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GROWTH PERFORMANCE OF CASSAVA *(MANIHOT ESCULENTA)* VARIETY NR8082 IN CRUDE OIL POLLUTED SOIL IN IMO STATE

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ABSTRACT: In this study the effect of crude oil applied at the following doses, 0, 50, 100 and 150ml/12kg of soil on growth performance of cassava variety NR8082 was studied. The experiment was carried out using completely randomized design with four treatments of four replicates. The parameters assayed include number of leafs, shoot height, leaf area, shoot dry weight, root dry weight, number of roots and root length. There was significant reduction ($P<0.05$) on number of leaves, shoot height, leaf area, shot dry weight and root dry weight which was dependent on the level of pollution and also time lag for the experiment except for root length and number of root that significantly showed, tolerance to severe crude oil pollution. Also the pollution level of 50ml was observed to have promoted growth of cassava significantly ($P<0.05$) compared to 150ml level of pollution.

KEY WORDS: Cassava, crude oil pollution, growth performance, variety NR8082, soil.

INTRODUCTION

Pollution of the soil environment with petroleum and refinery products is one of the factors expressing anthropopression due to its toxicity, widespread presence and complex nature, this type of pollution is a serious problem, one reason being that as the modern civilization, urbanization and mechanization develop; the use of petroleum and petroleum-based products grows. Contamination of soils with crude oil and refinery products is becoming an ever-increasing problem, especially in the light of several breakdowns of oil-pipelines and wells reported recently. (Wyszkowski *et al.,* 2004). Contamination of soil by crude oil spills is a wide spread environmental problem that often requires cleaning up of contaminated sites (Bunday *et al.,* 2002).

Crude oil spills affects plant adversely by creating conditions which make essential nutrients like nitrogen and oxygen needed for plant growth unavailable to them. (Ogbo, *et al.,* 2009) crude oil contamination of soil results in damage of crop growth which depend on the degree of contamination, the soil may remain unsuitable for plant growths for months or several years (Ogbo, 2009). Damages due to soil contamination may be extensive and its effects may be long term (Kirk *et al.,* 2002).

Changes in some soil properties resulting from contamination of soil with petroleum-derived substances bring about some changes in the biological composition of soil. This can lead to water and oxygen deficits as well as to a shortage of available form of nitrogen and phosphorous (Wyszkowska and Kucharaski, 2000). It also inhibits seed germination and plant growth (Odjegba and Sadiq. 2002; Hazel, 2005).

Further limitations to the growth of plants and microbes may arise from the severity of a contamination and the heterogeneous nature of soil. Soil pollution penetrates the pore spaces of pedestrian vegetation and subsequently impedes photosynthesis and other physiological processes of the plant. (Odu, 1981; Odejimi and Ogbalu, 2006).

Plant on such soil becomes suffocated due to the exclusion of air by oil. The exhaustion of oxygen in the soil decreases the microbial activity and this interfers with the plant soil water relationship (Esenowo, *et al.,* 2006).

Niger Delta region (Imo State inclusive) is prone to incessant oil spillage. Considering the large quantities of oil spill in Agricultural lands, it has become imperative to investigate the effects of oil spillage on agricultural lands and the crops grown in them. Therefore this study is aimed to investigate the ability of improved cassava cultivars to grow in crude oil contaminated soil.

MATERIALS AND METHODS

The research was carried out at the Teaching and Research farm of Imo State University, Owerri between April to August, 2009. Owerri lies between latitude $5^0\ 10^1$N and $6^0\ 0^1$N, longitude $6^0.35^1$ E and $7^0 0^1$E, in the South Eastern zone of Nigeria. The average temperature, annual rainfall and relative humidity of Owerri are 27^0C, 2500mm and 75% respectively (NIMET 2007).

The stem cuttings of cassava variety NR8082 were sourced from Imo State Agricultural Programme (IMOADP). Fresh unweathered Bonny Light Crude (BLC) Oil obtained from Shell Petroleum Development Company (SPDC). Port Harcourt River State, Nigeria. Polythene bags were purchased from Ekeonunwa market Owerri, Imo State. Top soil were obtained from the University Teaching Farm.

The polythene bags measuring 14x14m perforated with (3 holes) were filled with top soil weighing 12kg per bag, leaving a space of 2cm from the top to make allowance for addition of crude oil. The pollution of the soil was carried out in 4 treatment levels. In the first treatment level 0ml (control) of crude oil was used, the second treatment 50mls of crude oil was added. The third treatment 100mls was used and fourth treatment have 150ml crude oil. Trowel was used to mix the sand thoroughly to enhance uniform spread.

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Data collected in the measured parameters were analyzed with the analysis of variance method and treatment means were separated with the list significant difference (LSD) test at 5% level of probability (Onuh and Igwemma, 2001).

RESULTS

The cassava cultivars planted in soils polluted with crude oil (150ml) gave the least mean number of leaves (8.0) at one month after planting (MAP) which was significantly difference from (11.5) which was observed from the control plots which have a highest mean number of leaves (Table 1). This trend in reduction in the number of leaves were observed at 2MAP in treated plots. However 100ml polluted plot gave a high mean number of leaves (60.0) which was not significantly different ($P<0.05$) when compared with the control:

The leaves number recorded at 3 MAP and 4 MAP from polluted plots were significantly different from control, and among the treated plots there was significant different in the number of leaves recorded. It was observed that 100ml and 150ml pollution level drastically reduced the number of leave recorded, compared to the control and 50ml.

The shoot height of cassava in the different levels of pollution varied. At one month after planting (1 MAP), the height observed in polluted plots was not significantly difference ($P<0.05$) compared to the control. At 2 MAP, the cassava plot that received 150ml of crude oil pollution gave the least shoot height (43.5cm) which was significantly different form (75.0cm) observed from the control (Table 2). At 3 MAP, the shoot height was significantly reduced by the cassava plots that received crude oil treatment, compared to the control. While at 4 MAP, the control produced the shoot height (140cm) which was significantly different from the values recorded in the polluted plots. The reduction in shoot height increases as level of concentration of crude oil pollution increases.

Table 3, shows that the leaf area of cassava was generally, adversely affected by the crude oil pollution. At 1 MAP the cassava plot that received 150ml of crude oil pollution gave the least leaf area ($51.0cm^2$) which was significantly different from ($88.0cm^2$) observed in the control. Also, at 2 MAP, the least mean leaf area ($14cm^2$) was observed in plots treated with 150ml crude oil which was significantly different from 50ml which gave the highest mean leaf area of $390cm^2$. However, the value in control plots was significantly different at $P<0.05$ compared to plots that received 100ml and 150mls of crude oil pollution. At 3 MAP and 4 MAP, the control plots gave the highest leaf area when compared to treated plots as shown in table 3. The reduction in the leaf area was drastic at 4 MAP in plots treated with 150ml crude oils and this was significantly different ($P<0.05$) compared to the control, 50ml and 100ml levels respectively.

Biomass or yield of the cassava cultivar showed that crude oil pollution affected the NR 8082 variety negatively reducing the yield using dry weight values. (Table 4). At 1 MAP the cassava plot that received 100ml and 150ml gave the least shoot dry weight, 2.7g and 3.7g respectively and this was significantly different compared to control and 50ml plots. (6.9g and 4.5g respectively). At 2 MAP, the reduction of yield was only observed in 150ml, 100ml and 50ml which were significantly lower than the control (table 4).

However, at 3 MAP, the cassava plot that gave the least mean shoot dry weight (47.2g) was the ones treated with 100ml crude oil which was significantly different from (208.5g) observed in the control. Similarly at 4 MAP, the cassava that received 150ml gave the least mean shoot dry weight (59.8g) which was significantly different from (261.3g) observed in control.

The crude oil pollution affected the root dry weight of the cassava variety NR 8082 reducing it significantly (table 5). At 1 MAP the control plots gave the highest mean dry weight which was significantly different compared to the treated plots. However, the plot polluted with 50ml did not show any significant different with 100ml plot as shown in table 5. At 2 MAP, the 50ml plot produced highest mean root dry weight (5.6g) while 100ml and 150ml gave (3.9g and 0.9g) respectively and these were significantly different at $P<0.05$ compared to the control. At 3 MAP. The root dry weight recorded in control was highest than that for 50ml, 100ml and 150ml levels of pollution. The root dry weight recorded in control was significantly higher than those recorded in treated plots. At 4 MAP the root dry weight recorded in 150ml pollution level was significantly lower than those recorded in 50ml, 100ml and control.

In table 6, the root length of NR 8082 was affected according to different levels of crude oil pollution. The values recorded at 1 MAP varied slightly from control to 150ml although it was least (13cm) at 100ml pollution, control recorded 17cm which was significantly different. However, among the treated plots the variations in value were significantly different at $P<0.05$ (table 6).

The numbers of root were affected mostly by 100ml at 1 MAP, 3 MAP and 4 MAP respectively and these were significantly different compared to other treatment levels. Meanwhile, the control recorded highest mean number of roots at 1 MAP and 2 Map which were significantly different compared to other treatments. This trend was reversed at 3 MAP and 4 MAP when the 150ml crude oil pollution gave a highest number of roots which was significantly different compared to other treatment levels.

Table 1: Effects of crude oil pollution on the number of leaves of cassava variety NR8082

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control	11.5^{a}	46.0^{b}	40.0^{a}	44.5^{a}
50ml	10.0^{ab}	47.0^{b}	38.0^{b}	43.5^{b}
100ml	8.5^{bc}	60.0^{ca}	25.0^{d}	41.5^{c}
150ml	8.0^{c}	31.0^{c}	29.0^{c}	28.0^{d}

Mean in the same column having the same alphabet(s) are not significantly different at $P<0.05$.

Table 2: Effects of crude oil pollution on shoot height (cm)

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control	15.2^{a}	75.0^{a}	99.5^{a}	140.0^{a}
50ml	14.9^{a}	70.5^{b}	91.0^{b}	131.0^{b}
100ml	15.0^{a}	59.5^{c}	55.5^{d}	92.0^{c}
150ml	14.6^{a}	43.5^{d}	60.0^{c}	75.0^{d}

Mean in the same column having the same alphabet(s) are not significantly different at P<0.05.

Table 3: Effects of crude oil pollution on leaf area (cm^2) of cassava variety Nr8082.

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control (0ml)	88.0^{a}	389.0^{b}	1552.0^{a}	2407.0^{a}
50ml	79.0^{b}	390.0^{b}	1457.0^{b}	1906.0^{b}
100ml	55.0^{c}	362.0^{a}	750.0^{d}	1697.0^{c}
150ml	51.0^{c}	140.0^{c}	791.0^{c}	641.0^{d}

Mean in the same column having the same alphabet(s) are not significantly different at P<0.05.

Table 4: Effects of crude oil pollution on shoot dry weight (g) of cassava variety NR8082.

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control (0ml)	6.9^{a}	41.2^{a}	208.5^{a}	261.3^{a}
50ml	4.5^{b}	33.0^{b}	144.1^{b}	234.2^{b}
100ml	2.7^{a}	31.9^{c}	47.2^{d}	211.8^{c}
150ml	3.7^{c}	9.9^{d}	104.8^{c}	59.8^{d}

Mean in the same column having the same alphabet(s) are not significantly different at P<0.05.

Table 5: Effects of crude oil pollution on root dry weight (g) of cassava variety NR8082.

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control (0ml)	0.8^{b}	2.0^{c}	64.4^{c}	142.5^{a}
50ml	0.3^{c}	5.6^{a}	31.3^{b}	130.7^{b}
100ml	0.3^{c}	3.9^{b}	27.6^{c}	70.6^{c}
150ml	1.4^{a}	0.9^{d}	8.0^{d}	23.9^{d}

Mean in the same column having the same alphabet(s) are not significantly different at P<0.05.

Table 6: Effects of crude oil pollution on length of Root (cm) of cassava variety Nr8082.

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control (0ml)	17.0^{a}	35.0^{b}	26.0^{d}	55.0^{c}
50ml	16.0^{b}	34.0^{c}	33.0^{c}	57.0^{b}
100ml	13.0^{d}	36.0^{a}	41.0^{a}	43.0^{d}
150ml	15.0^{c}	33.0^{d}	39.0^{b}	74.0^{a}

Mean in the same column having the same alphabet(s) are not significantly different at P<0.05.

Table 7: Effects of crude oil pollution on number of Root of cassava variety Nr8082.

Treatment levels	1 MAP	2 MAP	3 MAP	4 MAP
Control (0ml)	29.0^{a}	21.0^{b}	11.0^{c}	18.0^{c}
50ml	20.0^{b}	15.0^{d}	14.0^{b}	20.0^{b}
100ml	18.0^{c}	30.0+a	10.0^{a}	14.0^{d}
150ml	21.0^{b}	16.0^{c}	20.0^{a}	25.0^{a}

Mean in the same column having the same alphabet(s) are not significantly different at P<0.05.

RESULTS

The ability of cassava to grow and tolerate adverse environmental pollution have been demonstrated in this research. It was observed that different levels of crude oil pollution exacted reduction on the number of leaves. This reduction increases with increase in the level of crude oil pollution; this however, affected the growth of cassava by reducing the number of leaves which could have been involved in the physiological synthesis of material needed for plant growth. This observation agrees with the work of Odejimi and Ogbalu (2006). Also it agrees with the work of Giel, *et al.,* (1994) that pollution affects plant growth, has toxic effects on seed and causes morphological and anatomical aberration in the leaf, stem and root.

The shoot height was equally affected by different levels of crude oil pollution. The shoot height of cassava was reduced by crude oil pollution compare to the control. This could be attributed to deficiency in available nutrients needed to maintain growth especially at the apical regions of the crop. These findings agree with the work of Molina-Baharahona *et al.,* (2005) who recorded similar results caused by petroleum hydrocarbons in diesel fuel and inferred that the negative effect could be due to impermeability effect of petroleum hydrocarbons or immobilization of nutrients mainly nitrogen or inhibitory effect of some polycyclic aromatic compounds.

The growth recorded in mild pollution (50ml) was higher than those in severe pollution (150ml). This could be due to stimulatory role of crude oil at lower concentration thereby enhancing growth. This could also be attributed to lower concentration of toxic substance that could have inhibited growth and reduced microbe actions that used available nutrient for their metabolic activities.

The leaf area of cassava variety NR 8082 was also reduced due to severe pollution throughout the experiment. It was shown that the reduction increases as the pollution level increases. This could be attributed to reduction in soil fertility occasioned by crude oil pollution which limits nutrients uptake needed for expansion of leaf area by plant. It also agrees with the findings of Ogbuehi and Akonye (2007) that crude oil pollution at higher concentration affected the leaf area of cassava cultivars studied. Oil contamination also reduced the soil fertility by causing immobilization of nutrients by microbes. (Agbogidi *et al.,* 2007). Such immobilization of nutrients leads to difficulty in the uptake of nutrients in oil contaminated soil which will be difficult despite availability of such nutrients in the soil.

Moreover, the result of shoot dry weight and root dry weight were significantly reduced by crude oil pollution and this reduction in dry weight increases as level of crude oil concentration in soil increases. This could be attributed to reduction in leaf area, which invariably limit the amount of carbon fixed by the leaves, since all the metabolic activities were disrupted due to unavailability of essential nutrients in crude oil polluted soil, needed for synthesis and transport of synthate to the various tissues. Other explanations inferred for this reduced growth was the effect of small aliphatic, aromatic, naphthalic and phenolic like compounds in crude oil that may reduce respiration, transpiration and photosynthesis and hormonal stress response (Baker, 1970, Vouillamon and Mike, 2001; Trapp *et al.,* 2005; Ogbo *et al.,* 2009).

The root length and number of root going by this experiment were not seriously affected by the level of crude oil pollution as evident in table 6 and 7. This could be due to tolerant nature of cassava to crude of polluted soil due to its genetic and physiological make up. This agrees with findings of (Onwudinwe and Akonye 2004; Ogbuehi and Akonye 2007).

The high number of rooting recorded in severe pollution at the beginning and towards the end of this experiment could be attributed to proliferation of root in search of nutrients and increase in microbial activities due to high level of crude oil pollution.

In conclusion, we found out that cassava growth performance was enhanced at low level of pollution but severely reduced by high level of pollution. However, it showed some level of tolerance making cassava one of the crops that grow well in such adverse condition.

Secondly, the dry weight of shoot and root which could be used to assess the level of physiological work, were seriously reduced by high level of pollution. We deduce here that tolerant nature of cassava to crude oil pollution does not commensurate with level of physiological activities in the crop. Therefore, low yield and poor quality products will be recorded in such crude oil polluted environment.

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