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Effect of calcium carbide waste on the growth and biomass of Okra*(Abelmoschus esculentus* l. Moench)

*Abiya, S.E., Odiyi, B.O. and Salau, I.O.
Department of Biology, Federal University of Technology, Akure, Nigeria.

Abstract:*The effects of different concentration of spent calcium carbide on the growth indexes (percentage germination, plant height, leaf area, number of leaves, and plant biomass) on okra (Abelmoschus esculentus) were studied at a screen house located beside the academic building of the Federal University Of Technology, Akure, Nigeria. 5kg of soil was polluted with varying concentrations of spent carbide (100g, 200g and 300g) with the control having 0g of spent carbide. Okra seed were introduced and completely randomized design was used. The whole experiment was replicated 4 times. Result indicates that the plants grown in 100g spent carbide polluted soil did better in terms of plant height when compared to other treatments and the control. At 8 weeks after planting (WAP), 100g concentration had the highest possible mean plant height (38.25±1.59) while the control recorded (25.78±1.76). This height was significantly higher ($p<0.05$) than 300g concentration (8.75±1.53) which was the lowest. Number of leaves was also significantly higher ($p<0.05$) in 100g plants (5.75±1.18) than 300g plants (1.75±1.18). Dry weight was not significantly different ($p<0.05$) although 100g plants had the highest of the treatments (5.97±1.11).Other growth indexes show okra plants in 100g polluted soil performing better than other treatments and control. This growth reduces drastically as the concentration of spent calcium carbide increases above 100g concentration level of spent calcium carbide. This shows that okra (Abelmoschus esculentus) grows well in low concentration of spent carbide.*
Keywords: *Abelmoschusesculentus, concentration, pollution, spent carbide.*

I. Introduction

Calcium carbide (CaC_3) is a chemical compound used industrially in the production of acetylene and cyanamide [1]. Carbide waste is a by-product from the use of calcium carbide to generate acetylene gas. The acetylene gas in combination with oxygen produces oxyacetylene flame used by panel beaters and welders for welding and fabrication work. This waste product is whitish or grayish in colour and has high pH (alkaline). After the welding work, these wastes (carbide waste) are usually dumped carelessly in the environment which sooner or later gets incorporated into the soil. Calcium carbide is also used by cavers as a source of caving fuel acetylene [2].As a result of this use, large deposit of spent carbide is usually left by some cavers anywhere in caves where the recharging of gas generators takes place. This can result in substantial accumulation of such wastes such as carbide dumps over the years [2].

An analysis carried out by [3]indicate that spent carbide is composed mainly of calcium and to a lesser extent, magnesium compounds. This makes up about 90% of the sample mass. Another 5 – 7% is made up of impurities from silica, aluminium and iron. Heavy metal concentration was considered insignificant.

Spent carbide is disposed into the environment without adequate treatment. On entering into the soil, it leads to nutrient enrichment and the accumulation of toxic compounds in biomass and sediments [4]. Most of these infiltrated substances lead to the death of soil living biota.

A significant adverse effect of dumped carbide on water infiltration, vegetation regeneration and biomass accumulation of plants was found to occur. In a pot experiment conducted by [5] to investigate the effect of calcium carbide on the growth and yield of rice, wheat and cotton, observed that encapsulated calcium carbide released large amount of acetylene that was slowly reduced to ethylene. This brought about the slowing down of nitrate release from the applied urea.This might help in improving nitrogen use efficiency.A significant adverse effect of spent carbide on water infiltration, vegetation regeneration and biomass accumulation of plants was also observed by [6]. Also, [7] reported a reduction in the growth and yield of *Zea mays* (maize) and *Arachis hypogea* (groundnut) in carbide waste polluted soil especially at high concentration.

The study was aimed at investigating the effects of spent calcium carbide on Okra (*Abelmoschus esculentus*) with particular attention on germination rate, growth parameters and on biomass.

II. Materials And Methods

Experimental location:The experiment was conducted in a screen house located besides the Academic Building of Federal University of Technology, Akure, Ondo State, Nigeria.

Source of materials used for the experiment:The Okra seeds used for this study were obtained from Agricultural development project (ADP) Akure in Ondo State. Thespent carbide was also gotten from the waste of calcium carbide used by the welders for their welding work. Loamy soil was dug up from an area with no recorded incidence of pollution.

Soil Preparation:Loamy 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 each polluted pots were made in four replicates and the total pot used were 16 pots including four control pots without the carbide.

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. The pots were arranged using complete randomized design (CRD) system and each treatment is represented at each row.

Planting Procedure:The polluted soil was left for one week after pollution (WAP) to allow for proper homogenization of the spent calcium carbide with the soil before Okra seeds were planted. The okra seeds were soaked in water for two hours to remove the seed coat; ten seeds per pot were later sowed into each pot so as to determine the percentage germination rate.

Data Collection:After planting, data was collected on the basis of weeks after planting (WAP). Percentage germination was determined after germination by using the formula:

$$\frac{number of germinatedplants}{number of sowedplants} x\ 100$$

The plants per pot were thinned to 1 plant per pot at 2 WAP. Growth parameters like plant height, number of leaves and leaf area were now determined on a two weekly basis. Plant was determined by measuring the plant from their tip to their base with the aid of a measuring tape. Number of leaves was determined by physically counting the number of leaves found in each plant. Leaf area was determined by using [8]. Here, leaf area of Okra is length X breath X 0.75 where 0.75 is the correction factor.

At 12 WAP, which was when the experiment was concluded, the plants were carefully harvested and their fresh and dry weights determined. Fresh weight was determined by first uprooting the plant carefully to ensure that the roots are intact; soil particles in the roots were washed off with water and allowed to dry before weighing each plant using a digital sensitive balance at resolution ± 0.000g. This was carefully recorded. Dry weight was obtained by wrapping the plant material in an aluminium foil and drying in a Gallenkamp drying cabinet at 80^{o}C for 48 hours until constant weight was obtained. It was then measured using the same digital sensitive balance.

Statistical Analysis: Data obtained was subjected to analysis of variance (ANOVA) and the means compared using Turkey's Honestly Significant Test in Statistical Package for Science Student (SPSS) software. Means were compared at5% probability.

III. Results And Discussion

The results of the effect of spent calcium carbide on Okra are shown in tables 1 to 6. Germination rate was significantly higher in the control when compared with Okra seedssown in soils polluted with spent carbide. This could be as a result of blockade of soil pores by calcium carbide waste particles [6]. This can bring about reduction in germination rate. Also, [9] noted that there is an increase in soil P^H in spent calcium carbide waste polluted environment. This might be responsible for scanty regeneration and poor growth in the calcium carbide waste polluted soil since most plants grows best at P^H close to neutral [10].[11] recorded the soil pH to be 11.2 in carbide waste polluted soil.

Table 1: Effect of spent calcium carbide on the mean germination rate of okra

0g	100g	200g	300g
92.50 ± 0.79^c	72.50 ± 1.54^{bc}	37.50 ± 1.93^{ab}	15.00 ± 2.00^a

Means with same superscript along horizontal array indicates no significant difference (p<0.05)

Determination of plant height indicated that effect of spent calcium carbide on okra at low concentration (100g) brought about a significant (p<0.05) increase in height when compared to other treatments (200g and 300g). The increase in height was not significant (p<0.05) when compared with the control. There was gradual reduction in height as the concentration of spent carbide increased. This was in accordance with [7] in their report that maize and groundnut can tolerate carbide waste pollutant at lower concentrations but not at higher concentrations.

Number of leaves was higher in 100g concentrates at 8 WAP than both the control and other treatments. This was significantly higher (p<0.05) than 300g concentrates. This was not statistically different from result obtained in control and 200g ($p<0.05$). This indicates that at low concentration of spent calcium carbide, okra tends to do very well with the number of leaves.

Table 2: Effect of spent calcium carbide on the mean height of okra

Duration	0g	100g	200g	300g
2WAP	9.33 ± 0.40^{b}	9.50 ± 0.981^{b}	5.60 ± 0.94^{ab}	3.98 ± 0.95^{a}
4WAP	11.98 ± 0.25^{ab}	15.25 ± 0.55^{b}	11.33 ± 1.17^{ab}	7.95 ± 0.44^{a}
6WAP	18.63 ± 2.21^{a}	21.00 ± 1.38^{a}	16.25 ± 0.35^{a}	10.50 ± 0.96^{a}
8WAP	25.78 ± 1.76^{ab}	38.25 ± 1.59^{b}	15.25 ± 0.47^{a}	8.75 ± 1.53^{a}
10WAP	26.25 ± 1.18^{ab}	39.50 ± 1.08^{b}	15.25 ± 1.90^{a}	9.75 ± 1.06^{a}
12WAP	27.50 ± 1.85^{a}	28.75 ± 2.27^{a}	29.75 ± 1.45^{a}	11.00 ± 2.55^{a}

Means with same superscript along horizontal array indicates no significant difference ($p<0.05$)

Table 3: Effect of spent calcium carbide on the number of leaves of okra

Duration	0g	100g	200g	300g
2WAP	4.00 ± 0.00^{a}	3.75 ± 0.25^{a}	2.50 ± 0.87^{a}	2.25 ± 0.25^{a}
4WAP	4.00 ± 0.71^{a}	4.25 ± 0.75^{a}	4.50 ± 0.29^{a}	4.75 ± 0.75^{a}
6WAP	4.75 ± 0.25^{a}	4.50 ± 0.87^{a}	3.75 ± 1.03^{a}	4.00 ± 0.41^{a}
8WAP	5.75 ± 1.18^{ab}	6.00 ± 0.82^{b}	3.50 ± 0.50^{ab}	1.75 ± 1.18^{a}
10WAP	4.25 ± 1.49^{a}	5.50 ± 0.87^{a}	3.75 ± 1.03^{a}	1.75 ± 1.18^{a}
12WAP	4.00 ± 1.08^{ab}	1.00 ± 0.41^{a}	5.00 ± 1.08^{b}	1.25 ± 0.95^{ab}

Means with same superscript along horizontal array indicates no significant difference ($p<0.05$)

Results obtained on leaf area show that plants grown in 100g of spent carbide soil had highest leaf area in all weeks after planting. Although this was not statistically different ($p<0.05$) from the control, at 8 WAP 100g concentrate showed a significantly higher leaf area than both 200g and 300g. 300g consistently produced plants with the lowest leaf area.

Table 4: Effect of spent calcium carbide on the leaf area of okra

Duration	0g	100g	200g	300g
2WAP	11.30 ± 2.02^{ab}	15.22 ± 2.07^{b}	6.77 ± 2.91^{ab}	3.30 ± 1.01^{a}
4WAP	23.63 ± 1.46^{a}	29.08 ± 1.00^{a}	17.06 ± 1.68^{a}	7.64 ± 1.04^{a}
6WAP	63.41 ± 1.14^{a}	96.55 ± 2.63^{a}	53.52 ± 3.12^{a}	14.50 ± 2.43^{a}
8WAP	125.25 ± 2.00^{ab}	180.00 ± 3.44^{b}	69.50 ± 2.70^{a}	32.50 ± 2.30^{a}
10WAP	126.00 ± 2.28^{a}	183.00 ± 4.53^{a}	61.00 ± 3.17^{a}	39.00 ± 3.51^{a}
12WAP	95.75 ± 3.47^{a}	49.50 ± 4.50^{a}	122.25 ± 4.02^{a}	33.00 ± 3.00^{a}

Mean with same superscript along horizontal array indicates no significant difference ($p<0.05$)

Table 5: Effect of spent calcium carbide on the mean wet weight of okra

0g	100g	200g	300g
15.39 ± 1.51^a	27.10 ± 2.04^a	18.60 ± 2.37^a	3.38 ± 1.42^a

Means with same superscript along horizontal array indicates no significant difference ($p<0.05$)

Dry weight result show that there was no significant difference ($p<0.05$) in both control and the treatments. Dry weight at 100g was the highest with 300g also being the highest. Reduction in the dry weight as concentration increases is in agreement with [6] who confirmed in their report of a reduction in total plant biomass in carbide waste polluted habitats.

Table 6: Effect of spent calcium carbide on the mean dry weight of okra

0g	100g	200g	300g
4.43 ± 0.93^a	5.97 ± 1.11^a	5.60 ± 1.98^a	0.32 ± 0.14^a

Means with same superscript along horizontal array indicates no significant difference ($p<0.05$)

The lower value of all growth indexes obtained at higher concentration of spent carbide waste can be explained by [12] that it is possible that the toxicity of the carbide waste could have interfere with the plant metabolic activities leading to poor growth and development.

The better performance observed in Okra plants planted in 100g polluted soil could be as a result of the cyanamide released by carbide. Cyanamide is a known component of fertilizers [1].

IV. Conclusion

From the observed results, it is clear that spent carbide do affect okra negatively. This is mostly conspicuous at the 300g level of pollution. Of note is the discovery that spent carbide had a positive impact on plants grown in 100g spent carbide polluted soil. This is significant in that it means that spent carbide can be used to improve growth of okra albeit at a low level.

It is therefore recommended that further studies be carried to determine if okra and other food crops bio-accumulate spent carbide waste. Also, better ways of disposing spent carbide waste should be sought out rather than dumping it indiscriminately on the nearby vegetation.

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