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Growth and Development Response of *Telfairia occidentalis* Hook. f. to Aluminium Sulphate Treated Water

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Authors' contributions

This work was carried out in collaboration between both authors. Author POE designed the study, wrote the protocol and wrote the first draft of the manuscript. Author LAA reviewed the experimental design and all drafts of the manuscript. Authors POE and LAA managed the analyses of the study. Author POE identified the plants and performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

This study was conducted to examine the response of *Telfairia occidentalis* to aluminium sulphate treated water. The growth parameters (shoot length, root length, fresh weight, dry weight and moisture content) and mineral elements (Ca, Mg, Na, P, K, Zn, Cu, Fe, Mn, and Pb) were determined using the recommended method of analysis. The result of this study showed that the shoot length, root length and moisture content of the crop significantly (P=0.05) decreased with increase in the concentration of aluminium sulphate treatment. The calcium, magnesium, sodium, iron, manganese and lead content of the crop decreased with increase in the concentration of alum treatment. While the phosphorous, potassium, zinc and copper increased with increase in the concentration of aluminium sulphate treatment. Therefore this study suggests that higher concentration of aluminium sulphate in water can pose toxic effect to *Telfairia occidentalis.*

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Keywords: Aluminium sulphate; growth; mineral element; Telfairia occidentalis.

1. INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*, Hook F.) belongs to the family Cucurbitaceae. It is a vine which grows in the forest zone of West Africa. It is a large perennial crop which climbs by means of coiled tendrils. It is cultivated mainly for its succulent tender shoot. The crop is propagated solely by seeds; it is a woody climber with 3-5 lobed, deeply divided leaves [1].

The vegetable is grown mainly for its leaves which constitute an important component in the diet of the people [2]. The leaves which can be harvested at all stages of growth [3] are used in the preparation of 'edikang ikong' a much-sought after delicacy in Cross River and Akwa Ibom States and 'Ofe Ugu' in the Igbo - speaking States of Nigeria [4].

Aluminum sulphate is a chemical compound which is slightly soluble in alcohol, dilute minerals and acids [5]. Its appearance is a solid hygroscopic compound that can exist in solid, liquid and gas. Aluminum sulphate is mainly used as a flocculating agent in the purification of drinking water and waste water treatment plants and also in paper manufacturing. Aluminum sulphate can also occur naturally as a rare mineral found on volcanic environments and on burning coal mining waste dumps. Aluminum sulphate is used as a mordant in dyeing and printing of textiles [6]. Aluminum sulphate has been suggested as a best management practice to help reduce the potential environmental effects of poultry production [7].

Laboratory studies using ammonium alum effluent water and potassium alum showed a reduction in percentage germination of root and shoot growth [8,9].

Field experiment conducted with effluent sludge and effluent water revealed stimulation of growth in the above ground parts at low concentration followed by a reduction together with abnormalities at high concentration [7,10]. It is concluded that the alum factory effluent is toxic to plant growth, and suggested that the effluent be treated or diluted before its discharge from the factory premises. The addition of alum to soils decreased both slaking and dispersion of soils and resulted in improved aggregation, increased in water retention of the soil [7]. The application of aluminum sulphate to soil increased the dry matter of crops in the soil without an addition of fertilizer, but high rate addition of alum led to germination problems and a decreased in phosphate uptake by the crops in the soil [5]. Aluminum (Al) toxicity is widely considered as the most important growth limiting factor for plants in most strongly acidic soils [7,11]. In view of the toxicity characteristics of aluminum sulphate and its utilization in water purification for use in irrigation purposes, this study was conducted to examine the effects of Aluminum sulphate treated water on the growth and developmental response of *Telfairia occidentalis.*

2. MATERIALS AND METHODS

This study was conducted at Ofrima complex, Abuja campus, University of Port Harcourt.

Certified Seeds of *Telfairia occidentalis* were sourced from Agricultural Development Project, Rumuokoro Rivers State, while aluminium sulphate were sourced from a chemical company in Rivers State.

Various dilution series for aluminium sulphate were prepared using 1000 ml of water to obtain 1.0%, 2.0%, 3.0%, 4.0%, and 5.0% concentrations while 0% (water only) was used as control.

2 kg of sandy-loamy soil were weighed using a triangular weighing balance. Soil sample were placed in perforated polythene bags. Seeds of *Telfairia occidentalis* were removed from pods and sorted in order to select seeds of uniform size, they were sun-dried for two days to enhance germination. Three seeds of *Telfairia occidentalis* were sown directly in each perforated polythene bags. Aluminium sulphate treated water (0%, 1.0%, 2.0%, 3.0%, 4.0%, and 5.0%) were used to irrigate the soil samples containing the test crop. Seedlings of *Telfairia occidentalis* were thin down to one (1) per bag after germination. Each level of treatment was replicated three times using randomized complete block design. The experimental set up was maintained under light condition, the plant watered as need arose and allowed to grow for 8 weeks in order to determine the growth and mineral element content of the crop.

Physico-Chemical Characteristics of Experimental Soil were determined according to standard method of [12,13].

The following growth and biochemical parameters were analyzed: plant height (cm), root length (cm), fresh weight (g), dry weight (g), moisture content (%), Total organic carbon (TOC), pH, available phosphorus, Total Nitrogen and heavy metals.

The shoot length (plant height) was measured with a metre tape in centimetres from the soil surface to the plant apex. The plants were uprooted from each bucket and weighed immediately on a weighing balance to avoid moisture loss. This was done to obtain the fresh weights. To get the dry weights, the plants were taken to the laboratory, oven-dried at 80℃ for 24 hours to get rid of all moisture and ensure a constant weight. It was then weighed on a weighing balance. The leaves of the test crop were rinsed with distilled water and dried. The dried plant materials of each sample were macerated into powdered form using pestle and mortar. The powder form was sieved through a 0.2 mm wire mesh to obtain fine powdered form. Each sample of the powdered materials was kept in small bottles for analysis. The contents of the mineral elements (Ca, Mg, P, K, Zn, CU, Fe, Mn, and Pb) were determined using an AA-7000 atomic absorption spectrophotometer.

All data generated were subjected to statistical analysis such as Analysis of variance (ANOVA) and standard error means. New Duncan Multiple range test (NDMRT) was employed to separate means.

3. RESULTS AND DISCUSSION

The soil pH, Particles size, and elemental components are presented in Table 1.

The shoot length of *Telfairia occidentalis* significantly (P=0.05) decreased with increase in the concentration of Aluminium sulphate. The values recorded for Aluminium sulphate treatments were comparatively lower than that of the control (Fig. 1). The root length of the crop significantly (P=0.05) decreased from 13.17 cm at 1.0% level of treatment to 8.07 cm at 5.0% level of treatment (Fig. 1). The fresh weight of the crop decreased from 4.07 g at 1.0% level of treatment to 3.07 g at 5.0% level of treatment. Similarly, the dry weight of the crop decreased from 1.37 g at 1.0% level of treatment to 1.23 g at 5.0% level of treatment. The moisture content of the crop at the control treatment (66.27%) was comparatively lower than that of 1.0% (66.34%) level of treatment. The least value for moisture content was recorded at 5.0% level of treatment (Fig. 1).

Table 1. Physicochemical properties of experimental soil

Parameters	Values
pH	5.2
Total N (%)	0.42
Sand (%)	78.1
Silt (%)	16.5
Clay (%)	4.5
Available P (mg/Kg)	2.5
Mg (mg/Kg)	6.99
Zn (mg/Kg)	10.37
Cd (mg/Kg)	1.6
Pb (mg/ Kg)	2.07
Cu(mg/Kg)	2.16
Fe (mg/Kg)	128.26
Cr (mg/Kg)	1.16
Ca (mg/Kg)	5.59
Na (mg/Kg)	4.105
Al (mg/Kg)	1.15
K (mg/Kg)	3.64

The growth parameter of *Telfairia occidentalis* decreased with increase in the concentration of aluminum sulphate. Toxicity of alum on plant growth has been reported by various researchers [8]. This result agrees with the work of [8] that effluent water from ammonium alum and potassium alum impacted negatively on plant growth by reducing the percentage germination, root and shoot growth. Similarly, field experiment conducted with effluent sludge and effluent water of alum revealed stimulation of growth in the above ground parts at low concentrations followed by a reduction together with abnormalities at high concentration [7].

The content of calcium in the leaves of *Telfairia occidentalis* significantly (P=0.05) decreased from 4.67 mg/100 g at 1.0% level of treatment to 2.07 mg/100 g at 5.0% level of treatment against that recorded at the control (5.77 mg/l00 g) treatment (Table 2). The Magnesium content of the crop significantly (P=0.05) decreased from 6.05 mg/100 g at 1.0% level of treatment to 3.41 mg/100 g at 5.0% level of treatment. The value of 6.62 mg/100 g was recorded at the control treatment (Table 2). Similarly, the sodium, Iron, manganese and lead content of the crop significantly (P=0.05) decreased with increase in the concentration of aluminum sulphate treatment with values which are comparatively lower than that of the control (Table 2). The phosphorus, potassium, zinc and copper content

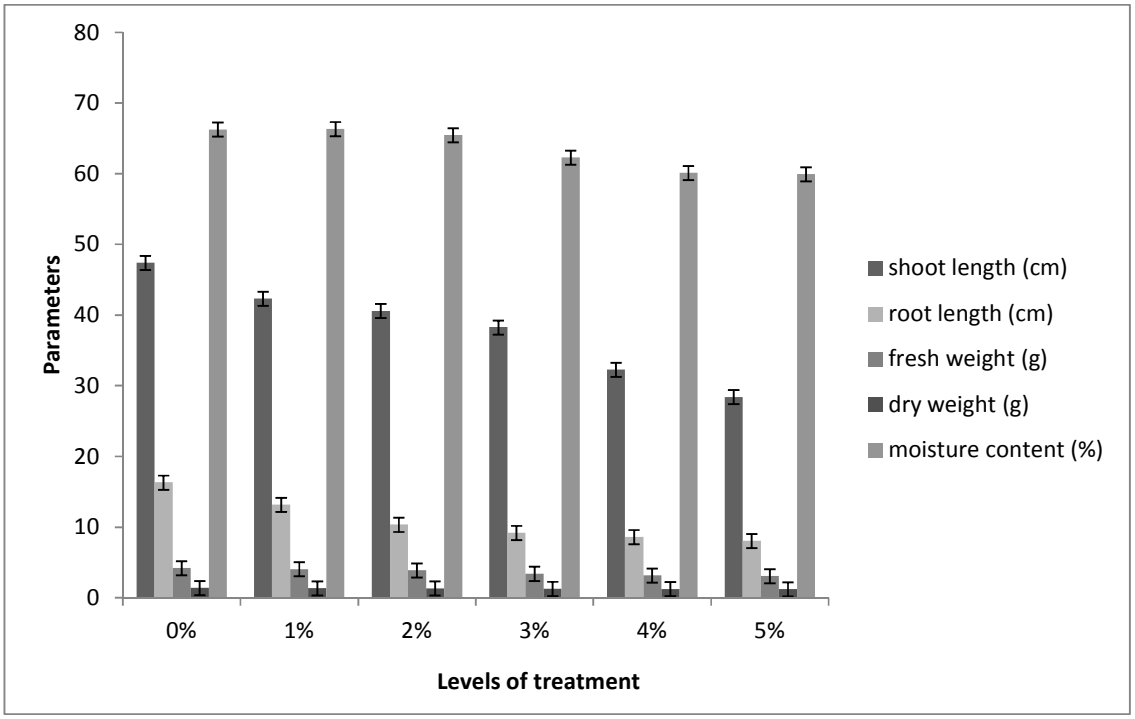

Fig. 1. The shoot length, root length, fresh weight, dry weight and moisture content of *Telfairia occidentalis* at different levels of concentration

Table 2. Mineral element contents in *Telfairia occidentalis* under alum treated water

Element (mg/l00 g)	0%	1.0%	2.0%	3.0%	4.0%	5.0%
Calcium	5.77 ± 0.21	4.67 ± 0.10	4.06±0.17	3.21 ±0.05	2.47 ± 0.72	2.07 ±0.11
Magnesium	6.62 + 0.14	6.05±0.22	5.76 ± 0.21	4.29 ±0.02	4.07 ± 0.31	3.41 ± 0.22
Sodium	3.49 ±0.10	3.16 ± 0.16	3.04 ± 0.14	2.52 ±0.10	2.17 ± 0.07	2.03 ± 0.02
Phosphorus	3.07 ±0.05	3.21 ±0.21	3.51 ±0.12	4.96 ±0.42	6.40 ± 0.72	6.52 ± 0.27
Potassium	2.43 ± 0.07	2.72 ±0.04	2.87 ±0.02	2.95 ± 0.02	3.01 ± 0.04	3.16±0.14
Zinc	0.62± 0.01	0.69± 0.02	0.77 ±0.02	1.01 ± 0.03	1.04± 0.02	1.12 ± 0.03
Copper	1.02 ±0.02	1.07 ± 0.01	1.12 ± 0.03	1.19 ± 0.02	1.20 ± 0.02	1.27 ± 0.07
Iron	0.43 ± 0.01	0.32 ±0.02	0.24 ±0.02	0.21 ±0.01	0.17 ± 0.01	0.58 ± 0.01
Manganese	1.07 ±0.02	0.95 ±0.03	0.90 ± 0.01	0.81 ±0.02	0.72 ± 0.02	0.58± 0.01
Lead	0.72±0.01	0.61 ±0.02	0.47 ±0.04	0.32 ±0.05	0.21 ± 0.07	0.12 ± 0.02

Mean ± standard error

of the crop significantly (P=0.05) increased with increase in the concentration of aluminum sulphate treatment. The values recorded here were comparatively higher than those of the control treatment (Table 2).

The elemental nutrient contents recorded increase as well as decrease in some nutrient elements. This result agrees with the work of [7] that aluminum toxicity is widely considered as the most important growth limiting factor for plant in strongly acidic soils. Thus, pH plays an overriding effect in regulation of plant nutrient in the soil. Aluminum toxicity is characterized by lower pH and destruction of symplasm, which may interfere with nutrient absorption by plant root [14,15].

4. CONCLUSION

The results of this study showed that the use of Aluminum sulphate in irrigation water at higher concentration could increase the availability of toxic elements, specifically aluminum, as well as result in toxicity problem most especially to the test crop *Telfairia occidentalis.* This study

revealed that Alum treated water affects the growth performance of *Telfairia occidentalis* by inhibiting the shoot length, root length, leaf number, fresh weight, dry weight, moisture content as well as the macro nutrient elements (Phosphorus, Potassium, Calcium and Magnesium) and micro nutrient elements (Copper, Iron, lead, and Manganese) of the crop. Therefore, this study showed that higher content of Aluminum sulphate in irrigation water could be toxic to plant growth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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