THE EFFECTS OF SAWDUST AND GOAT DUNG SUPPLEMENTS ON GROWTH AND YIELD OF OKRO (*Abelmoschus esculentus L. Moench) IN DIESEL OIL CONTAMINATED SOIL*

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ABSTRACT

Sawdust and goat dung supplements were studied for their effects on growth components and yield of Abelmoschus esculentus (L. Moench) in diesel oil contaminated soil. Each organic supplement was added at the rate of 3kg per 4kg of sandy-loam soil at various levels of diesel oil contamination (1.00, 2.00, 3.00, 4.00 and 5.00 %) in polythene bags alongside a control. Mean values of physico-chemical properties of experimental soils were expressed. Each level of treatment was replicated four (4) times and the set up maintained for 4 months. At harvest, the shoot length of the crop in the control treatment was significantly (P<0.05) higher than those at 2.00, 3.00, 4.00, 5.00 % (sawdust treatment) and 4.00 and 5.00 % (Goat dung treatment) levels of contamination, respectively. The shoot length and leaf area of the crop were comparatively higher in goat dung than in sawdust treatment. At harvest, there were significant (P<0.05) differences between the leaf area of the crop in goat dung and sawdust treatment at 1.00, 2.00, 3.00, and 5.00 % level of contamination. The root length, fresh weight, dry weight, moisture content, fruit number, and fruit weight of the crop were comparatively higher in goat dung than in sawdust treatment. Therefore, goat dung supplement is suitable for amelioration of diesel oil contaminated soil compared with sawdust supplement.

Key Words – Goat dung, sawdust, Abelmoschus esculentus, growth and yield performances, diesel oil, contaminated soil.

INTRODUCTION

The adverse effect of oil spillage on man and his environment has generated a great necessity to protect the environment from this hazard (Ekpo and Ebeagwu, 2009; Moeller *et al.*, 2008). Post oil spill rehabilitation measures are designed to enhance soil recovery and crop improvement. The use of optimized remediation practices, which stimulate and enhance the development of aerobic hydrocarbonclastic degrading population that can transform the pollutants of interest is desirable (Lei *et al.,* 2005). The application of organic nutrient supplements is one of such methods (Tabak *et al.,* 2003). Organic manure contains nitrogen, phosphorus, and potassium in addition to smaller level of zinc, calcium, manganese, magnesium, iron and sulphur, which are essential for microbial metabolism (Belay *et al*., 2001 ; Lei *et al.,* 2005). Goat dung and sawdust are organic based nutrient supplements which contain both macro and micro nutrients. Seed germination, growth parameters and proximate nutritive values of crops have been shown to be positively affected by the addition of organic supplements to

petroleum oil contaminated sites (Odoemena and Ekaso, 1995). *Abelmoschus esculentus* (Malvaceae) which is used in the tropics as vegetable fruit (Komolafe *et al., 1981*) is widely cultivated in Nigeria, most especially in the southern part where there is intensive oil exploration activity (Belay *et al., 2001;* Moeller *et al., 2008*) Therefore, this study was designed to evaluate the effects and ameliorative ability of goat dung and sawdust on the growth and yield parameters of *Abelmoschus esculentus* in diesel oil polluted soil.

MATERIALS AND METHODS

Soil samples obtained from University of Uyo Botanical garden was used for the study. Contamination treatment were obtained by mixing 4kg of sandy – loam soil with the various levels (0.00, 1.00, 2.00, 3.00, 4.00 and 5.00 %) of diesel oil. The amelioration treatments were carried out by adding organic supplement (goat dung or sawdust) at the rate of 3kg per 4kg of sandy-loam soil to the various levels; 1.00, 2.00, 3.00, 4.00 and 5.00 % of diesel oil contaminated soils alongside a control (0 %). The soil samples with organic nutrient were left undisturbed for four weeks before being placed in perforated poly bags (18 x 36cm).The physico-chemical properties of experimental soils were analyzed using standard procedures of A.O.A.C., (1999). The pH values of the soil were measured in 1:2 soil to liquid suspension with electro pH meter. Organic carbon was determined by dictrometric wet oxidation method. Total nitrogen was determined by the Macro-Kjeldal's method. Available phosphorus was estimated by the Bray P-1 method. Exchangeable bases were extracted with 1M ammonium acetate solution. The potassium and sodium extracts were determined by flame photometry, while calcium and magnesium were determined by the EDTA filtration method. The size of soil particles was determined by the hydrometer method (A.O.A.C., 1999).

Abelmoschus esculentus(Lady finger) seeds were sterilized with approximately 0.01% mercuric chloride solution for 30 seconds, and then thoroughly washed 3 to 4 times with steriled distilled water and air-dried. Ten (10) seeds of *Abelmoschus esculentus* were sown directly in each perforated polythene bag containing the treated soil and after germination were thinned to two (2) seedlings per bag. Randomized complete block design was used with 4 replications. The experiment was conducted at a mean minimum temperature of 21.46^{o}C and a mean maximum temperature of 34.07^{o}C under natural light condition, watered as need arose and maintained for four (4) months. Measurements of shoot length and leaf area were taken every four weeks, and at harvest, the root length, fruit number, fruit weight, fresh weight, dry weight and moisture content were determined. Data were subjected to analysis of variance (ANOVA) at P = 0.05 levels of significance and Duncan's multiple range test was used for mean separation.

RESULTS

The mean physico-chemical properties of experimental soils (uncontaminated, contaminated and amended) are presented (Table 1). The pH of experimental soils ranged from 6.84, 6.90. 7.27 to 7.56, in contaminated soil amended with goat dung, garden soil, contaminated soil amended with sawdust, and diesel oil contaminated soil, respectively. The essential soil nutrients in garden soil - NPK had values of 0.08 %, 9.90 mg/kg and 0.26 me/100g, respectively. While the values of NPK in diesel oil

contaminated soil were 0.05 %, 5.83 mg/kg and 2.96 me/100g, respectively. Similarly, NPK values in goat dung amended soils (1.30 %, 9.98 mg/kg and 2.81 me/100g) were comparatively higher than those of sawdust amended soils (0.59 %, 6.07 mg/kg and 2.4.7 me/100g. The carbon to nitrogen ratio of experimental soil ranged from 3.04, 12.83, 15.00 to 71.86 in goat dung amended soil, garden soil, sawdust amended soil and diesel oil contaminated soil (Table 1).

The responses of *Abelmoschus esculentus* to amelioration treatment varied between goat dung and sawdust supplemented treatments. There were no significant differences between the shoot length of the crop in the control and 1.00 % (week 4-16 for both treatments), 2.00 % (week 4-8 for both treatments ; week 12 and 16 for goat dung treatment), 3.00 % (week 4 for both treatments; week 8 for goat dung treatment; week 12 and 16 for sawdust treatment) and 5.00 % (week 4 for both treatments) levels of contamination (Table 2). The shoot length of the crop was comparatively higher in goat dung than in sawdust treatment. There were significant ($P<0.05$) differences between shoot length of crop in goat dung and sawdust treatments at 2.00 and 5.00 % (week 12 – 16), and 3.00 and 4.00 % (week 8-16) levels of contamination (Table 2).

At harvest (week 16), the leaf area of the crop in the control was significantly ($P<0.05$) higher than those at 1.00 and 2.00 % (sawdust treatment) and 3.00, 4.00, 5.00 % (both treatments) levels of contamination. Similarly, at harvest (week 16), there were significant ($P<0.05$) differences between the leaf area of the crop in goat dung and sawdust treatments at 1.00, 2.00, 3.00 and 5.00 % level of contamination (Table 3).

The fruit number and fruit weight were higher in goat dung than in sawdust treatment. At 5.00 % level of contamination, *Abelmoschus esculentus* failed to fruit in sawdust amended soil (Table 4). There were no significant ($P<0.05$) differences between root length, fresh weight, dry weight, moisture content, fruit number and fruit weight of the crop in the control and 1.00, 2.00, 3.00, 4.00 and 5.00% level of contamination in all treatments. (Table 4). Similarly, there were no significant ($P<0.05$) differences between root length, fresh weight, dry weight, moisture content, fruit number and fruit weight of the crop in goat dung and sawdust treatments, except at 4% level of contamination for moisture content and 5% level of contamination for fruit weight (Table 4).

Table 1: The Physico-Chemical Properties of experimental soils

Soil Properties	Garden soil	Contaminated soil	Contaminated soil amended with Sawdust	Contaminated soil amended with Goat Dung
pH	6.90 ± 1.02	7.56 ± 0.06	7.27 ± 1.34	6.84 ± 0.36
Available phosphorus (mgKg)	9.90 ± 2.17	5.83 ± 1.26	6.07± 1.25	9.98± 1.52
Calcium (me/00g)	2.36 ± 1.21	4.05 ± 0.22	5.10 ± 1.06	4.12 ± 1.60
Magnesium (me/100g)	2.40 ± 1.30	4.47 ± 1.66	10.05 ± 0.52	12.21 ± 2.58
Sodium (me/100g)	0.09 ± 0.01	4.98 0.06	4.91 ± 2.65	4.22 ± 2.17
Potassium (me/100g)	0.26 ± 0.02	2.96 ± 1.34	2.47 ± 0.39	2.81 ± 0.42
Organic Carbon (%)	1.20 ± 0.10	3.59 ± 1.07	3.72 ± 0.25	3.95 ± 0.61
Total nitrogen (%)	0.08 ± 0.01	0.05 ± 0.04	0.29 ± 0.56	1.30 ± 0.33
Sand (9%)	69.50 ± 2.31	69.64 ± 2.17	71.04 ± 3.36	69.99 ± 3.06
Silt (%)	20.40 ± 2.10	9.21 ± 1.30	14.30 ± 1.43	11.25 ± 1.50
Clay (%)	9.80 ± 1.34	17.20 ± 1.27	16.37 ± 1.02	15.05 ± 2.71
C/N ratio	15.00 ± 1.26	71.80 ± 2.23	12.83 ± 0.56	3.04 ± 1.34

Mean Standard Error

Table 2: Shoot Length(cm) of *Abelmoschus esculentus* treated with Sawdust (S) and Goat Dung(G) in Diesel Oil contaminated soils

Concentration (%)		0	1.00	2.00	3.00	4.00	5.00
Weeks	Treatment						
4	S	15.50 ± 2.02^{d}	13.32 ± 2.32^{d}	10.80 ± 1.34^{d}	11.23 ± 0.21^{d}	10.20 ± 0.36^{d}	10.05± 2.17^{d}
	G	15.50 ± 2.02^{d}	14.80 ± 1.02^{d}	14.30 ± 0.21^{d}	13.43 ± 2.72^{d}	12.68 ± 0.21^{d}	12.25 ± 2.06^{d}
8	S	32.90 ± 0.03^{b}	28.52 ± 3.21^{b}	27.02 ± 2.06^{b}	18.83 ± 2.21^{c}	18.21 ± 2.02^{c}	17.52 ± 1.41^{c}
	G	32.90 ± 0.03^{b}	32.52 ± 2.00^{b}	29.43 ± 1.72^{b}	28.24 ± 0.03^{b}	25.45 ± 1.21^{b}	24.30 ± 2.03^{c}
12	S	39.36 ± 2.62^{a}	36.06 ± 0.04^{a}	30.35 ± 0.02^{b}	26.20 ± 2.25^{b}	25.83 ± 0.36^{b}	23.02 ± 1.73^{c}
	G	39.36 ± 2.62^{a}	38.23 ± 1.26^{a}	36.35 ± 2.07^{a}	36.11 ± 0.03^{a}	34.02 ± 1.12^{a}	30.80 ± 2.52^{b}
16	S	40.50 ± 1.21^{a}	36.25 ± 2.04^{a}	31.50 ± 3.08^{b}	28.40 ± 3.10^{b}	26.33 ± 2.14^{cb}	23.50 ± 1.21^{c}
	G	40.50 ± 1.21^{a}	38.30 ± 0.31^{a}	38.75 ± 0.04^{a}	37.30 ± 2.02^{a}	34.20 ± 3.71^{b}	31.63 ± 2.56^{b}

Values with the same alphabet are not significantly different (P< 0.05)

Table 3: Leaf Area (cm^2) of *Abelmoschus esculentus* as affected by Goat Dung (G) and Sawdust (S) Treatment (T) in Diesel oil contaminated soils

Concentration (%)		0	1.00	2.00	3.00	4.00	5.00
Weeks	Treatment						
4	S	26.15 ± 2.04^{e}	25.84 ± 1.02^{e}	21.27 ± 2.73^{e}	21.59 ± 2.77^{e}	20.51 ± 2.70^{e}	16.93 ± 2.38^{f}
	G	26.15 ± 2.04^{e}	24.06 ± 2.77^{e}	23.08 ± 2.86^{e}	22.52 ± 2.81^{e}	20.50 ± 2.64^{e}	21.33 ± 2.71^{e}
8	S	72.53 ± 1.56^{c}	46.62 ± 1.40^{d}	36.45 ± 3.69^{d}	40.06 ± 1.36^{d}	28.09 ± 1.40^{e}	19.72 ± 2.80^{f}
	G	72.53 ± 1.56^{c}	71.48 ± 2.18^{c}	52.96 ± 1.56^{cd}	50.08 ± 2.07^{cd}	47.23 ± 2.41^{d}	46.82 ± 2.43^{d}
12	S	125.57 ± 2.23^{a}	92.23 ± 2.02^{b}	70.17 ± 2.27^{c}	67.48 ± 2.34^{c}	56.77 ± 1.60^{cd}	39.19 ± 2.74^{d}
	G	125.57 ± 2.23^{a}	123.43 ± 3.25^{a}	117.53 ± 1.74^{c}	105.88 ± 2.17^{b}	93.79 ± 2.30^{b}	95.13 ± 2.14^{b}
16	S	128.54 ± 1.96^{a}	97.35 ± 2.62^{b}	77.79 ± 2.33^{c}	79.69 ± 1.24^{c}	61.13 ± 1.54^{c}	42.24 ± 1.73^{d}
	G	128.54 ± 1.96^{a}	124.77 ± 2.43^{a}	121.28 ± 2.08^{a}	109.74 ± 1.77^{b}	76.78 ± 3.24^{c}	101.73 ± 1.41^{b}

Values with the same alphabet are not significantly different (P< 0.05)

Table 4: Root Length (cm), Fresh Weight (g), Dry Weight (g), Moisture Content (%), Fruit Number and Fruit Weight (g) of *Abelmoschus esculentus* as affected by Goat Dung (G) and Sawdust (S) Treatment (T) in Diesel Oil contaminated soils

Concentration (%)		0	1.00	2.00	3.00	4.00	5.00
Growth Parameter	Treatment						
Root Length (CM)	S	19.50 ± 0.31^{C}	17.65 ± 1.20^{c}	15.40 ± 0.72^{c}	15.43 ± 1.60^{c}	15.15 ± 2.51^{c}	14.40 ± 0.61^{cd}
	G	19.50 ± 0.31^{C}	19.30 ± 2.41^{c}	18.40 ± 0.65^{c}	17.50 ± 1.00^{c}	17.40 ± 2.12^{c}	16.30 ± 2.32^{c}
Fresh weight (g)	S	10.69 ± 1.20^{d}	9.53 ± 0.52^{d}	8.32 ± 3.24^{d}	7.05 ± 1.49^{d}	6.81 ± 2.23^{e}	5.32 ± 0.81^{e}
	G	10.69 ± 1.2^{d}	10.34 ± 1.67^{d}	10.01 ± 1.82^{d}	9.43 ± 0.15^{d}	7.84 ± 1.53^{e}	6.04 ± 1.75^{e}
Dry weight (g)	S	3.12 ± 0.61^{e}	2.84 ± 1.40^{e}	2.42 ± 0.13^{e}	2.24 ± 1.65^{e}	2.03 ± 1.36^{e}	1.82 ± 1.49^{e}
	G	3.12 ± 0.61^{e}	3.00 ± 0.28^{e}	2.96 ± 0.64^{e}	3.92 ± 0.81^{e}	2.42 ± 0.47^{e}	2.05 ± 1.63^{e}

Moisture content (%)	S	70.81 ± 0.61^{a}	70.91 ± 3.37^{a}	70.19 ± 1.48^{a}	68.65 ± 0.02^{a}	70.19 ± 2.50^{a}	65.79 ± 3.40^{b}
	G	70.81 ± 0.61^{a}	70.70 ± 1.25^{a}	70.43 ± 3.42^{a}	69.04 ± 2.57^{a}	62.13 ± 0.22^{b}	66.06 ± 1.41^{b}
Fruit Number	S	5.00 ± 2.24^{e}	2.56 ± 2.10^{e}	1.44 ± 0.42^{e}	1.33 ± 3.11^{e}	0.89 ± 2.17^{e}	0.00 ± 0.00^{e}
	G	5.00 ± 2.24^{e}	3.00 ± 2.32^{e}	1.67 ± 0.11^{e}	1.44 ± 0.32^{e}	1.22 ± 0.51^{e}	1.00 ± 0.21^{e}
Fruits Weight (g)	S	9.01 ± 2.01^{d}	7.85 ± 2.21^{d}	7.61 ± 2.36^{d}	7.05 ± 0.68^{d}	6.13 ± 1.29^{d}	0.00 ± 0.00^{e}
	G	9.01 ± 2.01^{d}	8.93 ± 0.54^{d}	8.61 ± 2.02^{d}	8.42 ± 2.98^{d}	8.21 ± 2.36^{d}	7.05 ± 1.98^{d}

Values with the same alphabet are not significantly different (P< 0.05)

DISCUSSION

The changes in physical and chemical characteristics of the garden soil were attributed to the negative effects posed by diesel oil. Petroleum oil interferes with the soil physical and chemical properties and subsequently, plant growth and development (Ekpo and Ebeagwu, 2009). Organic manure improves the soil characteristics as well as soil – plant – water relationship (Moeller *et al*., 2008) as shown in treatments supplemented with goad dung and sawdust.

In goat dung supplemented soils, the leaf area and shoot length of *A. esculentus* competed favourably at 1.00% level of contamination with those of the control treatment during the 4th, 12th and 16th week of study. The addition of organic supplements ameliorated the unfavourable conditions in the diesel oil polluted soil by not only increasing the nutrient reserve available for translocation but also had a profound effect on the soil that enhanced the biodegradation of petroleum pollutants (Belay *et al*., 2001; Odoemena and Ekaso, 1995). Reductions in shoot length, leaf area and yield of the crop were recorded in soil treated with sawdust relative to goat dung supplemented soil. This agrees with the work of Essien *et al.* (1995), that delayed flowering and stunted growth may occur in sawdust supplemented soil due to high carbon to nitrogen ratio. The differences in the shoot length, leaf area and yield parameters between goat dung and sawdust treatments maybe attributed to low nitrogen and phosphorus contents of sawdust treatment, and this is in consonance with the work of Amadi *et al.* (1992).

Goat dung treated soil positively affects the root length, fresh weight, dry weight and moisture content of the crop than in soil treated with sawdust. This is confirmed by the fact that in this study, goat dung amended soils contained higher proportion of available phosphorus, calcium, magnesium, organic carbon, total nitrogen and silt than in sawdust amended soil. The favourable conditions resulting from the addition of organic supplement may improve the anaerobic and hydrostatic conditions of the polluted soil and enhance soil-plant-water relationship (Essien, *et al.,* 1995; Moeller, *et al.,* 2008). Thus, this affected goat dung treatment more positively than in sawdust.

Finally, the generally enhanced plant growth and

yield in diesel oil polluted soil supplemented with goat dung may be attributable to the important role played by the organic supplement in supplying the readily available plant minerals, and in providing favourable condition for microbial activities as well as providing better soil texture and structure, which consequently help to improve soil temperature and water movement (Kapanen and Itavaara, 2001; Jacobson, 1995).

CONCLUSION

From the study, there is ample evidence to show that goat dung enhanced plant growth and yield more than sawdust in the diesel oil polluted soil, hence goat dung is recommended for efficient amelioration practice. However, much longer time of incubation is needed for effective decomposition of sawdust so as to enhance the rate of biodegradation.

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