Assessment of Floristic, Microbial Composition and Growth of *Sphenostylis stenocarpa* (Hochst Ex A. Rich) in Soil from Two Dumpsites in Benin City, Nigeria

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Abstract: Survey of dumpsite plant composition, assessment of rhizosphere microorganisms and growth performance of *Sphenostylis stenocarpa* grown on two dumpsite (CAPITOL and NITEL ROAD) soils in Benin City was investigated. Control treatment was top soil. A total of 9 and 30 flora were observed at the CAPITOL and NITEL ROAD dumpsites respectively. Analysis of the rhizosphere soils of the plants grown in dumpsite soils at different amendments showed a total heterotrophic bacterial count ranging from 1.57 x 10^4 to 4.18 x 10^4cfu/g and a total heterotrophic fungal count in the various rhizosphere soils ranged from 5.05 x 10^3 to 1.68 x 10^4cfu/g. The bacterial isolates from the rhizosphere soil samples were *Arthrobacter* sp., *Bacillus* sp, *Pseudomonas* sp., *Escherichia coli*, *Enterobacter* sp., *Klebsiella* sp., *Micrococcus* sp. and *Staphylococcus* sp. The fungal isolates were *Aspergillus* sp, *Mucor* sp, *Fusarium* sp, *Penicillium* sp, *Trichoderma* sp. and *Saccharomyces* sp. *Bacillus* sp., *Pseudomonas* sp., *Penicillium* sp. and *Aspergillus* sp. *Aspergillus* sp. 100 % (present in all dumpsite soils analyzed) had the highest frequency of occurrence amongst the isolates.Percentage seedling emergence was significantly reduced from 86.67± 13.33 % - 100.00 ± 0.00 % in control (top) soil to 60.00 ± 0.00 % to 93.33 ± 6.67 % in CAPITOL dumpsite soil. Shoot height at 6 weeks after planting (WAP) was significantly ($p < 0.05$) increased from 78.33± 18.53 cm in the control soil through 131.50 ± 18.79 cm in the CAPITOL dumpsite soil to 186.33 ± 13.68 cm in NITEL road dumpsite soil, all without amendment. Number of leaves at 6 WAP increased on addition of FYM in both soil types. Chlorophyll content was not significantly different ($p > 0.05$) from control plants. Leaf area in both dumpsite soils was found to be significantly different ($p < 0.05$) from the control soil but leaf area increased on addition and increase in amendment in both soil types. In all parameters observed, it was noted that the control treatment did better than the plants grown in the dumpsite soils with increased amendment.

Keywords: amendment, dumpsite soil, growth, Rhizosphere microorganisms, *S. stenocarpa*.

INTRODUCTION

The African yam bean [*Sphenostylis stenocarpa* (Hochst. Ex A. Rich) Harms] is a climbing legume adapted to lowland tropical conditions. It is one of the lesser-known legumes [1-3] and widely cultivated in the Southern parts of Nigeria. The legumes are a good source of dietary protein [4]. They are cheaper than animal products such as meat, fish, poultry and egg – therefore they are consumed worldwide as a major source of cheap protein and especially in the developing or poor countries where consumption of animal protein may be limited as a result of economic, social, cultural or religious-factors [4]. Studies have shown that the lesser known legumes together with other conventional legumes can be used for combating protein malnutrition prevalent in the third world; achieving this by consumption of the legumes both in whole and various processed forms or as condiments [5].

Due to developmental pressures leading to limited land space in most urban areas, it has become a common practice to utilize lands previously used as dumpsites (the major waste disposal option in the country) for crop production [6] or to utilize soils from such places as manure. These lands are usually converted to agricultural fields for the cultivation of crops such as vegetables, cereals and fruits as they are considered by most people as being fertile [6].

The rhizosphere is the volume of soil surrounding and under the influence of plant roots, and the rhizoplane is the plant root surfaces and strongly adhering soil particles [7]. An extremely complex microbial community including saprophytes, epiphytes, endophytes, pathogens and beneficial microorganisms is harboured in the rhizosphere [8]. Important and intensive interactions take place between the plant roots, soil microorganisms and soil microfauna [9], thus the importance of studying the rhizosphere organisms to understand these interactions.

In natural systems, microbial communities tend to live in relative harmony where all populations generally balance each other out in their quest for food and space [8]. In agriculture, there is a modification in this natural balance that can drastically alter the microbial community and can lead to loss of beneficial microbes and/or ingress of plant pathogens that may have a

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ISSN: 1814-8085 / E-ISSN: 1927-5129/14

devastating effect on plant productivity [10]. Thus, the integration of beneficial microorganisms into production systems can somewhat shift the balance of the microbial communities toward a population structure more conducive to increased plant health and productivity [10]. Due to the need for improvement of the yield of AYB as well as the current trend of increased use of dumpsites for agricultural purposes in Africa, it is therefore important to study the effect of various dumpsite soils on the growth and rhizosphere microorganism diversity of AYB. This study aims at determining which dumpsite soil better supports beneficial or harmful microbial system and hence growth of *Sphenostylis stenocarpa.*

MATERIALS AND METHODS

Study Location

The study was carried out at the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Nigeria which lies within the rainforest ecological zone of the South - South Nigeria (6^{o} 23' 50'' N and 5^{o} 37' 23'' E) with a mean annual rainfall of 1825 mm.

Source of Experimental Materials

Seeds were obtained from Genetic Resources Centre of the International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria on the 15^{th} of August, 2012. Soils were collected from 2 dumpsites in Benin City namely; NITEL road and CAPITOL dumpsites.

NITEL road dumpsite is located in Government Reservation Area (G.R.A.), Benin City. The land area is about 200 m^2. CAPITOL dumpsite is located behind the Ugbowo campus of the University of Benin, Benin City. The dumpsite occupies an area of about 4,000 m^2. Both dumpsites were composed mainly of municipal and household solid wastes such as waste food items, clothes, paper, broken glasses, rubber cans and polythenes. The control soil was collected from a plot which consisted mainly of Guinea grass (*Panicum maximum*) prior to usage from the Botanical garden of the Department of Plant Biology and Biotechnology, University of Benin. All soil samples collected from the various dumpsites were placed in sterile polythene bags until required for use.

Land Preparation and Sowing

Soil chemical parameters were determined prior to experiment to ascertain the chemical nature of the soil [11]. The dumpsite soils were sundried for 2 weeks prior to usage and afterwards 3 kg of soil of each dumpsite was weighed into nursery polythene bags previously perforated measuring 30 cm in height and 23 cm in diameter. Cow dung (farm yard manure) collected from a cattle shed at the Technical School Road, Ugbowo, Benin City served as amendment in the following proportions; 100.00 % soil and 0 % cow dung, 87.50 % soil and 12.50 % cow dung, 75.00 % soil and 25.00 % cow dung, 50.00 % soil and 50.00 % cow dung. The bags were placed on the field at a spacing of 60 cm x 30 cm as proposed by Okeleye *et al*. [12], amounting to 55,000 stands/Ha.

Planting was done on August 23, 2012 following the methods of Klu *et al*. [13]. Seeds were sown at the rate of 5 seeds per bag and at a depth of about 3 cm [14]. When seedling had attained 2 leaf stage (8 – 15 cm in height), they were thinned down to 2 seedlings per bag. The 2 dumpsites and control soils received amendment with cow dung in four concentrations and had 6 replicates each. A total of 36 bags and 72 plants including control were prepared and used for the experiment.

Plant Survey of Dumpsites

Plant species present at the two dumpsites prior to soil collection were identified and counted.

Growth Performance (Parameters Determined)

Percentage seedling emergence was recorded per dumpsite. Shoot height was measured from the soil level to the tip of the plant using a metre tape. Number of leaves was counted *in situ*. Leaf area was determined using the graph sheet method as described by Eze [15]. Chlorophyll content was determined using the chlorophyll content meter [16].

Experimental Design

The Experimental design used for the experiment was the completely randomized design (CRD) following assumption of homogeneity of the experimental plot in use.

Isolation of Organisms from Rhizosphere Soil

Rhizosphere soil was separated from 5 – 6 roots with the help of a sterile brush into a Petri dish. Ten grams of the soil sample was suspended in 100 ml sterile distilled water in a conical flask and shaking with a magnetic stirrer was done for 15 minutes. The soil suspension was serially diluted up to 10^{-3} using tenfold

dilution. Using pour plate technique, aliquots from each dilution was plated in triplicates on sterile nutrient agar for total heterotrophic bacterial counts and potato dextrose agar for total heterotrophic fungal counts. The nutrient agar plates were incubated aerobically at 37 ° C for 24 - 48 hours to enumerate the aerobes and facultative heterotrophic bacteria. The potato dextrose plates were incubated at room temperature (28 ^{o} C) for 72 hours. After incubation, counts obtained from culture plates were recorded [17].

Microbial counts in rhizosphere soils per gramme of the soil (on a dry weight basis) are calculated by applying the formula: [17].

$$\text{Number of microorganisms / g of soil} = \frac{\text{Number of colonies / plate X dilution factor}}{\text{Dry weight of the soil taken}}$$

The bacterial isolates were identified on the basis of classification schemes published in Bergey's Manual of Systematic Bacteriology [18]. Bacterial isolates were characterized to generic level, and where possible to the species level, on the basis of their cultural characteristics (i.e. colour, shape, edge, elevation, etc), morphological characteristics (Gram-reaction, cell arrangement, and shape) and biochemical characteristics.

RESULTS AND DISCUSSION

Plant Species Composition

A total of 9 (Table **1a**) and 29 (Table **1b**) plants were observed at the CAPITOL and NITEL ROAD dumpsites respectively. The plants of the two dumpsites used in this study are listed based on family groupings according to Aigbokhan [19].

Rhizosphere Microorganisms

Analysis of the rhizosphere soils of the plants grown in dumpsite soils at different amendments showed a total heterotrophic bacterial count ranging from 1.57 x 10^4 to 4.18 x 10^4cfu/g. The total heterotrophic fungal count in the various rhizosphere soils ranged from 5.05 x 10^3 to 1.68 x 10^4cfu/g (Table **2**). Table **2** shows the bacterial and fungal isolates from the rhizosphere soil of *S. stenocarpa* grown in the two dumpsite soils and their frequency of occurrence. *Bacillus* sp., *Pseudomonas* sp., *Penicillium* sp. and *Aspergillus* sp. (100 %) had the highest frequency of occurrence while *Arthrobacter* sp., *Fusarium* sp. and *Mucor* sp. (33.33 %) were the least occurring isolates.

About 2 to 5 % of rhizobacteria, when reintroduced by plant inoculation in a soil containing competitive microflora, exert a beneficial effect on plant growth and are termed plant growth promoting rhizobacteria (PGPR) [20]. PGPR are free-living bacteria and some of them invade the tissues of living plants and cause unapparent and asymptomatic infections [21]. PGPR may induce plant growth promotion by direct or indirect modes of action [22, 23]. Production of stimulatory bacterial volatiles and phytohormones, lowering of the ethylene level in plant, improvement of the plant nutrient status (liberation of phosphates and micronutrients from insoluble sources; non-symbiotic nitrogen fixation) and stimulation of disease-resistance mechanisms (induced systemic resistance) are direct mechanisms for plant growth promotion [9]. Indirect effects originate for example when PGPR act like biocontrol agents reducing diseases, when they stimulate other beneficial symbioses, or when they protect the plant by degrading xenobiotics in inhibitory contaminated soils [24].

Some of the microbes isolated from the rhizosphere soils of the AYB plants grown in the different dumpsite soils were PGPR. Thus, they must have had a bearing on the growth performance and yield (another paper) of the plants in the various soil types.

The frequency of occurrence of *Bacillus* sp corresponds with the work of Garbeva *et al*. [25], which showed that 95 % of Gram-positive bacteria in soil under different regimes (permanent grassland, grassland turned into arable land and arable land) were putative *Bacillus* species. The observation of *Arthrobacter* sp as the least frequently occurring bacteria isolate in this research also conforms to the work of Tzeneva *et al*. [26].

Bacterial isolates such as *Arthrobacter* sp., *Bacillus* sp., *Pseudomonas* sp., and *Enterobacter* sp. usually termed growth promoting rhizobacteria (GPR) have been implicated at different times to be involved in growth promoting activities in plants whose rhizospheric region they colonize. [20]. *Bacillus* spp. is able to form endospores that allow them to survive for extended periods under adverse environmental conditions and have been reported to promote the growth of a wide range of plants [9, 27, 28]; however, they are more effective in the biological control of many plant microbial diseases.

Strains of pseudomonads (*Pseudomonas fluorescens* and *P. putida*) have been shown to induce

Table 1a: Plant Composition in CAPITOL Dumpsite

Plant	Family	Habit	Origin
Amaranthus spinosus	Amaranthaceae	Herb	Exotic
Amaranthus viridis	Amaranthaceae	Herb	Native
Cyperus rotundus	Cyperaceae	Sedge	Cosmopolitan
Euphorbia hirta	Euphorbiaceae	Herb	Native
Ipomea triloba	Convoloulaceae	Vine	Native
Panicum maximum	Poaceae	Grass	Native
Pennisetum pupurum	Poaceae	Grass	Native
Tridax procumbens	Arteraceae	Herb	Exotic

Table 1b: Plant Composition of NITEL ROAD Dumpsite

Plant	Family	Habit	Origin
Ageratum conyzoides	Asteraceae	Herb	Native
Amaranthus spinosus	Amaranthaceae	Herb	Exotic
Amaranthus viridis	Amaranthaceae	Herb	Native
Carica papaya	Caricaceae	Herb	Exotic
Commelina erecta	Commelinaceae	Herb	Exotic
Cromolaena odorata	Asteraceae	Shrub	Exotic
Crotelaria retusa	Fabaceae	Shrub	Native
Cyperus rotundis	Cyperaceae	Sedge	Cosmopolitan
Digitaria horizontalis	Poaceae	Grass	Exotic
Eleusine indica	Poaceae	Grass	Cosmopolitan
Euphorbia heterophylla	Euphorbiaceae	Herb	Exotic
Euphorbia hirta	Euphorbiaceae	Herb	Native
Euphorbia hyssopifolia	Euphorbiaceae	Herb	Exotic
Gomphrena celosioides	Amaranthaceae	Herb	Exotic
Icacina tricanta	Icacinaceae	Vine	Exotic
Ipomoea triloba	Convoloulaceae	Vine	Native
Mimosa diplotricha	Fabaceae	Herb/Vine	Native
Musa sapientum	Musaceae	Herb	Cosmopolitan
Panicum maximum	Poaceae	Grass	Native
Phyllantus amarus	Phyllanthaceae	Herb	Exotic
Phyllantus amarus	Phyllathaceae	Herb	Exotic
Physallis angulata	Solanaceae	Herb	Exotic
Senna occindentalis	Fabaceae	Shrub	Native
Sida acuta	Malvaceae	Shrub	Native
Solenostemum monostachys	Lamiaceae	Herb	Native
Spigellia anthemia	Loganiaceae	Herb	Exotic
Talinum triangulare	Portulacaceae	Herb	Exotic
Tridax procumbens	Asteraceae	Herb	Exotic

Table 2: Total Heterotrophic Bacterial Counts in the Rhizosphere Soil Samples of *S. stenocarpa*

Samples	Mean bacterial count (cfu/g)	Mean fungal count (cfu/g)
Control (0 %)	1.69×10^4	1.05×10^4
Control (12.5 %)	1.89×10^4	1.51×10^4
Control (25 %)	2.17×10^4	1.30×10^4
Control (50 %)	2.48×10^4	1.64×10^4
Capitol (0 %)	1.57×10^4	6.80×10^3
Capitol (12.5 %)	1.67×10^4	8.20×10^3
Capitol (25 %)	3.24×10^4	1.68×10^4
Capitol (50 %)	1.92×10^4	1.45×10^4
Nitel (0 %)	4.18×10^4	5.05×10^3
Nitel (12.5 %)	2.24×10^4	7.65×10^3
Nitel (25 %)	3.11×10^4	7.00×10^3
Nitel (50 %)	2.91×10^4	5.60×10^3

statistically significant increases in yield ranging from 14 to 33 % in *Solanum tuberosum* L. seeds treated with them [29]. Apart from their involvement in yield increase, pseudomonads are well known for their involvement in the biological control of several plant pathogens [9]. Alabouvette *et al.* [30] showed that in addition to non-pathogenic *Fusarium oxysporum*, *P. fluorescens* and *P. putida* are the main candidates for the biological control of fusarium wilts. Thus, the high frequency of occurrence of pseudomonads in this experiment may also have been responsible for the low occurrence of *Fusarium* sp observed in the rhizospheric soil of the plants used in the experiment.

The beneficial effects of these bacteria have been attributed to their ability to promote plant growth and to protect the plant against pathogenic microorganisms [31].

All the benefits of the isolates as mentioned in the literatures reviewed above shows the fact that most of the bacterial isolates were most likely beneficial to the plants as increase was observed in plant mass and productivity with increased bacterial population (Tables **6** and **9**). These suspected PGPR isolated could also be responsible for the fact that none of the plants died from disease infestation throughout the duration of the experiment as they may have been responsible for keeping the population of the pathogenic microbes present in the rhizosphere to the barest minimum.

A number of the isolates in this study were plant growth promoting microorganisms which enhances the growth performance and health of plants. The control plants which had a better growth performance in comparism to the dumpsite grown plants had the highest diversity of these microorganisms that help enhance growth.

Percentage Seedling Emergence

Percentage seedling emergence was only significantly reduced from 86.67± 13.33 % to 100.00 ± 0.00 % in control (top) soil to 60.00 ± 0.00 % to 93.33 ± 6.67 % in Capitol dumpsite soil (Table **3**).

Shoot Height

All through the 6 weeks of observation for shoot height as shown in Tables **5** and **6**, significant differences ($p<0.05$) were observed at the first and sixth weeks after planting. In 1 week after planting (WAP), plants grown in the control soil exhibited higher shoot lengths ranging from 13.75 ± 1.61 cm to 17.17 ± 1.01 cm in the different amendments when compared to the plants grown on the dumpsite soil whose shoot heights ranged from 10.50 ± 0.80 cm to 14.58 ± 0.90 cm. There was no significant difference ($p>0.05$) observed in 2, 3 and 4 WAP both in the different dumpsite soils and control as well as in application of amendments.

In the sixth WAP, there was no significant difference ($p>0.05$) in control plants from the plants grown in the NITEL dumpsite soils as these groups exhibited high shoot length values ranging from 78.33 ± 18.53 cm to 249.50 ± 22.02 cm. However, this was observed to be significantly different from the crops planted on the

Table 3: Distribution and Occurrence of the Microorganisms in the Rhizosphere Soil Samples

Bacterial isolates	Control	NITEL	Capitol
Arthrobacter sp.	+	-	-
Bacillus sp.	+	+	+
*Pseudomonas*sp.	+	+	+
Escherichia coli	+	-	-
Enterobacter sp.	-	-	+
Klebsiella sp.	+	+	-
Staphylococcus sp.	+	+	-
Fungal isolates			
Aspergillus sp.	+	+	+
Mucor sp.	-	+	-
Fusarium sp.	+	-	-
Penicillium sp.	+	+	+
Saccharomyces sp.	-	+	+

+ = Present- = Absent.

Table 4: Percentage Seedling Emergence of *S. stenocarpa* Seeds in Dumpsite Soils

Treatments	Control soil[1]	NITEL[1]	Capitol[1]
0 % FYM	100.00 ± 0.00	80.00 ± 11.55	60.00 ± 0.00
12.50 % FYM	100.00 ± 0.00	86.67 ± 6.67	73.33 ± 6.67
25.00 % FYM	86.67± 13.33	86.67 ± 13.33	93.33 ± 6.67
50.00 % FYM	100.00 ± 0.00	86.67 ± 6.67	80.00 ± 11.55

[1]Values represent mean ± standard error of six determinations.
FYM = Farm Yard Manure.

Table 5: Effects of Dumpsite Soils on Shoot Height (cm) 1 and 2 WAP

Treatments	1 WAP			2 WAP		
	Control [1]	NITEL [1]	Capitol [1]	Control [1]	NITEL [1]	Capitol [1]
0 % FYM	13.75 ± 1.61 [a]	13.75 ± 0.99 [a]	11.08 ± 0.87 [c]	18.33 ± 1.26 [a]	22.17 ± 1.75 [c]	18.42 ± 1.01 [a]
12.50 % FYM	16.08 ± 1.29 [a]	14.58 ± 0.90 [b]	12.00 ± 1.44 [c]	22.17 ± 1.49 [a]	24.50 ± 1.12 [a]	19.50 ± 2.01 [c]
25.00 % FYM	17.17 ± 1.01 [a]	10.50 ± 0.80 [c]	13.50 ± 1.33 [d]	24.33 ± 2.23 [a]	18.83 ± 1.75 [c]	20.83 ± 1.72 [c]
50.00 % FYM	16.02 ± 0.76 [a]	12.33 ± 0.49 [b]	10.75 ± 1.07 [c]	21.83 ± 1.46 [a]	20.67 ± 0.85 [c]	17.00 ± 1.53 [b]

[1]Values represent mean ± standard error of six determinations.
Means with same alphabets as control within the same row do not differ significantly (p>0.05) from the control.
Means with same alphabetical letters within the same row do not differ significantly (p>0.05) from each other.

Capitol dumpsite soil which exhibited shoot length values ranging from 68.67 ± 9.85 cm to 215.83 ± 16.16 cm (Tables **5** and **6**). The implication of these results reported above was that some dumpsite soils improved plant shoot height significantly with increasing amendment while others didn't.

Number of Leaves

No significant difference (p>0.05) was observed in number of leaves in all experimental setups in weeks 1 - 3. However, significant difference (p<0.05) was observed in weeks 4 and 6 in which the number of leaves in some amendments of the plants grown on the NITEL road dumpsite soils was significantly different

Table 6: Effects of Dumpsite Soils on Shoot Height (cm) 3, 4 and 6 WAP

Treatments	3 WAP			4 WAP			6 WAP		
	CONTROL [1]	NITEL [1]	CAPITOL [1]	CONTROL [1]	NITEL [1]	CAPITOL [1]	CONTROL [1]	NITEL [1]	CAPITOL [1]
0 % FYM	20.67 ± 1.38[a]	29.33 ± 4.01 [b]	21.33 ± 1.05[b]	23.67 ± 3.27 [a]	54.83 ± 8.85[c]	30.17 ± 5.71[d]	78.33 ± 18.53[a]	186.33 ± 13.68 [b]	131.50 ± 18.79 [d]
12.50 % FYM	29.17 ± 2.98[a]	32.67 ± 3.45 [b]	21.92 ± 2.15[a]	61.17 ± 15.75[a]	80.00 ± 12.08 [a]	42.50 ± 11.64 [b]	199.00 ± 30.58 [a]	235.67 ± 16.91 [b]	160.50 ± 20.41 [b]
25.00 % FYM	38.83 ± 8.08[a]	21.50 ± 2.14 [b]	28.33 ± 5.51[b]	84.67 ± 15.94[a]	45.17 ± 12.18 [c]	59.67 ± 11.72 [c]	233.17 ± 39.01 [a]	183.33 ± 15.35 [b]	215.83 ± 16.16 [c]
50.00 % FYM	30.50 ± 3.88[a]	24.58 ± 1.38 [b]	20.17 ± 2.02[b]	73.33 ± 13.10[a]	62.00 ± 10.92 [a]	38.67 ± 12.59 [b]	242.67 ± 21.94 [a]	218.17 ± 12.99 [a]	144.83 ± 27.90 [b]

[1]Values represent mean ± standard error of six determinations.
Means with same alphabets as control within the same row do not differ significantly (p>0.05) from the control.
Means with same alphabetical letters within the same row do not differ significantly (p>0.05) from each other.
FYM = Farm Yard Manure.

(p<0.05) from all the other dumpsite soils and control plants as well (Tables **7** and **8**).

Leaf Area and Chlorophyll Content

Leaf area (LA) was observed to be significantly different (p<0.05) from the control plants. Leaf area was observed to be highest in the control plants with a range of 37.18 ± 3.68 cm^2 to 68.24 ± 4.59 cm^2. Leaf area was observed to increase with corresponding increase in amendment (cow dung) in all dumpsite soils and control soil respectively as shown in Table **8**. Introduction of nitrogen (which helps in the vegetative growth of plants as well as leaf formation) to the soils from amendment may be responsible for this increase. This is in line with the work of Ikhajiagbe, [32], who showed that AYB exhibited an increase in LA with increase in nitrogen supplied to plants.

Nitrogen is a chlorophyll component and it promotes vegetative growth and green colouration of foliage which is important in the process of photosynthesis. Although, no significant differences (p>0.05) were observed amongst the plants grown on the dumpsite soils and control plants (Table **9**), it was observed that there was profound increase in chlorophyll contents of the plants in this experiment when compared to the

Table 7: Effects of Dumpsite Soils on Number of Leaves 1 and 2 WAP

Treatments	1 WAP			2 WAP		
	Control	NITEL	Capitol	Control	NITEL	Capitol
0 %FYM	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	5.00 ± 0.00 [a]	5.00 ± 0.00 [a]	5.60 ± 0.60 [b]
12.50 %FYM	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	5.00 ± 0.00 [a]	5.00 ± 0.00 [a]	5.60 ± 0.60 [b]
25.00 %FYM	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	5.00 ± 0.00 [a]	5.00 ± 0.00 [a]	5.00 ± 0.00 [a]
50.00 %FYM	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	2.00 ± 0.00 [a]	4.83 ± 0.17 [a]	5.50 ± 0.50 [b]	5.00 ± 0.00 [c]

[1]Values represent mean ± standard error of six determinations.
Means with same alphabets as control within the same row do not differ significantly (p>0.05) from the control.
Means with same alphabetical letters within the same row do not differ significantly (p>0.05) from each other.

Table 8: Effects of Dumpsite Soils on Number of Leaves 3, 4 and 6 WAP

Treatments	3 WAP			6 WAP			4 WAP		
	Control	NITEL	Capitol	Control	NITEL	Capitol	Control	NITEL	Capitol
0 % FYM	7.50 ± 0.50 [a]	7.83 ± 0.17[a]	7.60 ± 0.40[a]	14.17 ± 2.79[a]	27.83 ± 1.60[b]	28.20 ± 3.10[b]	8.83 ± 1.74[a]	12.83 ± 1.72[c]	13.6 ± 1.29[c]
12.50 % FYM	8.00 ± 0.00 [a]	7.50 ± 0.50[b]	8.00 ± 0.00[a]	38.00 ± 5.42[a]	33.83 ± 3.31[a]	36.60 ± 3.04[a]	16.67 ± 3.19[a]	17.33 ± 2.08[b]	18.40 ± 2.02[b]
25.00 % FYM	8.00 ± 0.00 [a]	7.17 ± 0.54[b]	8.00 ± 0.00[a]	37.33 ± 7.35[a]	35.17 ± 3.42[a]	35.40 ± 1.44[a]	17.83 ± 3.53[a]	15.17 ± 1.40[b]	17.20 ± 0.66[b]
50.00 % FYM	8.33 ± 0.00 [a]	8.50 ± 0.92[a]	7.40 ± 0.60[b]	34.33 ± 1.78[a]	38.00 ± 2.61[a]	32.40 ± 4.76[c]	18.00 ± 1.75[a]	19.67 ± 1.45[a]	15.00 ± 2.41[b]

[1]Values represent mean ± standard error of six determinations.
Means with same alphabets as control within the same row do not differ significantly (p>0.05) from the control.
Means with same alphabetical letters within the same row do not differ significantly (p>0.05) from each other.
FYM = Farm Yard Manure.

Table 9: Effect of Dumpsite Soils on Leaf Area (cm^2) and Chlorophyll Content of *S. stenocarpa*

Treatments	LEAF AREA (cm^2)			CHLOROPHYLL CONTENT		
	Control	NITEL	Capitol	Control	NITEL	Capitol
0 % FYM	37.18 ± 3.68 [a]	13.88 ± 2.18 [c]	36.16 ± 3.79 [a]	8.85 ± 1.64 [a]	9.68 ± 1.01 [b]	8.35 ± 0.81 [a]
12.50 % FYM	64.04 ± 3.77 [a]	25.40 ± 2.58 [b]	38.87 ± 1.97 [b]	10.28 ± 0.86 [a]	9.55 ± 0.92 [c]	9.93 ± 0.80 [a]
25.00 % FYM	59.05 ± 4.76 [a]	42.14 ± 5.46 [b]	52.82 ± 7.31 [b]	10.13 ± 1.23 [a]	11.47 ± 1.17 [b]	9.95 ± 0.86 [a]
50.00 % FYM	68.24 ± 4.59 [a]	42.18 ± 7.13 [b]	39.89 ± 3.60 [b]	9.93 ± 1.38 [a]	10.82 ± 1.51 [c]	8.97 ± 0.97 [b]

[1]Values represent mean ± standard error of six determinations.
Means with same alphabets as control within the same row do not differ significantly ($p>0.05$) from the control.
Means with same alphabetical letters within the same row do not differ significantly ($p>0.05$) from each other.
FYM = Farm Yard Manure.

work of Ikhajiagbe, [32] who reported total chlorophyll content ranging from 3.26 ± 0.11 mg/g to 3.50 ± 0.07 mg/g in African yam bean plant supplemented with N, P and K nutrients.

In effect, growth performances of *S. stenocarpa* in the dumpsite soils without amendment were better when compared to those grown in control soils without amendment. Also plants grown on the CAPITOL dumpsite soil had a greater performance than the plants grown on the NITEL road dumpsite soil without amendment. However, with the introduction of amendment, both the plants grown in the NITEL dumpsite soil and the control (top) soil did significantly ($p < 0.05$) better than the plants grown on the capitol dumpsite soil.

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Received on 27-05-2014 Accepted on 25-07-2014 Published on 19-08-2014

http://dx.doi.org/10.6000/1927-5129.2014.10.47