



Assessment of Effect of Cement Dust from Cement Factory on Elemental Properties of Some Cultivated Crops, Obajana, Kogi State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author NOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BAS and AJ supervised the study. Author AEI assisted in the study design and manuscript preparation. All authors read and approved the final manuscript.

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ABSTRACT

This study assessed the effects of cement dust pollution on cultivated crops in Obajana, Kogi State, Nigeria. Plant samples used were obtained directly from cultivated lands in Obajana closed and far away from the cement industry within the community. The 12 plant samples collected were analyzed at Soil Science Laboratory, Faculty of Agriculture, Ahmadu Bello University, Nigeria. Mean, standard deviation, coefficient of variability and T-test were used in analyzing the data. The results revealed that except in the case of potassium concentration (2.21) the maize controls site nitrogen (1.01) and phosphorus (0.23) concentrations are higher than the polluted site (0.21 and 0.15 for nitrogen and phosphorus respectively). Results also showed that the 3 element (nitrogen (0.784), phosphorus (0.38), and potassium (2.42) concentrations studied in the cassava plant of the polluted site were higher than those obtained in the control site with 0.31, 0.36 and 1.83 for nitrogen, phosphorus and potassium. It was concluded that there was significant difference in the

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elemental properties of maize potassium only but in other elements and in cassava plant there was no significant difference. Dusts emitted from the factory have affected the elemental properties of maize and cassava farm lands that are proximate to the cement factory in the study area. The study recommends that the proposed 5th plant by the cement company operating in the study area should be diverted to another settlement in order to boost agricultural produce from Obajana community.

Keywords: Environmental pollution; cement dusts; elemental properties; maize and cassava crops.

1. INTRODUCTION

Global attention is now focused on declining quality of the environment resulting from the rapid expansion in resources exploitation. There is an increasing need to use resources in a sustainable way such that, there is concurrent increase in production while also protecting the environment, biodiversity and global climate systems. This type of compromise requires careful resource planning and decision-making at all levels [1]. Nigeria's environment (at urban and rural levels) has suffered an accelerated decline in quality of air, soils, biodiversity and water resources [2,3,4]. Some of the key environmental pollutants in Nigeria are dusts and noises generated from cement industries. The pollutions generated have caused dust laden air, cracking of soil and walls of structures, vegetation and water pollution to unprofitable farming [5].

Environmental pollution generated from cement industry could be considered as an undesirable process that is responsible for the pollution of water, air and land through its various activities from mining of the raw materials (e.g. limestone, dolomite etc.) to crushing, grinding and other associated processes in cement plant [6]. The production of cement has been increasing by about 3% annually with diverse environmental effects [7]. For instance, the contribution of Portland cement production worldwide to the greenhouse gas emission is estimated to be about 7% of the total greenhouse gas emissions to the earth's atmosphere [8]. These catastrophic effects of global warming are self-evident in melting of the polar ice, flooding, drought and changing flora and fauna of natural habitat for both plants and animals. In slightly over a century, both marine air temperatures and sea surface air temperatures have increased between 0.4°C and 0.8°C [9].

The typical gaseous emissions into the air from cement manufacturing plants include nitrogen oxide (NO_x), sulphur-dioxide (SO₂), carbon oxides (CO and CO₂) and dust [10,11]. The

dusts escaping from cement factories is often transported by wind and deposited in areas close and far away from the factories. The affected areas include cultivated lands, natural vegetation, towns and villages. These depositions of particulate matter and other pollutants interfere with normal metabolic activities of plants, causing direct injury and impairment of growth, quality and decrease in plant yields [12]. Another consequential effect of cement industries is anthropogenic activities that pose highest threat to the conservation of biodiversity and fragile ecosystems (environmental degradation) is mining of mineral resources including limestone.

Considering the observed environmental impact of the present Obajana cement plant, coupled with the expansion and projected plan of establishing 5th production line in the same Obajana community, there is need to carry out a research to assess the extent of damages on some cultivated crops within Obajana community as a step in the direction of impact mitigation for the present facility and prevention for future/proposed facilities. Hence, assessment of effects of cement dusts on the elemental composition of cultivated crops (cassava and maize) in Obajana, Kogi State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

Obajana lies between latitude 7°54'N and 7°56'N and longitude 6°24'E and 6°27'E in Kogi State (refer Fig. 1). It covers an area of approximately 686.81 sqkm and has an undulating surface. Obajana is a small and very important community in Lokoja local government, Kogi state, north central Nigeria. Obajana lies within the sub-humid tropical region and its climate are classified as tropical savanna with two main seasons (wet and dry seasons). Rainfall starts in April and ends in October and its mean annual rainfall ranges between 1100 and 1320 mm, it is characterized by moisture laden southwesterly winds blowing from the Atlantic Ocean and dry

season starts in November and ends in March with an average temperature of 26°C almost consistent throughout the year and its characterized by northeast trade winds [13].

2.2 Sample Collection

The type of sampling design adopted for sample collection was simple random sampling. Plant samples were collected from cultivated land at

0km from the factory. The 3 random locations were generated with a hand-held GPS and divided into 4 radiant directions of east, south, west and north in clockwise manner [14,15]. The 3 locations were randomly selected at a grid sampling pattern. At each sampling location, 6 sampling points were determined with 10 m distance within each sampling points. Ear leaves of 6 cassava and maize plants were collected.

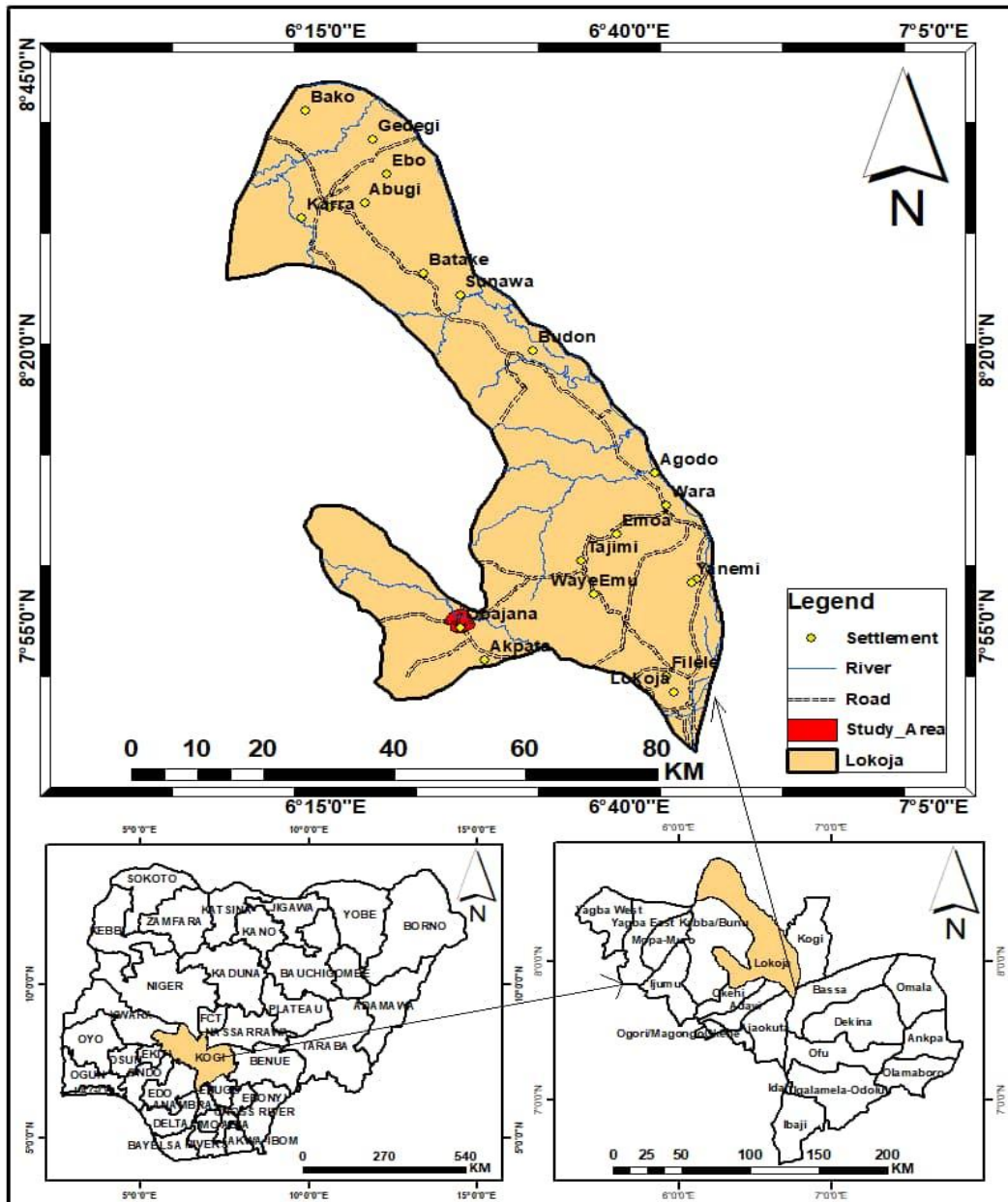


Fig. 1. Kogi State showing Obajana
 Source: Adapted from Administrative of Kogi State (2018)

The control plant samples were collected at a distance of about 7 km from the cement factory where there is no record of cement dust pollution. Six (6) samples were collected using the procedures used to collect the polluted site. A total of 12 plant samples were used to represent cultivated crop plants of the study area. The 12 crop plants used were partly due to homogeneity of the area. The plant samples collected were placed and properly labeled in a paper bag to avoid decay and/or contamination of sample. Forty (40) leaves each of cassava plants were collected per sample and 25 leaves of maize plants were collected per sample based on recommended sampling size for plant tissue analysis.

2.3 Laboratory Analysis

The plant samples collected directly from the field at Obajana were analyzed at Soil Science laboratory of Faculty of Agriculture, Ahmadu Bello University, Nigeria. The elemental properties of various plant samples collected were carried out. The samples were decontaminated by washing, rinsing with deionized water, and dried at temperature not more than 70°C. The properties were then grinded and reduced to 0.5 - 1.0 mm particle size to ensure homogeneity. The properties of the following elements were considered in the process:

2.3.1 Total Nitrogen (TN)

The total nitrogen determination was done by macro Kjeldahl method as described by Bremner and Mulvaney [16]. The optimum amount of nitrogen required by most plant is 1.5%. Any plant with < 1.5 nitrogen is low, 1.5 is moderate, and > 1.5 is considered high. Although, the range usually found in plant is 1% - 5%.

2.3.2 Potassium (K) and total phosphorous (P)

Wet Digestion method was used as described by [17]. The optimum amount of potassium required by most plant is 1%. <1 (low), 1 (moderate) and >1 (high). Amount of phosphorus required by plant is 0.2% <0.2 (low), 0.2 (moderate) and > 0.2 (high). The concentration of phosphorus usually found in plant is 0.1% - 0.5% and that of Potassium (K) is 0.5% - 5%. T-test was employed in comparing the elemental composition of maize and cassava plant. The level of significance was tested at .05 α .

3. RESULTS AND DISCUSSION

3.1 Elemental Properties of Maize Crops

The elemental properties of maize crops of the polluted and control sites were analyzed and presented in Table 1.

3.1.1 Nitrogen concentration

The mean concentration as seen on Table 1 of polluted site is 0.21 while the control is 1.01. These results showed that Nitrogen content is higher in maize samples collected at the control site than the ones collected from the polluted site. This implies that the concentration of nitrogen increases with increase in distance to the cement factory. The decrease in nitrogen concentration could be as a result of burning of plant residues during farming operations, leaching and the high rate of organic-matter decomposition as well as continuous cropping which promotes rapid mineralization and absorption of nitrogen [18]. The findings also agree with [19] who carried out similar research at Jaintia Hills, Meghalaya.

3.1.2 Phosphorus concentration

The mean phosphorus concentration as indicated on Table 1 of polluted site is 0.15 while the control site is 0.23. The concentration of phosphorus at the control is observed to be higher than the one obtained at the polluted site. This showed an increase in content with increased distance. Phosphorus is one of the vital components of cement and it is deposited along with cement dusts. The availability of phosphorous in soil is heavily dependent upon the soil pH and its form present in the soil. Cement dusts contain calcium and when it comes in contact with phosphorus forms chelate resulting in reduction of phosphorus availability in the soils [20].

3.1.3 Potassium concentration

The mean concentration of polluted site is 2.21 while the control is 1.51 as shown in Table 1. From the Table, the concentration at the polluted site is higher than that of the control site showing a decrease in concentration as distance increases. This increase could result from cement dusts pollution. Supporting this was a report in a similar study at Larfage cement factory, Sagamu, Nigeria where it was shown that cement dusts improved potassium content in soil and tend to remain higher than other cations.

Table 1. Statistical comparison of elemental properties of maize crops in the dust polluted and control sites with required amount

Elemental properties	Polluted	Control	t-value	P-value	Optimum range
Nitrogen	0.21	1.01	-12.035	< 0.000	1.5
Phosphorus	0.15	0.23	-2.347	0.041	0.2
Potassium	2.21	1.51	-3.768	0.004	1

Table 2. Statistical comparison of elemental properties of cassava crop in the dust polluted, control site and they require amount

Elemental properties	Polluted	Control	t-value	P-value	Required amount
Nitrogen	0.784	0.31	4.569	0.001	1.5
Phosphorus	0.38	0.36	0.240	0.815	0.2
Potassium	2.42	1.83	3.089	0.022	1

3.2 Elemental Properties of Cassava Crops

The results of elemental properties of cassava crops of the polluted site and control site were analyzed and presented in Table 2.

3.2.1 Nitrogen concentration

The mean concentration of nitrogen in cassava as presented in Table 2 at the polluted site is 0.784 while the control site is 0.31. The concentration of nitrogen in plant samples collected at the control site is observed to be higher than those collected at the polluted site. However, the nitrogen concentrations recorded at the two sites were lower than the amount required in plant. The result also showed that there is significant difference between the polluted and control site.

3.2.2 Phosphorus concentration

The polluted site cassava's phosphorus mean concentration is 0.38 while the control site is 0.36 as presented in Table 2. The result shows that, the concentration of phosphorus at the control site is higher than the polluted site. Looking at these results both site results are higher than the amount required in plant. The result also shows that there is no significant difference between the polluted and the control site. The results imply that cement dusts does not affect the concentration of phosphorus.

3.2.3 Potassium concentration

The mean concentration of potassium in cassava as contained in Table 2 at the polluted site is 2.42 and that of the control site is 1.83. From the results, despite some variance shown in the mean value of the polluted site and control site,

the concentration of potassium concentration of both polluted and control site is high. Looking at the results (refer Table 2) the amount of potassium found in cassava plant is higher than what was discovered in the maize plant because cassava plant is highly tolerant to acidity and alkalinity of soil. Another peculiarity to this is cassava taps more potassium from the soil than any other plant. More to this potassium acts on the synthesis and starch accumulation in the storage roots. The result also revealed that there is significant difference between the polluted and control site.

4. CONCLUSION AND RECOMMEDATION

Based on the results of this study, assessment of effects of cement dusts pollution on cultivated crops in Obajana, Kogi State, Nigeria. It was concluded that, except in the case of potassium concentration (2.21) the maize control site nitrogen (1.01) and phosphorus (0.23) concentrations are higher than the polluted site (0.21 and 0.15 respectively). The 3 studied elements are [nitrogen (0.784), phosphorus (0.38), and potassium (2.42)] concentrations in cassava plant of the polluted site are higher than those obtained in the control site with 0.31, 0.36, and 1.83 respectively. Only in the case of phosphorus where increased concentration with increasing distance from the factory were noticed other elemental properties studied in maize plants were altered as a result of cement dusts pollution hence, nitrogen and potassium decreased with increasing distance away from the factory site. There is no significant difference in elemental properties except for potassium which showed significant difference. The cassava plant nitrogen and phosphorus increased with increasing distance away from the factory as potassium decreases with increasing

distance away from the factory site. There is no significant difference for all the elemental composition in cassava plant. The amount of potassium found in cassava plant was higher (2.42) than what was found in maize plant (1.83). Dusts emitted from the factory have affected the elemental properties of maize and cassava farm lands that are proximate to the cement factory in the study area. The study recommends that the propose 5th plant by the cement company operating in the study area should be diverted to another settlement in order to boost agricultural produce from Obajana community.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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