude oil, confirm earlier reports [4, 22, 30, 32]. Atuanya [8] also reported that oil causes a breakdown of soil texture and structure following soil dispersion. Absence of germination in *D. tripetala* seeds sown in 10.61% of the crude oil and death of seedlings grown in 7.96% of the crude oil could be related to the increased effect of oil. It showed that the oil concentrations were too toxic for the plant.

The poor performance of seedlings in terms of plant height, number of leaves, leaf area and collar girth in soils treated with

crude oil, as observed in this study, is attributable to the adulterated structure of the soil which could have created a stress condition consequent upon water stress, nutrient immobilization, heavy metal toxicity as well as a disturbance in some vital metabolic functions within the plant body and other stress imposing properties of crude oil. Crude oil contamination of soil has been shown to cause a reduction in cell expansion and enlargement, leaf initiation and its subsequent growth, photosynthesis and translocation of photosynthates [9, 27].

The study has demonstrated that *Dennettia tripetala* is highly susceptible to crude oil effects. It also indicated that *D. tripetala* has some remediation potentials in a crude oil polluted site.

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