The Effect of Cassava Processing wastes on the Growth and Development profiles of *Zea mays* L.

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ABSTRACT

Background: Cassava processing wastes usually generated from edible roots of *Manihot esculenta* Crantz may cause environmental problems when abandoned in the surroundings of processing plants or carelessly disposed. This study was conducted to assess the response of *Zea may* L. to cassava wastes affected soil in the study area.

Methods: Viable seeds of *Z. mays* were sterilized and sown in polybags containing 2.0kg of sandy loam soil obtained from cassava processing site, alongside a control (normal soil) treatment containing 2.0kg sandy loam soil obtained from an area of about 1km away from the cassava mill processing site. Plant growth parameters such as plant height, leaf number and root length were examined. In addition, mineral nutrients such as Ca, K, P, Mg, Na, Cu, Fe and Zn in the test plant samples were assessed. Standard methods were used to determine the soil parameters of the experimental soils.

Results: The plant height, leaf number and root length of *Z. mays* grown in cassava processing wastes affected soil were comparatively lower ($P < 0.05$) than that of the control treatment. The pH value of cassava processing wastes affected soil was 4.23, while that of the control treatment was 5.20. The calcium, potassium, sodium, and magnesium contents of *Zea mays* grown in cassava processing wastes affected soil were significantly ($P <0.05$) lower than that of the control treatment. The organic matter, the total nitrogen, potassium, sodium and magnesium contents of cassava processing wastes affected soil were significantly ($P <0.05$) lower than that of the control treatment.

Conclusion: This study showed that the growth and development parameters of *Zea mays* were negatively affected by cassava processing wastes affected soil.

***Key words*— Cassava, Processing wastes, Growth, Development, *Zea mays*,**

1. INTRODUCTION

Zea mays L. commonly called corn belongs to the family Poaceae and grows as an erect annual grass up to 2 to 3 meters in height and occasionally grows as tall as 7meters. The number, size and orientation of leaves differ considerably amongst the various corn varieties [1]. Corn is regarded as a C4 grass and exhibits optimum growth in warm, sub-humid climates with high rainfall (600 to 1500 millimeters) and long photoperiods. [1,2,3]. It is well adapted to a wide variety of soil types ranging from sand to heavy clay, but grow best on well-structured soils with intermediate texture ranging from sandy loams to clay loams. It is usually cultivated on slightly acidic to neutral soil (pH 5.5-7), and requires a soil temperature of at least 10 degrees Celsius (°C) for germination and emergence, while field temperatures of at least 18°C are optimal for germination [1,2,3]. Maize is known to be the third leading crop of the world after rice and wheat and is regarded as a staple food crop in many parts of the world [4]. Maize is generally used as an active ingredient in the production of animal feed and widely processed into various types of products such as cornmeal, grits, starch, flour, tortillas, snacks, and breakfast cereals. In northern States of India maize flour is used to make palatable food such as chapatis or flat breads [5,6]. Cassava is known to generate huge proportion of waste when processed into various useful products. These wastes, namely, cassava peels, solid materials and wastewater contribute significantly to environmental pollution. Cassava wastes constitute one of the waste materials commonly produced in towns and villages in Nigeria. These wastes have been identified to be toxic to the environment [7,8, 9]. Cassava wastes are known to contain higher levels of organogenic glucosides, highly acidic and possess antinutritive factors [10, 11]. The processing method and type of technology used have a greater influence on the composition of cassava wastes [12].The test crop *Zea mays* is usually cultivated in farmlands around cassava mill processing sites, therefore,

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cassava wastes are considered as one of the major factors that could restrict the productivity of the crop. This study becomes increasingly important in order to assess the response of *Z. mays* to soil condition resulting from disposal of cassava wastes in the study area.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Equipment

Equipment and apparatus used include; soxhlet apparatus, heating mantle, blender, autoclave, incubator, automatic weighing balance, refrigerator, and spectrophotometer. Glass wares used include; test tubes, beaker, conical flask, reagents used include; distilled water, petroleum ether, sulphuric acid , sodium hydroxide, anhydrous sodium sulphate, ethyl acetate, ferrous sulphate, ferrous chloride, aluminum chloride, ammonia solution,. Other materials include; aluminum foil, spatula and spectrophotometer.

2.1.2 Biological Materials

The biological materials used for this research were: the plant samples of *Zea mays* obtained from Ogoja, Cross River State.

2.2 Methods

2.2.1 Study Area: The research was carried out in Ogoja, Cross River State. Ogoja is characterized by derived savanna vegetation. The coordinates of Ogoja are 6 ^{o}30′N and 8^{o}40′E. Average precipitation of 3000mm occurs annually along the coastal areas of Cross River State with an ambient minimum and maximum temperature of 22.4^{o}C and 33.2^{o}C, respectively [13] and Altitude of 32m (105ft) [14].

2.2.2 Collection of Samples: Seeds of *Zea mays* were obtained from certified farmers from the study area, Ogoja, Cross River State. Similarly, normal soil and cassava wastes affected soil samples were collected from the study Area. Three replicates were maintained per treatment.

2.2.3 Analysis of Soil samples: Top soils of about 0-20cm depth collected from the study areas were analyzed for soil-chemical properties using standard procedures [15].

2.2.4 Germination and Growth Studies

2.0kg of sandy loam soil obtained from cassava processing site in the study area was transferred into polybags, alongside a control (normal soil) treatment containing 2.0kg sandy loam soil obtained from an area of about 1km away from the cassava mill processing site. Viable seeds of *Zea mays* were sterilized with 0.01% mercuric chloride solution for 30 seconds, washed several times with distilled water and air dried. Three (3) seeds were sown directly in each polythene bag containing the experimental soils. Each level of treatment was replicated three (3) times using randomized complete block design. The experimental set up was maintained for 40 days under light condition for assessment of the test crop growth parameters.

2.2.5 Mineral nutrient Analysis in Plant Samples

Plant samples were analyzed using standard methods [16]. The whole plant samples of *Zea mays* were uprooted, washed several times with water, rinsed with distilled water and placed in polybags. This was followed by drying in an oven maintained at 60^{o} C to a constant weight and thereafter, plant samples were macerated to powder, and stored in sample bottles for analysis. The powdered plant samples were oven dried at 105^{o}C for 2 hours, 1.0g weighed into a platinum crucible and placed in a muffle furnace maintained at 400^{o}C. The powdered plant materials were ashed for 5 hours and then dissolved with 10cm^{3} of 1M HCL. The solution obtained was filtered through Whatman No. 1 filter paper into 50cm^{3} volumetric flask and made up to the required mark with distilled deionized water. Standard reagents for analytical experiment were used, and contents of mineral elements in the solution were determined using Atomic Absorption Spectrophotometer (AAS) of Unicam Model.

2.3 Statistical Analysis

The mean readings from three (3) replicates were subjected to Analysis of variance (ANOVA) and differences in the means were tested using Least Significant Differences (LSD) at probability level of 5% [17].

3. RESULTS

The chemical properties of experimental soil before cultivation of *Zea mays* are presented in Table 1. The pH value of cassava processing wastes affected soil was 4.23, while that of the control treatment (soil only) was 5.20. The electrical conductivity and available phosphorus content of cassava processing wastes affected soil were significantly (P. 0.05) higher than that of the control treatment. Conversely, organic matter, the total nitrogen, potassium, sodium and magnesium contents of cassava processing wastes affected soil were significantly (P <0.05) lower than that of the control treatment (Table 1). The elemental contents of *Z. mays* grown in cassava processing wastes affected soil are presented in Table 2. The calcium, magnesium, potassium and sodium contents of *Z. mays* grown in cassava processing wastes affected soil were significantly (P <0.05) lower than that of the control treatment. In addition, the phosphorus, iron, copper and zinc contents of *Z. mays* grown in cassava processing wastes affected soil were relatively higher than that of the control treatment (Table 2). The growth parameters of *Z. mays* grown in cassava processing wastes affected soil are presented in Table 3. The plant height, leaf number and root length of *Z. mays* grown in cassava processing wastes affected soil were comparatively lower than that of the control treatment (Table 3).

Table 1: Chemical Properties of Experimental Soils before Cultivation of *Zea mays*

Soil parameters	**Control treatment**	**Soil affected by cassava wastes**
Ph	5.20 ±0.24	4.23±0.20
Organic matter (%)	4.16± 0.19	2.23± 0.72
Total nitrogen (%)	1.23± 0.42	0.26± 0.02
Avail. Phosphorus (%)	1.70± 0.34	1.30± 0.82
Potassium (mg/100g)	2.90± 0.31	2.13±0.27
Sodium (mg/100g)	3.40± 0.14	3.01± 0.45
Magnesium (mg/100g)	5.22±0.65	4.04±0.40
E. conductivity (ds/m)	0.06± 0.02	0.19±0.05

Mean ± standard error from three replicates

Table 2: Elemental Contents of *Zea mays* grown in soil affected by cassava wastes

Mineral nutrients (mg/100g)	Control treatment	Soil affected by cassava wastes
Calcium	4.21 ±0.14	3.42±0.29
Potassium	2.22± 0.10	2.13± 0.21
Phosphorus	2.24± 0.20	2.04± 0.14
Magnesium	3.32± 0.44	3.10± 0.23
Sodium	2.59± 0.12	1.67±0.72
Copper	0.03± 0.04	0.34± 0.02
Iron	0.12±0.05	0.32±0.03
Zinc	0.17± 0.03	0.23±0.04

Mean ± standard error from three replicates

Table 3: Growth Parameters of *Zea mays* grown in soil affected by cassava wastes

Growth parameters	**Control treatment**	**Soil affected by cassava wastes**
Plant Height (cm)	42.20±0.33	31.32±0.47
Leaf number	6.67± 0.28	5.67± 0.46
Root length (cm)	15.06± 0.53	12.24± 0.50

Mean ± standard error from three replicates

4. DISCUSSION

In this study, the pH of cassava processing wastes affected soil was acidic. This result may be due to high cyanide content usually associated with cassava wastes affected soil [18]. Effluents produced from cassava processing plants have been reported to be deleterious, hence, should not be dumped on agricultural soils [19]. Soil pH is an important parameter to be regulated since it influences the availability of nutrients, the activities of toxic substances and the soil physical characteristics [20]. Cassava peels have been shown to contain a higher level of cyanogenic glucosides than the pulp, consequently, large concentration of cyanide has been found in soil receiving cassava processing effluents [21, 22]. The presence of cyanide in the soil and fermented cassava could inhibit the growth of soil microorganisms [23]. A wide variety of harmful microorganisms have been shown to thrive predominantly in soil characterized by irregular dumping and discharge of cassava wastes from processing mills, thus leading to the release of toxins into the surrounding soils [19]. The organic matter, total nitrogen, sodium and magnesium contents of cassava processing wastes affected soil were significantly lower than that of the control treatment. The calcium, magnesium, sodium and potassium contents of soil contaminated with cassava processing effluent have been reported to be significantly lower than that of the normal soil [18]. The presence of hydrogen cyanide in the soil solution leads to a decrease in soil pH with a resultant decrease in the contents of magnesium, potassium, calcium and sodium while cyanide content, conductivity, phosphate, nitrate and sulphate increase [19]. The physical and chemical properties of soil have been shown to be affected by long term disposal of cassava processing wastes on farmlands [24]. In this study, the calcium, magnesium, potassium and sodium contents of *Z. mays* grown in cassava processing wastes affected soil were significantly lower than that of the control treatment. In addition, the phosphorus, iron, copper and zinc contents of *Z. mays* grown in cassava processing wastes affected soil were relatively higher than that of the control treatment. The nutrients status of *Z. mays* were greatly influence by the pH value of the experimental soil, which could have affected the test crop growth parameters. This clearly reveals the reason for the plant height, leaf number and root length of *Z. mays* grown in cassava processing wastes affected soil being comparatively lower than that of the control treatment. Factors such as pH, available nutrients, texture, organic matter content, soil water relationship, weather and climate factors among others have been reported to directly or indirectly affect the nutritional quality of plants [25]. In addition, soil pH and organic matter affect plant nutrient availability and soil functions. Soil pH has a significant influence on the solubility, and availability of plant nutrients, and organic matter decomposition [26].

5. CONCLUSION

Cassava processing wastes affected soils had a negative effect on the growth parameters of *Zea mays* and decreased the calcium, magnesium, potassium and sodium contents of the test crop. Similarly, Cassava processing wastes contaminated soils decreased the organic matter, total nitrogen, sodium and magnesium contents of the soil.

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Conflict of Interest

Conflict of interest was not applicable.

Contribution of the Author

The author conducted a single authored paper with collaborative assistance from senior colleagues in the field.

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