Early Growth Response of Maize (*Zea mays* L.) in Spent Lubricating Oil-polluted Soil

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Abstract
The study investigated the early growth response of maize in spent lubricating oil-polluted soil in the Screen House of the University of Ado-Ekiti, Nigeria to determine the effect of the indiscriminate disposal of spent lubricating oil on the crops and agricultural soils. Sandy-loamy top soil collected from a 4-year old fallowed plot in the University Farm within a depth of 5cm were packed in plastic planting pots, polluted with 500ml spent lubricating oil and maize seeds were planted on the oil-contaminated soil at varying times of one week interval. Results obtained revealed that 100% emergence was observed in the control experiment at 5DAP whereas the average emergence observed were 37.6%, 38.4%, 40.5%, 76.4% and 91.4% respectively in the maize planted in spent oil-polluted soils at first, second, third, fourth and fifth week after pollution respectively. It was observed from this study that spent lubricating oil-polluted soil at high concentrations, inhibited seed germination, seedling heights and girths, shoots and roots biomass of maize. In some of the seedlings in the polluted soils, the leaves were observed to be yellow in colour, some of the leaves were aborted while in some seedlings, complete shed off of leaves and stunted growths were observed. It is evident from this study that the release of spent lubricating oil into agricultural soils interferes with the growth of maize and thus reduced its yields. It is therefore necessary to cob this menace of indiscriminate disposal of spent lubricating oil into our environment most importantly, our agricultural soils.

Keywords: *agricultural soil, growth, maize, spent lubricating oil, soil pollution.*

Introduction

In Nigeria, the indiscriminate disposal of spent lubricating oil by motor mechanics and other allied users has now constituted another vital and dangerous environmental pollutant which spread throughout the country. Lubricating oil is a major product of crude oil that aids the reduction of friction between contacting metal surfaces. It is produced by vacuum distillation of crude oil (Kalichevsky and Peters, 1960). The spent lubricating oil is usually obtained after servicing and subsequent drainage from engines (Anoliefo and Vwioko, 2001; Osubor and Anoliefo, 2003 and Ogbo *et al.*, 2006).

Service stations in most parts of Nigeria find it difficult to properly dispose of spent lubricating oil and as a result of this, considerable volume of spent lubricating oil is dumped on plots of land as well as sewage and drainage ditches (Odejegba and Sadiqi, 2002). This existing mode of disposal of spent lubrication oil increases pollution incidences in the environment and is wider spread than crude oil pollution (Atuanya, 1980). The oil readily penetrates the pore spaces of terrestrial vegetation on land (Bossert and Bartha, 1984) with heavier friction which may block the pores and this subsequently impedes photosynthesis and other physiological processes in plants (Odu, 1977 and 1981).

Thus, environmental pollution resulting from spent lubricating oil poses a great threat to the ecosystem, economy, human health and well being. This study aimed to determine the effects of the spent lubricating oil pollution on the germination, early seedling growth, root and shoot biomass of maize, which is an important agricultural crop in Nigeria.

Materials and Methods

The study was conducted in the Screen House, Department of Plant Science, University of Ado-Ekiti, Nigeria between February and May, 2007. Ado-Ekiti, (7^0 40N, 5^0 15E) has a tropical humid hot climate with two seasons: a relatively cool rainy season which lasts from March to October and hot dry season between November and February. The town, which is over 400meteres above sea level, enjoys abundant rainfall of over 1450mm annually (Kayode and Faluyi, 1994). Smyth and Montgomerry (1962) described the soil in the study area, as overlying metamorphic rock of basement complex which shows greater variation in grain size and mineral composition. Faluyi (1987) gave the soil composition of the site of the experiment as showing high percentage of sand, silt and clay.

Methods

The maize cultivar - Dowmy Mildrew Resistant Swamp Variety (Yellow)- used in this study was collected from the International Institute of Tropical Agriculture, Ibadan, Nigeria, while its viability test was determined by floating method, according to Anoliefo and Vwioko (1995). Eight hundred seeds were soaked in a water bath that contained distilled water for a period of 10minutes. The seeds that floated were discarded and 725 seeds were selected out of the seeds that submerged in the water. 275 viable maize seeds, out of the submerged seeds, were used in the study.

The sandy-loamy top soil used in the study was collected from a 4-year old fallowed plot in the University Farm within a depth of 5cm. 30 liters of spent lubricating oil were collected from a road side mechanic whose workshop was situated along Ado-Iworoko road, Ado Ekiti, Nigeria. 50 medium sized (2000cm^3 each) plastic planting pots were filled with the top 3kg topsoil from the location described above; each planting pot was polluted with 500ml spent lubrication oil. The planting pots, each with a uniform weight of 3kg, were arranged in the Screen House. They were divided into five groups. Each group consisted of 10 planting pots, arranged in a row. The groups were labeled as Treatment GA, GB, GC, GD and GE. Treatment GA was planted in the first week of the experiment, GB in the second week, GC in the third week, GD in the fourth week and GE in the fifth week respectively.

Control experiment (i.e. top sandy- loamy soil without spent lubricating oil) was equally set up and replicated five times while the constant weight of 3kg was maintained for the planting pot plus its soil contents. The control experiment pots were labeled control CGA, CGB, CGC, CGD, and CGE to serve as control experiment. All the treatments and control pots were arranged in the Screen House and were watered for two consecutive days, at 7:00 GMT after which 5 maize seeds were sown in each of the pots in treatment GA and its control experiment in the first week of the experiment. Similar planting was carried out in the pots of treatments GB, GC, GD and GE in the second, third, fourth and fifth week of pollution. Watering of all the planting pots was done daily at 7:00 GMT.

The rate of emergence in each treatment and its control was observed and recorded. Seedling emergence percentage in each treatment and its control was calculated, according to Faluyi (1997) as:

$$\text{Emergence Percentage (E \%)} = \frac{\text{Number of seedling that emerged}}{\text{Total number of seed sown}} \times 100$$

The Co-efficient of velocity (COV) in each treatment was determined, according to Chaco and Singh (1966) and Kayode (2000) as:

$$\text{Co- efficient of velocity (COV)} = \frac{A_1 + A_2 + \ldots\ldots A_{10}}{A_1T_1 + A_2T_2 \ldots\ldots A_{10}T_{10}}$$

Where, A is the number of seeds emerging and

T is the number of days taken to germinate.

The maize seedlings in each planting pot were thinned to one seedling per pot at one week after planting (1WAP). Weekly records of seedlings girths and heights in each treatment were taken on weekly basis for four weeks after planting (4WAP). Mean of the girths and heights observed in each treatment were determined and recoded. At 4WAP the seedlings were carefully harvested and the roots carefully washed in distilled water to remove soil particles. The seedlings were separated into shoot and root and their fresh and dry weights were determined. Mean of fresh and dried weights in each treatment was calculated and recorded. Similarly measurements were carried out on the seedlings produced in the control experiment.

Results and Discussion

The presence of spent lubricating oil in the soil inhibits seedling emergence and growth of maize (Table 1).

Table 1: Seedling emergence (E %) and Co-efficient of Velocity (COV) of maize in spent lubricating oil-polluted soil

Treatments	E(%)	COV*
GA	32f	37.60f
GB	64e	38.40e
GC	68d	40.50d
GD	68c	76.40c
GE	72b	91.40b
CONTROL	100a	100.00a

*Mean with the same letter in each column is not significantly different by Duncan Multiple Range Test (DMRT) at 5% level of probability.

The results revealed that while 100% emergence was observed in the control experiment at 5 days after planting (DAP), the average emergence observed in Treatments GA, GB, GC, GD and GE at 5 DAP were 37.6% , 38.4%, 40.5%, 76.4% and 91.4% respectively. These constituted 62.4%, 61.6%, 59.5%, 23.6% and 8.6% reduction in the seedling emergence in Treatment GA, GB, GC, GD and GE respectively when compared to the control experiment (Table 1). Statistical analyses at 5% level of significance revealed that the emergence in the Treatments GA, GB, GC, GD and GE were significantly different when compared to the control experiment. Table 1 also revealed that the degree of the inhibition tends to decreased with the increase in the length of time of planting of the seeds, that is, decrease in the concentration of the spent lubricating oil due to watering of the Treatments. Thus the proportions of the seedlings that emerged improved in Treatment GB than GA, GC than GB, GD than GC and GE than GD. Field observation also revealed that some of the leaves of the maize planted in the spent lubricating oil-polluted soils were yellow, some were later aborted while complete shed off and stunted growths were observed in some of the seedlings.

Seedling heights of maize grown in spent lubricating oil-polluted soil

Table 2 showed the mean weekly heights of maizein the spent lubricating oil-polluted soils. The control experiment had higher value than any of the treatments. In the control experiment, average height of 34.87±0.428cm was observed at 4WAP while 14.41±0.483cm, 15.16±0.470cm, 16.05±0.452cm, 16.58±0.329cm and 19.43±0.362cm were observed in Treatments GA, GB, GC, GD and GE respectively. However, better seedling heights were observed in the Treatments GD and GE than treatments GA, GB and GC when compared to the control experiment. Statistical analyses at 5% level of significance revealed that results from the treated soil were significantly different from that of the control experiment. Also the inhibitory effects decreased with the decrease in the concentration of the spent lubricating oil in the treated soils due to watering of the treatments (Table 2). This further suggests that the inhibitory effect is concentration dependent.

Table 2. Seedling Heights of maize in spent lubricating oil-polluted soil

Treatments	Seedling Heights (cm) / WAP^{+}			
	1	2	3	4*
GA	2.53±0.262	7.41±0.390	10.56±0.380	14.41±0.483 e
GB	2.78±0.268	8.09±0.391	12.31±0.381	15.16±0.470 d
GC	3.07±0.666	8.66±0.396	12.50±0.558	16.05±0.452 c
GD	4.39±0.274	9.59±0.500	12.57±0.385	16.58±0.329 b
GE	4.68±0.376	9.92±0.430	14.01±0.350	19.43±0.362 b
CONTROL	8.43±1.023	11.35±0.184	27.11±1.054	34.87±0.428 a

$^{+}$Week after planting.

*Mean with the same letter in each column is not significantly different by Duncan. Multiple Range Test (DMRT) at 5% level of probability.

Seedling girths of maize grown in spent lubricating oil-polluted soil

The effect of spent lubricating oil on the girth of maize seedlings is shown in Table 3.

Table 3. Seedling Heights of maize in spent lubricating oil-polluted soil

Treatments	Seedling Heights (cm) / WAP+			
	1	2	3	4*
GA	0.10±0.000	0.21±0.008	0.24±0.016	0.28±0.033a
GB	0.10±0.000	0.23±0.020	0.29±0.006	0.31±0.015a
GC	0.10±0.000	0.23±0.020	0.30±0.006	0.33±0.012a
GD	0.13±0.011	0.24±0.012	0.31± 0.015	0.34±0.013a
GE	0.22±0.034	0.27±0.062	0.32±0.015	0.38±0.010a
CONTROL	0.30±0.060	0.35±0.010	0.43±0.024	1.16±0.028a

+Week after planting.

*Mean with the same letter in each column is not significantly different by Duncan. Multiple Range Test (DMRT) at 5% level of probability.

All the seedlings in the treated pots appeared stunted in growth with reduced girths when compared to the seedlings in the control experiment. The girth value in the control experiment at 4WAP was 1.160±0.028mm while the girth values in Treatments GA, GB, GC, GD and GE were 0.28±0.033mm, 0.31±0.015mm, 0.33±0.012mm, 0.34±0.013mm and 0.38±0.010 mm respectively. Thus, a reduction of 73.30%, 75.86%, 71.55%, 70.69% and 67% in girth values were recorded in Treatments GA, GB, GC, GD and GE respectively at 4WAP. Statistical analyses at 5% level of significance however revealed that there were no significant differences in the girths of the seedlings in the treated soils when compared to the seedlings in the control experiment (Table 3).

Biomass yield of maize seedlings grown in spent lubricating oil-polluted soil

Table 4: Shoot and Root Biomass of maize grown in Spent lubricating oil-polluted soil

Treatments	Shoot		Root	
	Fresh Weight (g)	Dry Weight (g)	Fresh Weight (g)	Dry Weight (g)
GA	3.25d	0.52b	0.44b	0.016e
GB	4.98c	0.56b	0.53b	0.031d
GC	5.79b	0.58b	0.63b	0.048c
GD	6.30b	0.63b	0.64b	0.054c
GE	6.43b	0.63b	0.64b	0.058a b
CONTROL	11.88a	1.37a	1.00a	0.066a

+Week after planting.

*Mean with the same letter in each column is not significantly different by Duncan. Multiple Range Test (DMRT) at 5% level of probability.

Table 4 showed the biomass yields of shoots and roots of the seedlings from the treated soils and the control at 4WAP. Seedlings from treated soils had lower biomass values when compared to the control (Table 4). However, the values increased with the increase in the duration of watering (Table 4). Shoot dry weight in the control experiment was significantly different, by Duncan Multiple Range Test (DMRT) at 5% level of probability, when compared to those from the treated soils. Similarly, root dry weight in the control experiment was significantly different to those from the treated soils (i.e. soil in GA, GB, GC, GD and GE). These results suggest that the spent lubricating oil might have deleterious effect on the biomass of seedlings that grows on them.

Discussion

The results obtained in this study revealed that pollution with spent lubricating oilinterferes with maize seed germination and emergence, seedling heights and girths, roots and shoots biomass. Previous assertion by Mayer and Poljakof-Mayber (1989)had revealed that the growth of plant is affected by the chemical contents of the medium on which it is grown. Lubricating oil is a product of hydrocarbon. Hydrocarbon in soil, according to Chaineau *et al.* (1996 and 1997), is now known to inhibit seed germination and reduce plant growth. The results from this study also supported the findings of Anoliefo and Vwioko (1995), who had previously demonstrated that spent lubricating oil inhibit seedgermination in *Capsicum annuum* L. and *Lycopersicon esculentum* as well as the results ofAnoliefo and Edegbai (2000) on the effect of spent lubricating oil on *Solanum melongena* L.and S*olanum incanum*. The inhibition caused by the spent lubricating oil, according toRowell (1977) might be due to the loss of seed viability induced by the lubricating oil oraccording to McGill and Nyborg (1975) might be due to oil coating which could affectphysiological functions within the seed. Oil in soil had also been known to createunsatisfactory conditions for plant growth probably due to insufficient aeration of the soil(Dejong, 1980). Dominguez-Rosado *et al.* (2004) had also asserted that the presence of spentlubricating oil in the soil usually impede seed germination, and according to Odu (1977 and1981) impede photosynthesis and other physiological processes of plants.

Conclusion

It is evident from this study that the release of spent lubricating oil into agricultural soils interferes with the growth of maize and thus reduced its yields. Consequent on the above, the need for the promulgation of strict law against indiscriminate disposal, control as well as proper monitoring the disposal of spent lubricating oil is strongly considered necessary nowinNigeria.

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