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Effect of Spent Calcium Carbide Waste on the Growth Indices of Cowpea (*Vignaunguiculata*L. Walp)

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Abstract: *The adverse effect of different concentration of spent calcium carbide waste on the growth indexes of cowpea (Vignaunguiculata L. Walp) was studied at a screen house inThe Federal University of Technology Akure, Nigeria. The crop was planted in spent calcium carbide waste concentration of 100g, 200g and 300g per 5kg of soil alongside a control in experimental pots, each was replicated four times. Results indicate that spent calcium carbide waste had a significant adverse effect on plant height, number of leaves, leaf area, fresh and dry shoot and root biomass especially at 200g and 300g spent calcium carbide waste concentrations. Result showed that cowpea had highest yield in total number of leaves (124.50±2.69), leaf area (73.11±2.0cm^2), fresh shoot weight (122.33 ±3.01g) and dry shoot weight (33.28±3.01) at 100g concentration of spent calcium carbide waste to that of 200g and 300g although not significantly different to that of control. It can therefore be concluded that cowpea can tolerate spent calcium carbide at low concentration (100g) not at higher concentration (200g and 300g)*

Keywords*: Carbide waste; pollution;Vignaunguiculata; Phytotoxicity.*

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I. Introduction

Calcium carbideis a chemical compound with the chemical formula of CaC_2. It is majorly used industrially in the production of acetylene and calcium cyanamides(Patnaik 2003). Pure calcium carbide is a white crystalline substance. The Chemistry dictionary (2004), noted that modern industrial synthesis of CaC_2involves high-temperature combustion of a mixture of calcium oxide and coke.

Carbide is generally used by welders for their welding activities. Cavers also use carbide as a form of lightning in the caves. As a cultural practice in Nigeria, people use carbide to aid ripening of fruits like mango, pear and plants like banana and plantain. As a result of these uses, carbide waste is constantly generated and is indiscriminately disposed into the environment. According to Dunbabin (1992), generated wastes are disposed into the environment without adequate treatment thereby leading to nutrient de-enrichment and the accumulation of toxic compounds in biomass and sediments.

For many years cavers believed that the use of calcium carbide was harmless for human health and the environment. That commonly-held view was substantiated by the fact that the waste's main chemical compound is calcium hydroxide $Ca(OH)_2$,which reacts over time with atmospheric carbon dioxide to form non-toxic calcium carbonate (Semikolennkykh, 2012).

Kinako and Amadi (1997) observed a significant adverse effect of spent calcium carbide on water infiltration, vegetation regeneration and biomass accumulation of plants. In a pot experiment conducted by Ahmed *et al*. (2006) to investigate the effect of calcium carbide on the growth of rice, wheat and cotton, it was observed that encapsulated calcium carbide released large amount of acetylene that that was slowly reduce to ethylene. This they observed slowed down the release of nitrate from the applied urea which helps in improving nitrogen use efficiency.

With the indiscriminate disposal of carbide waste generated by panel beaters and welders, it is imperative that the impact this waste will have on plants be studied. This study therefore was designed to investigate the adverse effects of spent calcium carbide waste on the growth indexes of cowpea plant (*Vignaunguiculata*L.Walp).

II. Materials and Methods

Study Area: The experiment was conducted at a screen house besides academic building of Federal University of Technology Akure, between July and September 2014.

Source of Study Materials:The seeds of local cowpea (*Vignaunguiculata*L.Walp) Var. oloyin used for this study were obtained from the Agricultural Development Programme(ADP) Akure Ondo State, Nigeria. The Var.

Oloyin is a lightly brown variety of *Vignaunguiculata* with a brown helium plate. The spent calcium carbide used as the pollutant was obtained at a dump site close to a panel-beater workshop located at FUTA junction, Akure.The top soil was obtained from a fallow site close to the University Academic Building; the site has no recorded incidence of carbide contamination.

Soil Preparation:Top soil was dug from a depth of 1 – 30cm; it was bulked, homogenized and filtered through a 2mm mesh. 5 kg of the top soil was weighed using triple beam balance and placed into experimental pots. Spent calcium carbide was sun dried and milled into finer particles and weighed 100g, 200g, and 300g respectively, thereafter; the weighed carbide was homogenized with the top soil in the pots at 100g, 200g, and 300g respectively.A pot containing no carbide served as the control. The whole experiment was replicated four times.

Experimental Design:The polluted pots were labelled according to the amount of carbide they contain as well as the control pots. The pots were wet and left for a week before planting. This was to allow for proper mixing of the carbide waste and the soil before planting. The pots were arranged using complete randomized design (CRD) system and each treatment is represented at each row. After a week, the seeds were planted and two seeds sown in five places in each pot.

Data collection:The planting date was recorded, and as they began to germinate the percentage germination was determined. This was done using the formula:

$$\frac{number of germinated plants}{number of sowed plants} x\ 100$$

Seedlings from each pot were thinned to only one plant per pot after 2 weeks of planting. The plants were watered regularly and plant height, leaf area, and number of leaves were taken at two weeks interval for a period of 12 weeks. The plant height was determined by the use of a tape rule in centimetres while the number of leaves was determined by physical counting of the leaves from the shoot tip to the base.To determine the leaf area, lamina length (L) and maximum width (W) of each leaflet was measured with a ruler to the nearest millimetre. Leaf area was then calculated as the product of the length, width and a factor (F) determined for each type of leaflet. The F value was determined to be 0.68. i.e. 0.68 x L x W (Akyeampong, 1985).

Post-harvest analysis:After 12 weeks of observation, the plants were uprooted carefully to ensure minimum root-cut. The roots were washed to remove soil attached to them. The plant samples were transported to the laboratory where the fresh weights were determined. The roots were cut off from the stem and were weighed differently using a digital sensitive balance at resolution ± 0.000g. Thereafter, the samples (shoots and roots) were wrapped in a foil and dried in a Gallenkamp drying cabinet at 80^{o}C for two days. The dry weights of the dry roots and shoots were measured using the same sensitive balance at resolution ± 0.000g.

Data analysis:Data on the percentage germination, growth rate, number of leaves, leaf area, fresh shoot and root biomass and dry shoot and root biomass were statistically analysed using Tukey's Honestly Significant Test in Statistical Package for Science Student (SPSS) software. Means were compared at 5% probability.

III. Results and Discussion

The result of the effect of spent calcium carbide waste on the growth indices of *V. unguicultaa*re shown in figures 1 to 7. There was no significant difference (p≤0.05) in the percentage germination of the plant although differences do exist. The highest percentage germination was recorded in the control pot (50.00 ±3.3); this was closely followed by cowpea plants grown in 100g concentrate of spent calcium carbide (45.00 ±3.0).

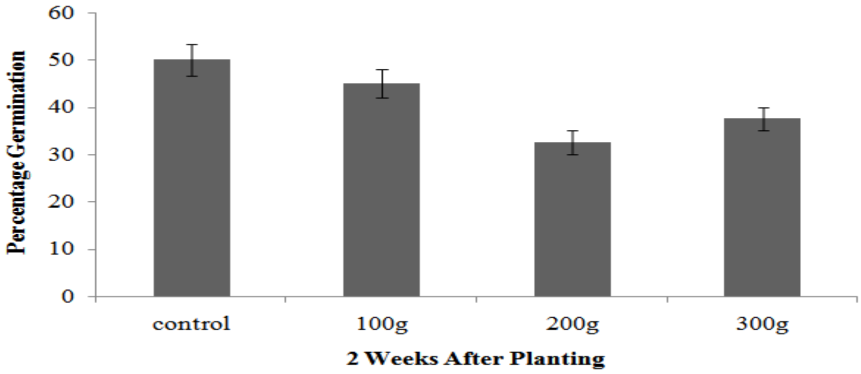

Fig 1: Percentage germination of cowpea on soil polluted with spent calcium carbide waste 2 weeks after planting.

Significant reduction ($p \leq 0.05$) in plant height was observed especially at higher concentrations of carbide waste. At the 10th and 12th week after planting (WAP), control plants and those grown in 100g concentration of carbide waste had significantly higher ($p \leq 0.05$) height than those grown in 200g and 300g respectively. This reduction in plant height at higher concentrations of carbide waste might be due to low level of nitrate present in the soil. This is in agreement with the findings of Berg *et al*., (1992) that acetylene gas (a product of reaction of calcium carbide with water) might inhibit nitrification process in soil. Nitrate will be lost more in high concentrated areas of calcium carbide waste. There are recorded cases of CaC_2 wastes being used as denitrificator in soil (Frankenberger, 2002).

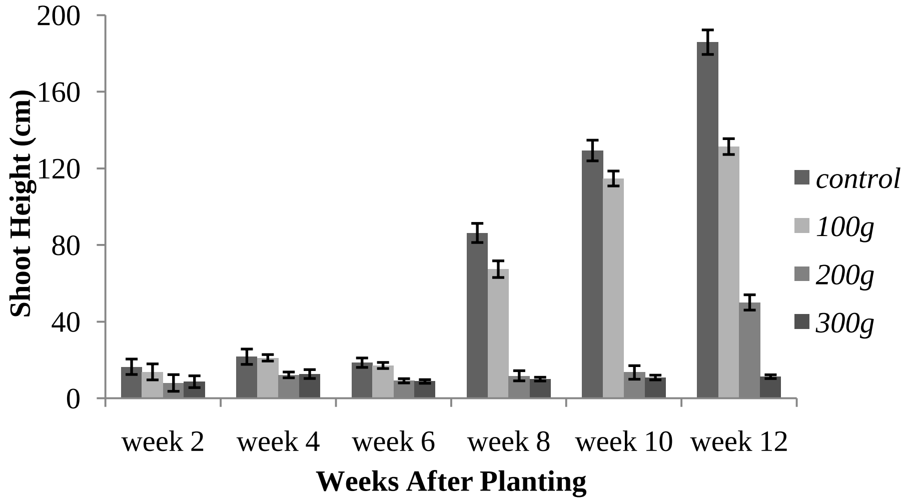

Fig 2: Effect of calcium carbide waste on cowpea plant height.

The result of the effect of spent calcium carbide waste on the total number of leaves is shown in figure 3. At the early stage of development of leaves (2-4 weeks after planting), it was observed that there was no significant difference($p \leq 0.05$) among the concentrations and the control. At 6 WAP, the number of leaves at 100g pollution was not significantly different ($p \leq 0.05$) from that of control. However, in 200g and 300g concentrates;increasedleaf fall was observed leading to a significant decrease ($p \leq 0.05$) in number of leaves.This trend continued till 12 WAP where there was a remarkable increase in the number of leaves in cowpea plants grown in 100g concentrate. This was the highest number of leaf obtained.

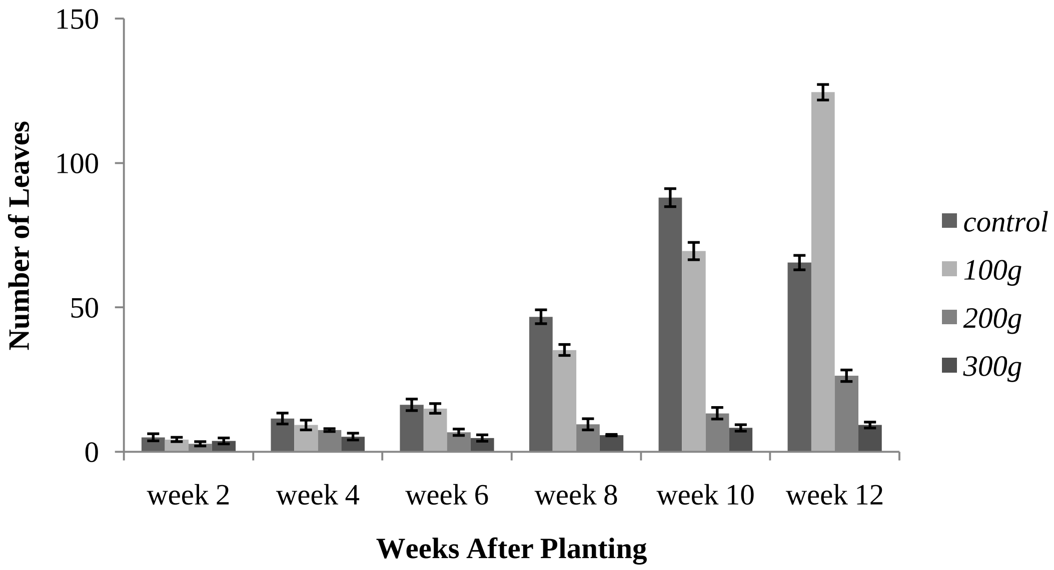

Fig 3: Effect of carbide waste on the number of leaves cowpea.

The result of the effect of spent calcium carbide waste on leaf area of cowpea is shown in figure 4. Leaf area was significantly higher ($p \leq 0.05$) in the control and plants in 100g concentrate when compared with those of 200g and 300g. From 6 WAP, cowpea plants grown in 100g concentrate of carbide waste had the highest leaf area although this was not significantly different ($p \leq 0.05$) from the control. This is in conformity with Abiya *et al.* (2015) that leaf area of Okra plants grown in 100g concentrate of spent carbide was significantly higher than those grown in 200g and 300g respectively.

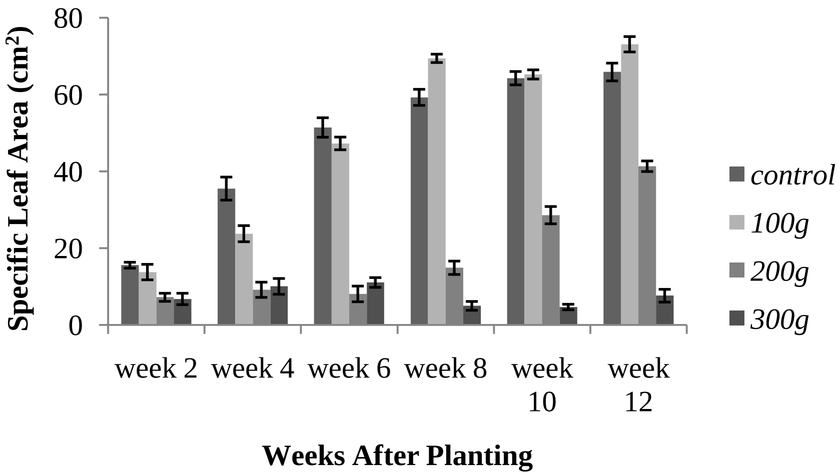

Fig 4: Effect of carbide waste on leaf area of cowpea.

Fresh root, dry shoot and dry root biomass were significantly higher ($p \leq 0.05$) at the control than 200g and 300g concentrates, although the difference was not significant ($p \leq 0.05$) when compared to 100g concentrate. This may be due to phytotoxicity of high level of spent carbide in the soil, this is in agreement with Tanee and Ochekwu (2010) that spent calcium carbide waste had significant ($p \leq 0.05$) adverse effects on dry weight of maize and groundnut especially at higher level of carbide waste concentrations. They concluded that maize and groundnut can tolerate carbide waste pollutant at lower concentration but the phytotoxicity can be high at higher concentration.

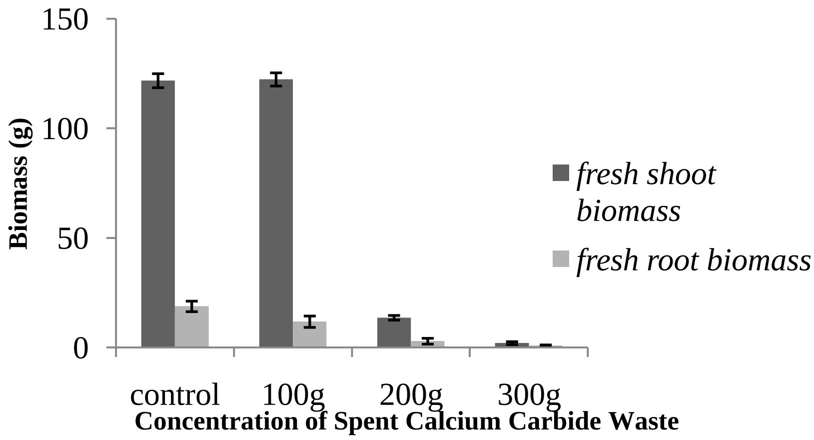

Fig 5: Cowpea shoots and roots biomasses in soil polluted with different concentration of spent calcium carbide waste from week 2 to week 12.

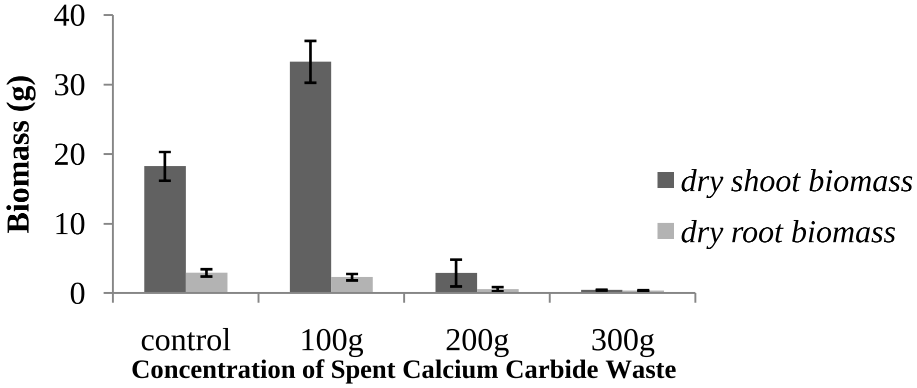

Fig 6: Cowpea shoots and roots biomasses in soil polluted with different concentration of spent calcium carbide waste from week 2 to week 12.

As was observed from the results, the negative impact of carbide waste on the growth indices was lesser in cowpea plants grown in 100g concentration of the waste.This can be explained by results from Kashniff*et al.*(2007)that acetylene released in carbide polluted soil was directly proportional to the level of carbide used. Knowing that acetylene inhibits nitrogen, it means that the higher the concentration of carbide used the higher the rate of inhibition.The decrease in all indices at the 200g and 300g concentrates confirms earlier studies that phytoxicity increases with increasing concentrations of carbide waste (Abiya *et al.,* 2015; Tanee and Ochekwu, 2010; Achuba, 2006).

IV. Conclusion

The results of this study show that spent calcium carbide waste have adverse effects on the growth indexes of cowpea especially where it is at high concentration. 200g and 300g of this pollutant in 5kg of soil has led to poor plant growth, reduction in the shoot and root biomass, reduction in leaf area and total number of leaves which amount to low rate of photosynthesis. However, cowpea can withstand low amount of this pollutant in the soil. This study has shown that 100g concentrate did better than the uncontaminated soil.

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