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Phytotoxic Effects of Gasoline on *Ischaemum rugosum* (Salisb), a Wetland Species

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Abstract: The phytotoxic effects of gasoline on *Ischaemum rugosum* were investigated in 2005 in Benin-City, Edo State, Nigeria. 0, 2, 4 and 8 L m^{-2} of gasoline served as the treatments. The experiment was arranged in a Randomized Complete Block Design (RCBD) and replicated four times. The results showed a significant decrease ($p \geq 0.05$) in plant height, number of leaves, leaf area, shoot and root biomass and percentage mortality with increasing concentration of gasoline in soil when compared with *I. rugosum* plants grown in soils without gasoline treatment (control). At 9 Weeks After Transplanting (9 WAT), *I. rugosum* plants at 2 and 4 L m^{-2} gasoline treatment showed generation potential compared to those in 8 L m^{-2}, which showed no regeneration capacity even at 12 WAT. The study has established that soils contaminated with gasoline have a highly significant effect of reducing the growth characters of *Ischaemum rugosum*. The study has also demonstrated that *I. rugosum* could regenerate at low concentration of gasoline contamination.

Key words: Toxic effect, gasoline, pollution, *Ischaemum rugosum*, wetland species

INTRODUCTION

The wetland area in the Niger Delta of Nigeria is composed of diverse and productive macrophyte species, which are components of riverine, estuarine and coastal ecosystems (Bamidele and Agbogidi, 2006). A significant amount of petroleum is refined, stored and transported through these ecosystems which provide fish, serve as wildlife habitats and improve water quality (Mitsch and Gosselink, 1993). Crude oil and its refined products including gasoline, kerosene, lubricating oil etc account for over 90% Nigeria's national income (NEST, 1991; Nwilo, 1998). Crude oil varies markedly in composition (Baker, 1970). Azad (2005) stated that crude and refined petroleum products are extremely complex mixtures of thousands of organic hydrocarbons and related compounds some of which are toxic. Oil in the aquatic environment may be damaging in a variety of ways whether floating as slick, buried in the soil or stranded on the seashore (Azad, 2005). The Nigerian coastal wetlands support a rich assortment of fisheries and wildlife that is heavily dependant upon for animal production of estuarine organisms. The Nigeria's coastal zone is the scene of intense activity associated with oil and gas exploration, drilling and extinction that has its potential for reducing the productivity of the area through the input of oil (Delaune *et al*., 1979).

Ischaemum rugosum is a usually straggling, sometimes erect, branched annual grass up to about 1 m high rooting at the lower nodes and reproducing from seeds. The stems are round, having short white hair at the nodes while the leaves have linear lanccotale blades (Mitchell, 1974). *I. rugosum* is a common weed of wetland areas. Aquatic macroplytes including *I. rugosum* are vital for primary productivity in water bodies (Bamidele and Agbogidi, 2002) and act as direct source of food for

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herbivorous animals. Bamidele and Agbogidi (2002) maintained that in addition to the chemical and physical changes they induce in the aquatic environment, macrophytes bring about a much more diversified habitat for animals and plants. Although work has been carried out on crude oil effects on crop species (Asuquo *et al*., 2002; Anoliefo and Okoloko, 2005; Agbogidi, 2006), no quantitative studies dealing with the toxicity of crude oil or its products to *I. rugosum* in the Nigeria's wetland has been conducted. This study was aimed at evaluating the phytotoxic effects of gasoline on *Ischaemum rugosum* a wetland species.

MATERIALS AND METHODS

The study was conducted in 2005 in the Department of Botany, University of Benin, Benin-City, Edo State (latitude 6° 36' longitude 6° 19') Nigeria. Garden soil was obtained from the vicinity of Botany Department, University of Benin. The plants (*I. rugosum*) were sourced from Uwasota, Ugbowo, Benin-City while Gasoline was procured from Iluobe filling station, Uwasota Junction, Ugbowo, Benin-City. The plants were allowed to establish in cylindrical plastic pots (16/10 cm) for four weeks before they were transplanted into the gasoline treated and untreated soils. The volumes of gasoline used were 0, 35, 70 and 140 mL per 1.5 kg weight of soil. Thus, by calculation, 0, 2, 4 and 8 L m^{-2} served as the treatments. The soil sample was thoroughly mixed with appropriate concentration of gasoline before they were transplanted. The experiment was laid out in a Randomized Complete Block Design (RCBD). There were therefore, four treatments replicated four times. Each treatment comprised 7 plastic pots. The trial was monitored for 12 weeks while parameters were measured once in three weeks starting from the third week after transplanting. Parameters measured included plants height, number of leaves, leaf area, above ground (shoot) biomass, below-ground (root) biomass, percentage mortality and percentage regeneration. Plant height was measured with a measuring tape at a distance from soil level to terminal bud. Number of leaves was determined by visual counting of the number of leaves per seedling per treatment. Leaf area determination was by tracing the leaves on a graph paper and the total leaf area per plant was obtained by counting the number of 1 cm squares. At the end of the trial (12 WAT), the plants were harvested and sorted into roots and shoots (stems and leaves) per treatment. The various parts were oven dried at 75°C for 18 h following the procedure of ISTA (1966). Percentage mortality was determined by counting the number of plants that died and values were based on percentage. While percentage regeneration was determined by counting the number of plants that regenerated relative to total No. of plants divided by 100. Data collected were subjected to analysis of variance while the significant means were separated with the Duncan's multiple range tests using SAS (1996).

RESULTS AND DISCUSSION

Phytotoxic effects of gasoline on the height, number of leaves, leaf area, above ground biomass (shoot dry weights), below ground biomass (root dry weights) and percentage and mortality percentage regeneration are presented in Table 1-6, respectively.

A negative interaction has been observed between the plant parameters measured and the level of gasoline applied to soil. *I. rugosum* plants grown in the uncontaminated soils had the highest values in all the growth variables considered and they were significantly ($p \geq 0.05$) greater than the seedlings exposed to the other treatments. Significant reductions ($p \geq 0.05$) were observed in *I. rusgosum* seedlings planted in soils treated with gasoline (Table 1-5). At 4 weeks after transplanting (4 WAT), *I. rugosum* seedlings subjected to all the gasoline treatments (2, 4 and 8 L m^{-2}), there was a gradual discolouration and withering while at 6 WAT, defoliation/leaf shedding was observed although this was more in seedlings grown in soils treated with 8 L m^{-2} of gasoline.

Table 1: Height (cm) of *Ischaemum rugosum* as affected by gasoline in soil

Gasoline in soil ($L\ m^{-2}$)	Plant height/WAT				
	3	6	9	12	Means
0	30.6	35.9	39.8	42.7	37.3a
2	28.5	28.7	28.9	29.5	28.9b
4	27.1	27.2	27.3	27.3	27.2c
8	26.3	26.3	26.3	26.3	26.3d
Means	28.1	29.5	30.6	26.3	31.5

Means in the same column (WAT) with the same letter(s) are not significantly different at $p \geq 0.05$ by Duncan's Multiple Range Test (DMRT)

Table 2: No. of leaves of *I. rugosum* as influenced by gasoline in soil

Gasoline in soil ($L\ m^{-2}$)	No. of leaves/WAT				
	3	6	9	12	Means
0	10.6	12.9	15.8	17.70	14.3a
2	10.5	10.8	9.8	9.20	10.8b
4	10.3	9.6	8.4	7.60	9.0c
8	10.4	7.8	2.8	0.01	5.3d
Means	10.5	10.3	9.2	8.60	

Means in the same column (WAT) with the same letter(s) are not significantly different at $p \geq 0.05$ by Duncan's Multiple Range Test (DMRT)

Table 3: Leaf area (cm^2) of *I. rugosum* grown in gasoline treated soil

Gasoline in soil ($L\ m^{-2}$)	Leaf area/WAT				
	3	6	9	12	Means
0	45.6	50.7	56.2	60.4	53.3a
2	40.1	39.0	32.5	30.4	35.5b
4	38.9	34.7	27.2	8.7	27.4c
8	37.6	22.0	4.3	0.0	16.0d
Means	40.6	36.6	30.1	24.9	

Means in the same column (WAT) with the same letter(s) are not significantly different at $p \geq 0.05$ by Duncan's Multiple Range Test (DMRT)

Table 4: Shoot dry weight (g) of *I. rugosum* grown in soils treated with gasoline

Gasoline in soil ($L\ m^{-2}$)	Shoot dry weight/WAT				
	3	6	9	12	Means
0	2.4	2.7	2.8	3.0	2.7a
2	1.6	1.4	1.0	0.9	1.3b
4	1.1	0.6	0.6	0.3	0.7c
8	0.6	0.5	0.3	0.2	0.4d
Means	1.4	1.3	1.2	1.1	

Means in the same column (WAT) with the same letter(s) are not significantly different at $p \geq 0.05$ by Duncan's Multiple Range Test (DMRT)

Table 5: Root dry weight (g) of *I. rugosum* grown in soils treated with gasoline

Gasoline in soil ($L\ m^{-2}$)	Root dry weight/WAT				
	3	6	9	12	Means
0	0.9	1.0	1.1	1.2	1.1a
2	0.5	0.4	0.3	0.2	0.4b
4	0.3	0.2	0.1	0.1	0.2c
8	0.2	0.1	0.1	0.1	0.1c
Means	0.5	0.4	0.4	0.4	

Means in the same column (WAT) with the same letter(s) are not significantly different at $p \geq 0.05$ by Duncan's Multiple Range Test (DMRT)

Table 6: Effects of gasoline on percentage mortality and percent regeneration of *I. rugosum*

Gasoline in soil ($L\ m^{-2}$)	Mortality/WAT					Regeneration/WAT				
	3	6	9	12	Means	3	6	9	12	Means
0	0.0	0.0	0.0	0.00	0.0d	0.0	0.0	0.00	0.0	0.0c
2	10.0	20.0	33.0	35.00	24.5c	0.0	0.0	52.00	56.0	27.0a
4	40.0	50.0	67.0	80.00	59.3b	0.0	0.0	33.00	40.0	18.3b
8	80.0	100.0	100.0	100.00	95.0a	0.0	0.0	0.00	0.0	0.0c
Means	32.5	42.5	50.0	53.75		0.0	0.0	21.25	24.0	

Means in the same column (WAT) with the same letter(s) are not significantly different at $p \geq 0.05$ by Duncan's Multiple Range Test (DMRT)

Significant differences ($p \leq 0.05$) in percentage mortality of *I. rugosum* plants planted in soils contaminated with gasoline were observed when compared with plants grown in soils without gasoline treatment (Table 6). The mortality rate increased with increasing concentration of gasoline in soil. Conversely, regeneration potential of *I. rugosum* plants at 2 and 4 L m^{-2} at 9 WAT of gasoline treatment was evident (Table 6) when compared with seedlings planted in 8 L m^{-2} of gasoline treated soil which showed no regeneration capacity even at 12 WAT (Table 6).

The reduction in the growth characters of *I. rugosum* exposed to gasoline could be due to a reduction in carbon fixation consequent upon oxygen tension. The dissolved oxygen tension in ecosystems polluted with organic hydrocarbons has been reported by Ekpo and Nwankpa (2005) to be due to the diversion of the dissolved oxygen meant for respiration to the oxidation of the pollutants. Horsfall and Spill (1998) maintained that the extent of depletion of oxygen in the ecosystem is often, a function of the concentration of the organic pollutants in it. Oil pollution of soil has been reported to affect physiological processes such as leaf initiation and leaf area expansion, photosynthetic activities, root activity, partition of nutrients and photosythates between various organs (Baker, 1970). Schwendinger (1968) noted that large amounts of oil soil damages plants not mainly from toxic effects, but from the formation of anaerobic and hydrophobic condition that interfere with soil-plant-water relationships. Growth reduction in plants following oil pollution of soils has been reported by various researchers (Agbogidi and Ofuoku, 2005; Ekpo and Nwankpa, 2005).

The observed reduction in the biomass of *I. rugosum* plants with increasing concentration of gasoline in soil may have been due to the disruption in the plant photosynthetic rate and hence its rate of dry matter accumulation. This result is consistent with the observation of Qianxin and Mendelssohn (1996) that the biomass of *Spartina patens* showed a significant reduction with increasing oil levels in soil.

The high mortality of *I. rugosum* plants sown in gasoline treated soils could be attributed in part to the toxicity of gasoline as well as a build up of metals. Qianxin and Mendelssohn (1998) further noted that the elimination of the vegetative cover can convert arable land to open land and such accelerate erosion, thus greatly reducing the value of these systems. The inability of *I. rugosum* plants sown in 8 L m^{-2} gasoline treated soils to recover or regenerate after death may be due to the death of the underground systems caused by oil penetration into the sediment and negligible recruitment of reproductive propagules into the oiled area. This observation is in line with the report of Teas *et al.* (1989) who noted that slow vegetative recovery from an oil spill may result in significant ecological consequences. Agbogidi and Eshegbeyi (2006) had also reported that application of oil to soil does not only result in the death of plants but also reduces their subsequent re-growth. Pezeshki and Delaunce (1993) and Webb (1995) stated that the recovery of plants from adverse effect of petroleum products is species specific. The faster regeneration of *I. rugosum* at lower gasoline concentrations may have been due to reduced toxicity in soil probably as a result of dilution from rain water, or to the fact that the rhizomes of the plants were not totally killed, thus, with passage of time and as the conditions of the soil became conducive, the plants were able to re-grow.

The study has established that gasoline has significant phytotoxic effects on *Ischaemum rugosum*. The positive role this species plays in the wetland ecosystem could be seriously disrupted if the present rate of oil pollution in the wetland is unchecked. For instance, any deleterious effect on *I. rugosum* by oil pollutants could have widespread repercussion on the food web for the entire ecosystem. The study has also demonstrated that *I. rusogum* is able to regenerate at low concentrations of gasoline pollution.

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