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Morphological alterations due to Spent Carbide Waste Pollution of *Sphenostylis stenocarpa* and *Vigna unguiculata* growth and development

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Abstract

The ability of *Sphenostylis stenocarpa* (Harms) and *Vigna unguiculata* (L.) to grow and develop in spent carbide waste (SCW) polluted soil of different concentrations was investigated in Port Harcourt, Nigeria. *Sphenostylis stenocarpa* (Harms) and *Vigna unguiculata* (L.) are tropical food crops usually known as African Yam Bean (AYB) and Cowpea (CP) respectively. The experiment was arranged in Randomized Complete Block Design, replicated five times. Four levels (0 g, 50 g, 100 g and 150 g) of spent carbide were used. Plant height, stem girth, number of leaf and leaf area were measured and recorded on weekly interval. Average nodule, total fresh weight and total dry weight were determined 12 weeks after planting (WAP). The study revealed that spent carbide waste (SCW) adversely affected the morphology of the two crops, *Sphenostylis stenocarpa* and *Vigna unguiculata* resulting in significant ($p < 0.05$) reduction in plant height, leaf area, stem girth and number of leaf. Also, significant ($p < 0.05$) reduction in nodule count and bio-mass (total dry weight) in the two crops occurred when compared to their controls.

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Introduction

Undesirable substance in any segment of the environment is primarily due to human activities that enhances everyday life. The aftermath of such feats always result in environmental pollution (Kayode *et al.*, 2009; Santra, 2012). In addition to the pollution occasioned by crude oil and refined oil spill, disposal of spent carbide waste (SCW) is another form of pollution which has enjoyed little attention from literature publications (Tanee and Ochekwu, 2010). SCW is a by-product from the use of calcium-carbide to generate acetylene gas, which in the presence of oxygen produces oxy-acetylene flame. This is employed by panel beaters in the metal weldering processes (Lavoie, 1890; Encarta, 2009; Ihimikaiye and Tanee, 2013). It is a grayish white steeped substance with garlic like odour that are often dumped carelessly by panel-beaters and related artisans at vacant plots and make-up-dump-sites by the side of their workshops. As time elapses, the waste gets integrated into the soil by agents of erosion, water and wind.

Sphenostylis stenocarpa and *Vigna unguiculata* (L) are annual leguminous crops grown in African regions (Saxon, 1981; Amoatey *et al.*, 2000; Klu *et al.*, 2001). *Sphenostylis stenocarpa* (Harms) and *Vigna unguiculata* (L.) are commonly known as African Yam Bean (AYB) and Cowpea (CP) respectively.eaten by human or used as feeds and fodder for livestock due to their high protein content (Ogbuechi *et al.*, 2011; Adewale and Odoh, 2013). Growth and development of plants have been depleted due to the impact of pollutants in many regions of the world (Emersion, 1983). Peck (1968) reported that SCW is toxic for biota and harmful to cave ecosystem, and the surrounding environment. Tanee and Ochekwu (2010) observed that the shoot root ratio of *Zea may* and groundnut in SCW pollution increased with increase SCW concentration. In a field experiment conducted by Keerthisinghe *et al.* (1996) to investigate the effect of encapsulated CaC_2 on growth and yield of rice crop, it was observed that CaC_2 slowed down the release of nitrate from the applied urea, which might help in improving nitrogen use efficiency, the encapsulated CaC_2 released large amount of acetylene that was slowly reduced to ethylene. The present study was undertaken in order to determine the morphological alterations due to SCW pollution of *Sphenostylis stenocarpa* and *Vigna unguiculata* (L) growth and development.

Materials and methods

The study was carried out at the demonstration screen house of agriculture department beside Ofrima building complex University of Port Harcourt. Seeds of *Sphenostylis stenocarpa* (Ss) and *Vigna unguiculata* (Vu) used for the study were purchased from a local market in Port Harcourt Nigeria. The SCW used was obtained from a panel beater workshop along NTA road Port Harcourt, Nigeria. This was sundried for seven days to get rid of water, so as to obtain the actual weight and afterward pulverized for homogeneity. The soil sample, top sandy loam soil used was collected from a fallowed land in the University of Port Harcourt demonstration farm. The sandy loam soil collected was filled into 40 perforated planting bags at 5 kg per bag on a scale calibrated in kilogram. SCW (0 g, 50 g, 100 g and 150 g) were measured respectively, thoroughly mixed with hand trowel to enhance uniformity with the soil and replicated five times.

The polluted soil was watered and left for one week after which four seeds of Ss and Vu were planted in each bag (at a distance of 2 cm apart) per treatment in the two units respectively, which was thinned down to two seedlings per bag a week after germination. Data were collected on the following; plant height, leaf area, stem girth, number of leaf, biomass (Total fresh weight and total dry weight) and nodulation count. Data on plant height, stem girth, leaf number and leaf area were measured and recorded on weekly basis. Plant height was determined with the aid of a measuring tape calibrated in centimeters, from the soil level to each plant terminal buds. Stem girth was taken by placing venier caliper at 1 cm above soil level of the crops stems and adjusted to scale the same point was maintained till the end of the experiment to ensure accurate reading. The leaves produced were counted every 7 days. At the end of the experiment, the root was harvested by scattering loose the potted plants and nodules were harvested and carefully counted. The harvested shoot and root of the plants were air-dried until constant weights were obtained and subsequently weighed on an electronic (SF-400c) compact scale.

Statistical analysis

All data obtained were subjected to analysis of variance (ANOVA) and standard error means (SEM) using Microsoft Excel version 2007. Least significance difference was used to separate means according to Ogbeibu (2005).

Results

The responses of Ss and Vu to SCW polluted soil are concentrations and time dependent. Results obtained indicated that both crop suffered set back in terms of growth, development and yield, especially, in treatments with higher levels of pollutant few weeks after germination. The shoot heights of Ss and Vu in different concentration of SCW are shown in Figure 1a and 1b. Height Vu that

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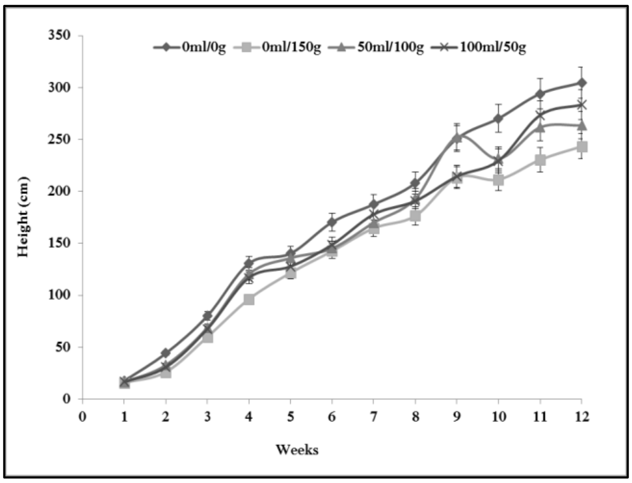

Figure 1a: Height of *S. stenocarpa* (AYB) in SCW treatment

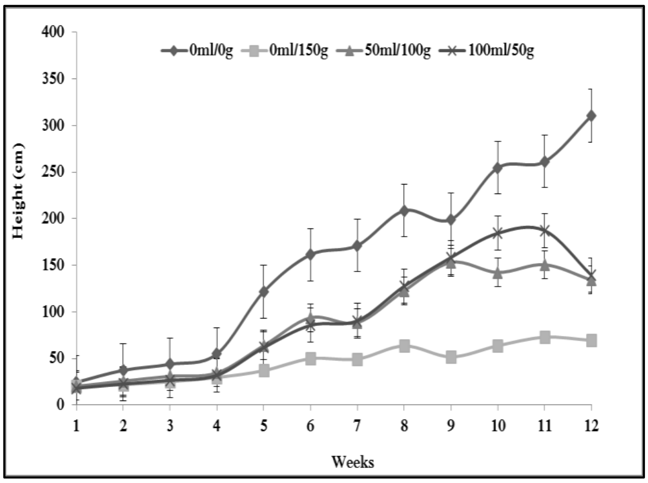

Figure 1b: Height of *Vigna unguiculata* (CP) in SCW treatment

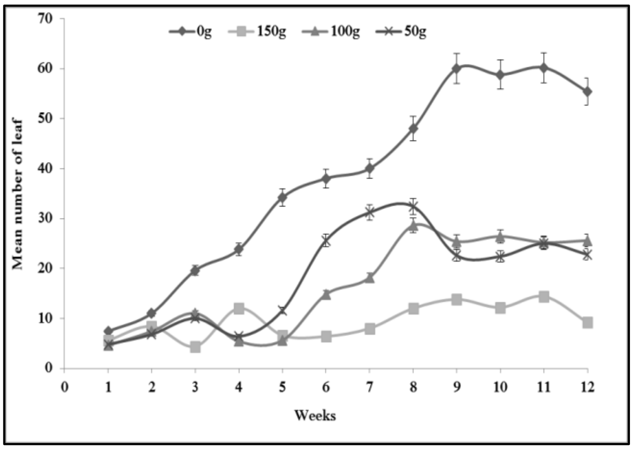

Figure 2a: Number of leaf on *Vigna unguiculata* (CP) in SCW treatment

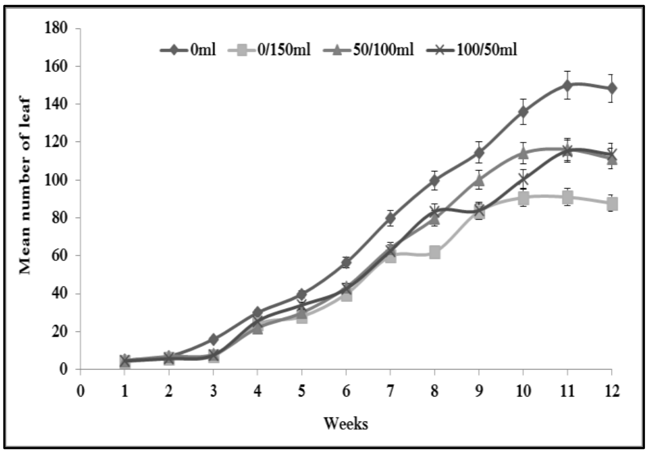

Figure 2b: Number of leaf on *S. stenocarpa* (AYB) in SCW treatment

received 50 g of SCW pollution were significantly different from that of Vu in the control experimental set ups ($p < 0.05$). Ss and Vu grown in 100 g and 150 g of SCW were likewise significantly different compared to those grown in 50 g of SCW at 12 weeks after planting (WAP) ($p < 0.05$). The plant girth of Vu and Ss are shown in Figure 2a and 2b.

At the initial stage, the stem girths of Vu in the control and the various treatments (50 g, 100 g and 150 g) increased rapidly in relation to increase in weeks, though at different rate. However, significant reduction occurred in stem girth of Vu in 100 g and 150 g when compared to the control ($p < 0.05$) experiment. The stem girth of Ss that received low concentration (50 g) of SCW was significantly different from the stem girth of Ss in higher concentrations of SCW ($p < 0.05$). In Figure 3a and 3b, statistical differences occur in the number of leaf on Ss and Vu in the different level of SCW pollution at 12 weeks after planting (WAP). The number of leaves on Ss at 50 g SCW was fewer than those on Ss at 0 g; number of leaf on Vu at 50 g, 100 g and 150 g were significantly different ($p < 0.05$) compared to Vu at 0 g. Similarly, significant ($p < 0.05$) reduction in number of leaves was noticed in Ss grown in 100 g and 150 g SCW compared to the control experiment. Constant shedding of leaves was noticed in the plants (Ss and Vu), which received higher concentrations (100 g and 150 g) of SCW.

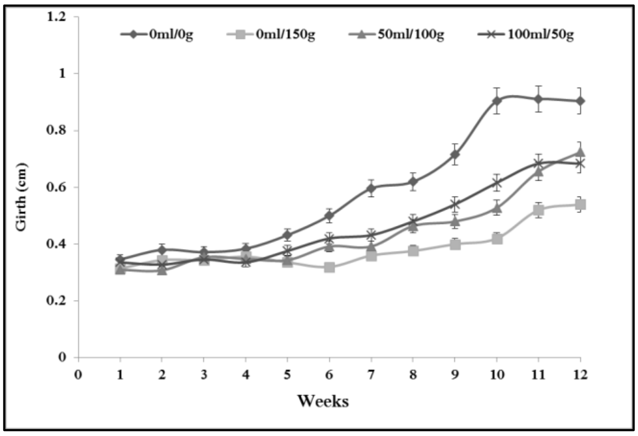

Figure 3a: Performance of *S. stenocarpa* (AYB) girth in SCW treatment

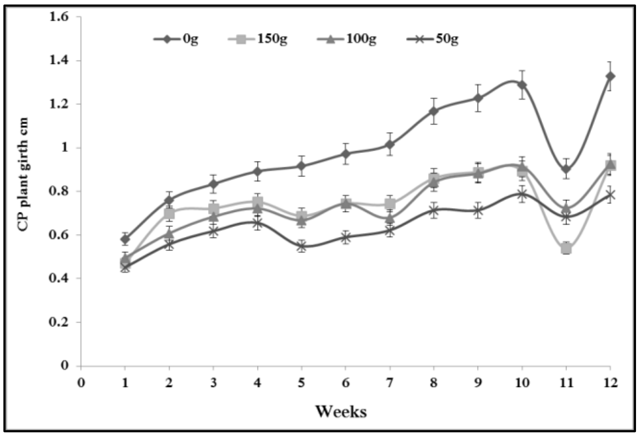

Figure 3b: Performance of *Vigna unguiculata* (CP) girth in SCW treatment

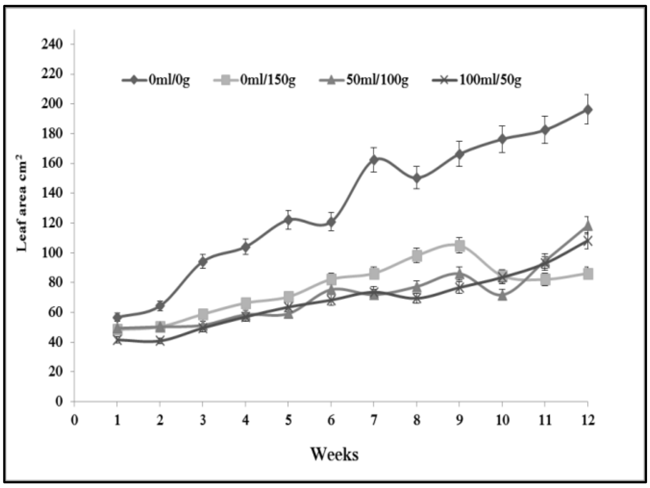

Figure 4a: Performance of S. stenocarpa (AYB) leaf in SCW treatment

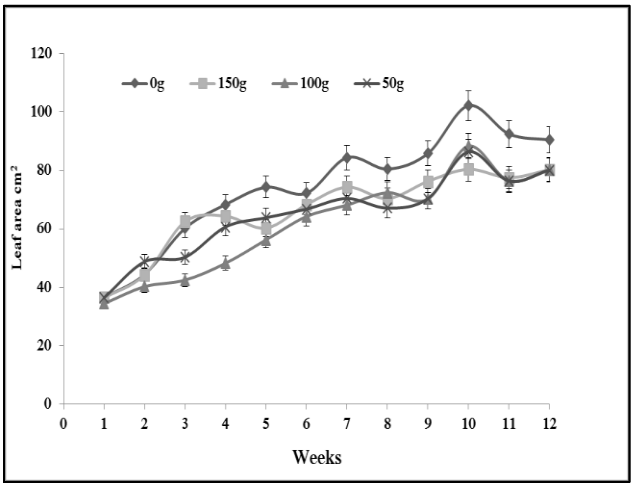

Figure 4b: Performance of *Vigna unguiculata* (CP) leaf in SCW treatment

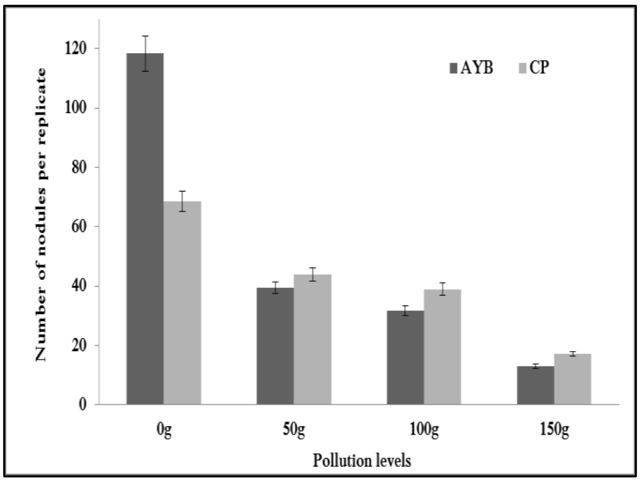

Figure 5: Average nodule of *S. stenocarpa* (AYB) and *Vigna unguiculata* (CP) in the various SCW treatment

The leaf areas of Ss as well Vu in treatments (Figure 4a and 4b) with 50 g, 100 g and 150 g respectively were significantly different ($p < 0.05$) compared to the leaf areas of Ss and Vu in unpolluted soil respectively. In Figure 5, result shows that the nodule levels of Ss and Vu varies inversely with the level of SCW pollution. The nodule levels of Ss and Vu in the controls were significantly different ($p < 0.05$) compared to the nodule levels of Ss and Vu in 50 g, 100 g and 150 g respectively. It was also observed that SCW at higher concentration reduced the nodule levels of the crops. The same patterns were observed in biomass (total fresh weight and total dry weight) of Ss and Vu (Figure 6 and 7).

Discussion

Morphological alteration of *Sphenostylis stenocarpa* and *Vigna unguiculata* in SCW contaminated soil was investigated. The result revealed that SCW significantly affected the aerial parts (plant height, stem girth, number of leaf and leaf area) of Ss and Vu at high concentration resulting in stunted growth. One of the most likely justifications for the pattern of growths observed was unsatisfactory soil condition (Tanee, 2011; Ekpo *et al.*, 2012).

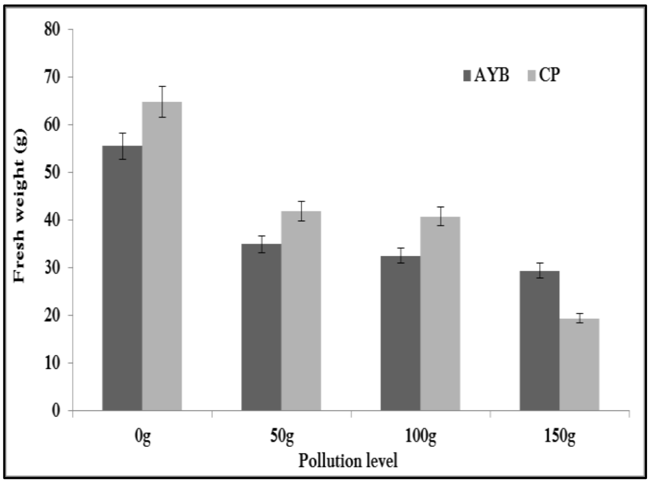

Figure 6: Total fresh weight of *S. stenocarpa* (AYB) and *Vigna unguiculata* (CP) in SCW treatment

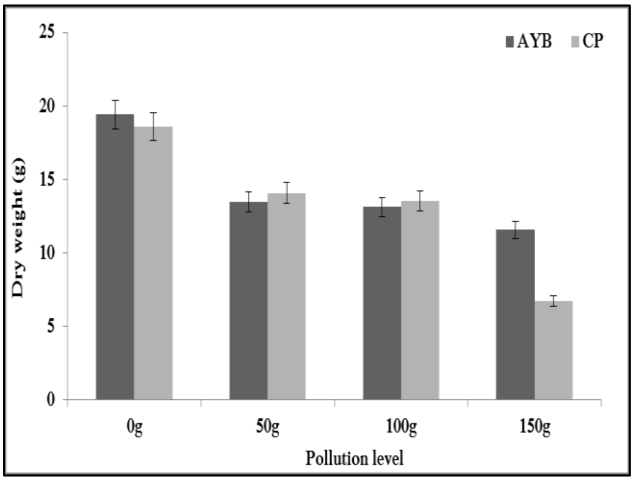

Figure 7: Total dry weight of *S. stenocarpa* (AYB) and *V. unguiculata* (CP) in SCW treatment

The impacts of SCW on the two crops were concentration dependent. Vu showed mark reduction in growth than Ss, indicating that the effect of SCW in soil was severe on Vu than Ss. Reduction in height and girth of the crops with respect to concentration of SCW was likely due to water deficit which impeded nutrient uptake (Adenipekun *et al.*, 2009). This agreed with Saif *et al.* (2007) report, where Okra plant showed a classical triple response to calcium carbide application i.e. reduction in plant height, hook formation of green pod and reduction in internodal distance.

Data of Ss and Vu girths indicated that the crops were not significantly affected at lower concentrations; this implies that Ss and Vu can endure low concentrations of SCW. Constant shedding of leaves on crops in contaminated soil caused reduction in the number of leaves on the crops; this might have resulted from high SCW in soil which immobilized water uptake (Kinako and Amadi, 1997). It is also clear from the data that reduction in the number of leaves were responsible for the reduction in leaf area.

The result of nodulation levels revealed that morphological disorder in the nodulation count of Ss and Vu was concentration dependent of SCW, this indicated that SCW hindered nodule formation and encumbered the activities of microbes in the polluted soil. Vigorous growths recorded at Ss and Vu in the control experiment juxtaposed the high levels of nodulation yielded in the control. Thus, it would be logical to assert that reduction in nodules formations were mainly due to reduction in plant height which also depended on the pollutant concentration.

Reduction in biomass (total fresh weight and total dry weight) of the plant in high concentrations of SCW might be due to poor absorption of nutrient (Sharifi *et al.*, 2007). SCW in the soil might be responsible for the poor nutrient uptake, hence the morphological disorder observed in the crops. In conclusion, this study has demonstrated that Soil contaminated with SCW becomes unsuitable for *Sphenostylis stenocarpa* and *Vigna unguiculata* growth and development. The effects became visible as necrosis, wilting and stunted growth particularly in plants that received high concentrations. Therefore indiscriminate disposal of SCW should be discouraged by the users and better ways of disposing the waste should be sorted out.

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