ISRJ ONLINE
INTERNATIONAL SCIENCE RESEARCH JOURNAL
ISSN: 2006-1730

ADAPTATION OF SOYBEAN (*GLYCINE MAX* (L.)MERR) IN SPENT-MOTOR-OIL POLLUTED LOAMY SOIL IN OWERRI,IMO STATE, NIGERIA

***Onuh, M.O, Ohazurike, N.C., and Madukwe, D.K**
Dept. of Crop Science & Biotechnology, Imo State University, Owerri, P.M.B 2000, Owerri, Imo State, Nigeria.

ABSTRACT: Pot experiment was carried out in the Teaching and Research Farm of Imo State University, Owerri, to investigate the growth and yield of soybean grown in a spent-motor-oil-polluted soil in Owerri. Soybean seeds were collected from the International Institute of Tropical Agriculture,Ibadan, Nigeria and sown 14 days after pollution, in 30 cm^3 plastic buckets filled with 20kg loamy soil polluted with spent-motor-oil collected from mechanic workshops in Orji Mechanic Village in Owerri, at different levels 0ml, 250ml, 500ml and 750ml. The seeds were sown at the rate of 2 seeds/bucket. The 0ml oil level represented the control (without oil pollution). The experiment was arranged in a Completely Randomized Design with four treatments and six replications. Poultry manure was applied to the polluted soils at the rate of 1kg/20kg soil at 4 weeks after germination. Soil analysis was carried out before application of treatments and after the experiment. Observations were made on the number of days to flowering, plant height (cm), number of pods/plant, number of leaves/plant, root length (cm), number of nodules/plant and seed yield/plant(kg/ha). Results showed that mean organic carbon and organic matter in the 750ml spent-oil-polluted soil recorded 4.26 and 7.38, respectively, which were significantly different ($p \leq 0.05$) from that of the control soils. Total nitrogen was significantly ($p \leq 0.05$) higher (0.36%) in the control soils than in the polluted soils. Plant heights, number of leaves/plants, root length, number of days to flowering and mean number of nodules in the control plots recorded, 30.0cm, 68.0, 28.0cm, 47, and 11.0, respectively, which were significantly different ($p \leq 0.05$) from those recorded in the polluted plots. Consequently, mean seed yield was significantly different with a yield of 10.67kg/ha in the control plants than in the polluted plants. From the observations, spent-motor-oil affected the growth and yield potential of soybean. Therefore, loamy soils polluted with spent motor oil should be remediated before using them for soybean cultivation.

KEY WORDS: Soybean, oil pollution, adaptation, spent-motor-oil, Owerri, Nigeria.

INTRODUCTION

Majority of activities connected with oil industries are sources of emission of pollutants and therefore causes of deterioration of land and water quality of the environment (Adekunle *et al.,* 2003). Oil spillages have caused massive destructions to farm lands, sources of drinking water, mangrove forest, fishing ground and crops. According to Adenkule *et al.* (2003) and Esenowo *et al.* (2006) many of these occurred in the course of production, mainly through careless handling or malfunction equipments or sabotage.

Many factors can affect the ability of a plant to grow in contaminated soils, for instance, soil pH which is often significantly reduced due to organic wastes containing toxic heavy metals can have a substantial effect on plant growth as well as microbial activity (Kayode *et al.,* 2008).

In Nigeria, crude oil pollution is of common occurrence in the oil producing areas. In Owerri, Imo State, spent motor oil are spilled or disposed indiscriminately, most especially by the motor mechanics and other allied workers (Uzoma, 2008). This fact constitutes danger for farmers in Owerri, who battle for the remediation of their farm lands.

Soybean (*Glycine max* (L.) Merr) was one of the oldest crops grown by man, and it was introduced into most tropical countries like Nigeria in the 20th century, where it is an important source of protein and has contributed so much in combating protein energy malnutrition (PEM) in most developing nations (Nwokoma, 2003). Soybean is a warm season crop; however, it thrives well under soil temperature of about 23^{o}C, and optimum soil pH range of 6.0 6.5. Soybeans, like most legumes perform nitrogen fixation by establishing a symbiotic relationship with the bacterium, *Bradyrhizobium japonium.* However, for best result an inoculum of the correct strain of bacterial should be mixed with the soybean seed before planting (King and Purcell, 2005). Considering the harmful effects of oil pollution to plant growth and development, the present study is therefore aimed at investigating adaptation of soybean to grow well in spent motor oil-polluted loamy soil.

MATERIALS AND METHODS

The study was conducted between May and August, 2008 at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri. Soybean seeds were collected from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria while spent motor oil collected from the motor mechanic workshops in Orji Mechanic Village, Owerri were used as the soil oil pollutant at the following concentrations, 0ml, 250ml, 500ml and 750ml (the 0ml served as the control). 24 plastic buckets of 30cm3 capacity were filled each to 2/3 of its volume with 20kg of loamy soil collected from the University's farm site. The various levels of the pollutants were mixed with the soil and allowed to stand for 14 days before the soybean seeds were sown. Soybean seeds were sown in the polluted soils and thee control at the rate of 2 seeds/bucket. The experiment was arranged in a Completely Randomized Design, with six replications of the treatments. Poultry manure was applied to the soils at the rate of 1kg/20kg soil at 4 weeks after planting. Soil samples were collected from the polluted soils and the control before and after the end of the

***Corresponding Author:** E-mail: deracom@yahoo.com

experiment for analysis to ascertain the soils physical and chemical properties. The soybean seeds germinated between 5-6 days after planting; while the plants were growing, the following parameters were monitored and recorded: number of days to flowering, plant height, number of pods per plant, number of leaves per plant, root length, number of nodules per plant and seed yield. The data collected were subjected to statistical analysis using the analysis of variance (ANOVA) procedure as applied by Onuh and Igwemma (2002), while treatment means were separated by the Fisher's LSD test at 5% of significance.

RESULTS

Effects of spent motor oil pollution on the soil physical and chemical properties

Results showed that the soil properties were affected by the spent motor oil, however, the extent of effect significantly corresponds to the concentration of pollutant. For instance, organic carbon-contents of the soil was significantly higher in the soils that received 750ml of the spent motor oil, than in the other treatments including the control (Table 1). In the same order, organic carbon measured in the soils polluted with 500ml of spent motor oil was significantly ($p \leq 0.05$) higher than that of 250ml and 0ml as shown in table 1. The mean organic matter content of the soil was also affected by the level of concentration of the pollutant. Thus, soils that received 750ml of spent motor oil, like in the organic carbon, gave the highest (7.38%) organic matter contents. This value was significantly different ($p \leq 0.05$) from the 0.14% observed from soils treated with 0, 250 and 300ml of the pollutant, respectively (Table 1). The same trend was repeated whereby organic matter content of the soil increased with increased concentration of the spent motor oil. However, the highest total nitrogen of 0.36% was observed from the control experiment, and this was significantly different at $p \leq 0.05$ from the 0.03% observed from the plots that received 750ml of the pollutant (Table 1). The cation exchange capacity (CEC) of the soil was also influenced by the concentration of the pollutant as soils that received 750ml gave the highest (5.68) CEC which was significantly different from the 2.50 observed from soils that received 0ml of the pollutant (Table 1). It was observed that nodulation of soybean plant was significantly influenced by the concentration of spent motor oil. Soybean plants grown in soils treated with 750ml, gave the least (4.3) mean number of nodules which was significantly different from the 11.3 mean number of nodules recorded from soybean plants in the control (Table 2).

Effect of spent motor oil on the yield parameters of soybean

The number of pods produced by the soybean plants was affected by the pollution levels. While plants in thee control soils gave a mean number of 42.3 pods as the highest observed mean number of pods per plant, plants grown with 750ml of spent motor oil pollution gave 14.3 mean number of pods per plant, which was significantly different from that of the control (Table 3). Plants grown on soils that received 750ml of the spent motor oil gave a mean seed yield of 3.33kg/ha which was significantly ($P \leq 0.05$) different from the mean seed yield of 10.66kg/ha observed from plants in the control soils (Table 3).

Table 1: Physio-chemical properties of the soil

Treatment	Mean Organic Carbon	Mean Organic Matter	Mean Total Nitrogen	Mean CEC
0ml	0.07^{b}	0.14^{d}	0.36^{a}	2.50^{d}
250ml	1.07^{c}	1.83^{c}	0.19^{b}	4.11^{c}
500ml	2.29^{b}	3.96^{b}	0.09^{c}	4.32^{b}
750ml	4.26^{a}	7.38^{a}	0.03^{d}	5.68^{a}

Means in the same columns with the same letter(s) are not significantly different at $P \leq 0.05$ according to LSD test.

Table 2: Effect of the concentration of spent motor oil pollution on the growth parameters of soybean

Treatment	Mean Plant heights (cm)	Mean no. of leaves	Mean root length(cm)	Mean no. of days to flowering	Mean no. of nodules per plant
0ml	38.0^{a}	68.0^{a}	28.0^{a}	47^{c}	11.3^{a}
250ml	33.3^{b}	47.6^{b}	24.0^{b}	50^{b}	10.0^{ab}
500ml	29.3^{c}	33.3^{c}	10.6^{bc}	52^{b}	7.0^{b}
750ml	20.3^{d}	20.0^{d}	19.6^{c}	61^{a}	4.3^{c}

Means in the same columns with the same letter(s) are not significantly different at $P \leq 0.05$ according to LSD test.

Table 3: Effect of the concentration of spent motor oil pollution on the yield parameters of soybean

Treatment	Mean plant heights (cm)	Mean no. of leaves
0ml	42.3^{a}	106.66^{a}
250ml	29.0^{b}	75.55^{ab}
500ml	17.3^{bc}	50.00^{b}
750ml	14.3^{c}	33.33^{bc}

Means in the same columns with the same letter(s) are not significantly different at $P \leq 0.05$ according to LSD test.

DISCUSSION

Results of this study showed that there are significant differences on the effects of the different concentrations of spent motor oil contaminant on the characteristics of soybean, as well as the soil properties. The results however showed that the level of effects on the soybean increases with increase in the concentration of the pollutant. The higher level of organic carbon and organic matter content observed in the soil used for the experiment may be associated with the mineralization of the spent oil which may have released the carbon in the hydrocarbon of the spent motor oil. According to Goa and Zho (2004), increase in percentage organic carbon and organic matter content with increased oil in the soil could be attributed to microbial mineralization of the oil. On the other hand, the higher cation exchange capacity (CEC) of the soil observed in the soils that received 750ml of the spent motor oil could be due to reduction in the exchangeable site of the cation by the spent motor oil. This agrees with Palmroth *et al.* (2006), who reported that growth of the soybean plant was observed to be stunted on the soils that received oil pollution, while in the control soils, there was luxuriant growth as the number of leaves was also found to be highest on the soybean plants in the control soils and lowest on the 750ml oil-polluted soils. The poor performance in plant height and leaf production in the soybean plant grown in soil that received 750ml could be associated with the poor penetration of the roots of the plants in the polluted soils as the roots were observed to be short compared to that of the control. This observation confirms the findings of Kayode *et al.* (2008) who reported that the presence of engine oil in the soil holds the soil too compact for the roots of plants to penetrate and so affected the extent of root growth and nutrient absorption. Due to the insufficient nutrient absorbed by the plants grown on the 750ml spent motor oil-polluted soils, it was observed that the plants took longer time (61 days) to flower compared to the plants on the soils that received 250ml and 500ml which took 50 and 52 days, respectively to flower. Though, these flowering periods were longer than the 47 days flowering period observed from the plants in the control soils, which gave further evidence that the presence of oil in the soil prolonged the flowering periods of the soybean plants.

In the same vein, the yield components of soybean were affected by concentration of the spent motor oil in the soil. The highest number of pods observed in the control plants could be attributed to the ability of the plant to produce more leaves which contributed in the process of photosynthesis in the plants. This was in line with the work of Odejimi and Ogbalu (2005) who observed that greater number of leaves in plants makes for better reception of light which is a primary resource in the production of plant food.

Fewer numbers of root nodules was observed from plants grown in soils polluted with 750ml of spent oil while the highest number of root nodules was recorded in plants grown in soils without spent oil pollution. The reason for this could be attributed to the possibility of toxicity of the soils that received the soil pollution with aluminum. According to Esenowo *et al.* (2006), aluminum toxicity from soil pollution hinders the symbiosis of nodule bacteria with the host plant. It was also observed that seed yield of soybean was highest (106.66kg/ha) on plants grown in the soils without pollution than in the plants grown on the polluted soils. Consequently, plants grown on non-oil polluted soils produced more root nodules which may have contributed in making available, the needed nitrogen by the soybean for better growth and yield. This observation confirmed the findings of Madukwe *et al.* (2008) who observed that legume yield is positively influenced by the root nodulation capacity.

CONCLUSION

Spent motor oil pollution affected the performance of soybean plant and at the same time reduced yield of the crop; it also degraded the soil properties. However, it was observed that the extent of effect of the oil pollution on the soybean plant depends on the concentration of the pollutant; hence, the higher the concentration of the pollutant, the more adversely it affect the growth and yield of soybean.

It is suggested that soil remediation exercise should be carried out in spent motor oil-polluted soils before using them for soybean cultivation..

REFERENCES

Adekunle, V. O., Enos, O., and Addedunta, S. (2003). Challenge of environmental sustainability in a democratic government. *Proceedings of the 11th Annual Conference of Environmental and Behaviour Association of Nigeria.* Pp 279-288.

Esenowo, G.J., Sam, S.M. and Efuk, A.I. (2006). Effects of crude oil on germination and early seedling growth of *Telfaria occidentalis.* In Botany and Environmental Health. Akpan, G. and C, S.J. Odoemena (Eds) *Proceedings of the 15th Annual Conference of the Botanical Society of Nigeria.* University of Nigeria, pp. 93-96.

Gao, Y. and. Zho, L. (2004). Plant uptake, accumulation and translocation of phenanthorene and pyrene in soils. *Chemosphere 55***:** 1169-1178.

Kayode, J., Olowoyo, O. and Oyedeji, A. (2008). Effect of used engine oil pollution on the growth and early seedling performance of *Vigna unguiculata* and *Zea mays*. *Research Journal of Soil Biology*. *1(1*): 15-19.

King, C.A. and Purcell, L.C. (2005). Inhabitation of N_2 fixation in soybean is associated with elevated ureides and amin. Acids. *Plant physiology, 137*: 1389-1396.

Madukwe, D.K., Christo, I.E.C. and Onuh, M.O. (2008). Effects of organic manure and cowpea (*Vigna unguiculata* (L.) Walp) varieties on the Chemical properties of the soil and root nodulation. *Science World Journal* 3(1): 43-46.

Nwokoma, S.N. (2003). *Nigeria's Staple Foods,* Spring Field Publishers Limited, Owerri pp. 176.

Odejimi, R.A.O. and Ogbalu, O. (2006). Physiological impact of crude oil polluted soil on growth, carbohydrate and protein levels of edible shoot of fluted pumpkin In: *Botany and Environmental health.* Akpan G. and C.S.J. Odemena (Eds), *Proceedings of the 15th Annual Conference on the botanical society of Nigeria.* University of Uyo, Nigeria pp. 292.

Onuh, M.O. and Igwemma, A.A. (2002). *Applied Statistical Techniques for Business and Basic Sciences.* Skillmark media Ltd. Owerri Nigeria. Pp. 135.

Palmroth, M. R. Munster, U., Pichtel, J. and Pahakka, J. A. (2006). Uptake and metabolism of 14C anthracene by soybean (*Glycine max*). *Environmental Experimental Botany, 22*: 349-357