Mineral Elements Content and Growth Response of *Arachis hypogaea* (Linn) To Alum (Aluminium Sulphate) Treated Water

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Abstract

The study was conducted to examine the effect of Alum treated water on the growth and mineral elements of Arachis hypogaea Linn. The concentration levels of I. 0%, 2.0%, 3.0%, 4.0% and 5.0%, alum treated water per 2.0 kg of sandy-loam soil were used alongside a control (0%). Growth parameters (shoot length, root length, leaf number, fresh weight, dry weight, moisture content) and mineral element (Ca, Mg, Na, P, K, Zn, Cu, Fe, Mn and Pb) were examined. Treatment with Alum treated water significantly (P=0.05) decreased the shoot length, root length, leaf number and moisture content of the crop relative to the control treatment. Similarly, treatment with Alum treated water significantly (P=0.05) decreased the Phosphorus, Magnesium, Calcium, Potassium and Copper content of the crop relative to the control treatment. Therefore, this study showed that higher concentration of Aluminum sulphate in irrigation water could be toxic to plant growth and development.

Key words*; Alum treated water, Growth, Mineral element, Arachis hypogaea,*

INTRODUCTION

Aluminum sulphate is a chemical compound which is slightly soluble in alcohol, dilute minerals and acids (Brown, 2007). 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 (Lind, 2003). Aluminum sulphate has been suggested as a best management practice to help reduce the potential environmental effects of poultry production (Warren *et al.*, 2006). Laboratory studies using ammonium alum effluent water and potassium alum showed a reduction in percentage germination of root and shoot growth (Miyasaka and Hawes 2003).

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 (Warren *et al*., 2006). 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 (Warren *et al*., 2006). 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 (Delhaize *et al*.,1995). Groundnut is a major crop for man and animal as well as its importance as raw materials for agro-industries. Thus, it is used both as a food and cash crop. The seeds are eaten as a snack (boiled or roasted) and can also be mashed up and used to thicken soups and sauces. Commercially, groundnut can be crushed and made into butter, margarine, cream etc. It is also extracted for vegetable oil and the cake used as a protein source in livestock feeds. Stems and leaves are used as hay (Schippers, 2000; Udoh *et al*., 2005).Aluminum (Al) toxicity is widely considered as the most important growth limiting factor for plants in most strongly acidic soils (Warren et al., 2006). 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 *Arachis hypogaea*.

MATERIALS AND METHODS

This study was conducted at Ofrima complex, Abuja campus, University of Port Harcourt. Certified Seeds of *Arachis hypogaea* were sourced from Agricultural Development Project, Rumuokoro Rivers State, while Alum ($Al_2 (S0_4)_3$) were sourced from a chemical company in Rivers State. Various dilution series for alum ($Al_2 (S0_4)_3$) were prepared using 1000ml of water to obtain 1.0%, 2.0%, 3.0%, 4.0%, and 5.0% concentrations while 0% (water only) was used as control.

2kg of sandy-loam soil were weighed using a triangular weighing balance. Soil sample were placed in perforated polythene bags. Healthy Seeds of *Arachis hypogaea* were sorted and used for the research. Three seeds of *Arachis hypogaea* were sown directly in each perforated polythene bags. Alum 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 *Arachis hypogaea* were thinned 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 using standard procedures (A.O.A.C, 1990).

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 plant were uprooted from each bucket and weighed immediately on a weighing balance, model PN 163 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^oC for 24 hours to get rid of all moisture and ensure a constant weight. It was then weighed on a PN 163 model 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 0.2mm 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 atomic absorption spectrophotometer.

All data collected 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.

RESULT AND DISCUSSION

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

The shoot length of *Arachis hypogaea* 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 15.20cm at 1.0% level of treatment to 10.14cm at 5.0% level of treatment (Fig.1). The fresh weight of the crop decreased from 3.02g at 1.0% level of treatment to 2.41g at 5.0% level of treatment. Similarly, the dry weight of the crop decreased from 1.24g at 1.0% level of treatment to 1.13g at 5.0% level of treatment (Fig. 2). The moisture content of the crop decreased from 58.94 at 1.0% level of treatment to 53.11% level of treatment (Fig. 3).

This study showed that the use of Aluminum sulphate (Alum) treated water in irrigation of *Arachis hypogaea* inhibited the shoot length, leaf number, root length, fresh weight, dry weight and moisture content of the crop in relation to the control treatment. This growth reduction may be attributed to the presence of aluminum in the irrigation water which has been reported to be toxic to plant growth (Galloway 2006).This result agrees with the work of (Delhaize and Ryan, 1995) that the most easily recognized symptoms of Aluminum toxicity is the inhibition of root growth and resultant stress in plants.

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/ l0g)	0.025
Mg(mg/10g)	0.0699
Zn (mg/ l0g)	0.1037
Cd (mg/ l0g)	0.016
Pb (mg/ l0g)	0.0207
Cu(mg/10g)	0.0216
Fe (mg/ l0g)	1.2826
Cr (mg/ l0g)	0.0116
Ca (mg/ l0g)	0.0559
Na (mg/ l0g)	0.04105
A1 (mg/ l0g)	0.0115
K (mg/l0g)	0.0364

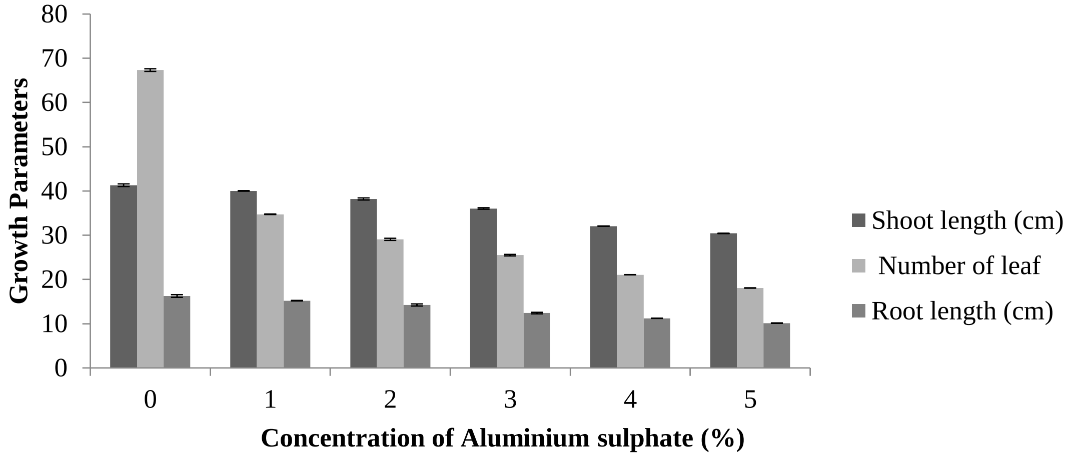

Fig. 1: Mean Shoot length (cm), Number of leaf and Root length (cm) of…

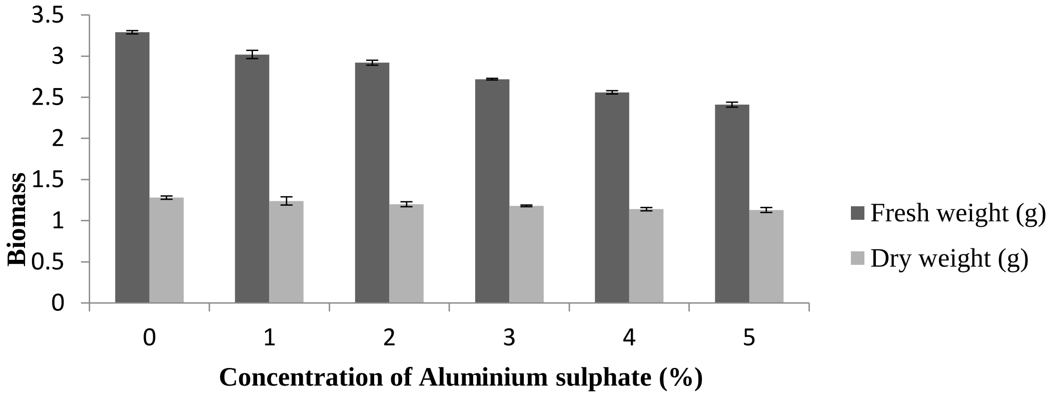

Fig. 2: Mean Fresh weight (g) and Dry weight (g) of…

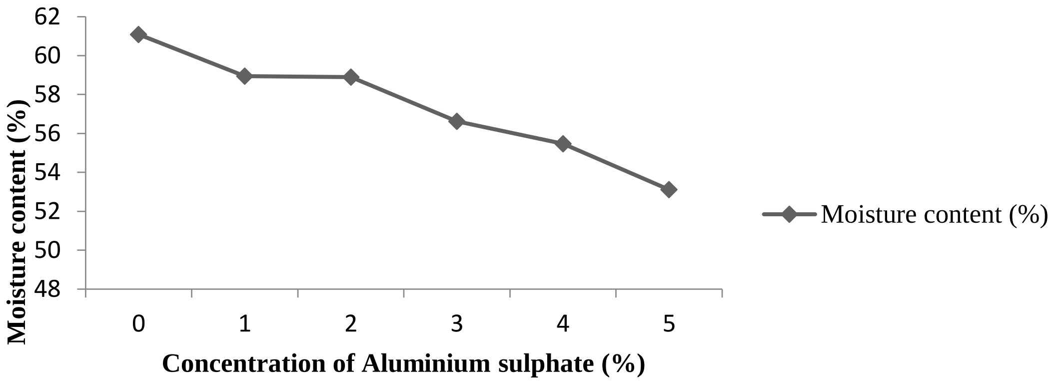

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Table 2: The effects of Aluminium sulphate treated water on the nutrient element in the leaves of *Arachis hpogaea.*

Element (mg/l00g)	**0%**	**1.0%**	**2.0%**	**3.0%**	**4.0%**	**5.0%**
Calcium	3.49 ± 0.21	3.02 ± 0.02	2.57±0.01	2.16 ±0.10	1.72 ± 0.06	1.57 ±0.02
Magnesium	4.20 + 0.18	3.18±0.91	2.84 ± 0.17	2.52 ±0.17	2.02 ± 0.02	1.92 ± 0.16
sodium	2.86 ±0.10	2.52 ± 0.21	2.32 ± 0.33	2.14 ±0.52	1.80 ± 0.17	1.62 ± 0.04
Phosphorus	5.82 ±0.05	4.02 ±0.30	3.84 ±0.16	3.02 ±0.10	2.72± 0.21	2.24 ± 0.10
Potassium	2.84 ± 0.17	2.69 ±0.24	2.60 ±0.05	2.42 ± 0.04	2.01 ± 0.11	1.97±0.13
Zinc	0.17± 0.02	0.28± 0.01	0.52 ±0.02	0.76 ± 0.03	0.92± 0.02	1.07 ± 0.02
Copper	1.62 ±0.11	1.57 ± 0.13	1.32 ± 0.19	1.24 ± 0.12	1.16 ± 0.13	1.04 ± 0.10
Iron	0.52 ± 0.03	0.40±0.01	0.37 ±0.02	0.18 ±0.03	0.07 ± 0.01	0.02 ± 0.01
Manganese	1.02 ±0.13	0.92 ±0.02	0.82 ± 0.01	0.75 ±0.02	0.52 ± 0.02	0.43± 0.01
Lead	0.82±0.02	0.56 ±0.02	0.43 ±0.03	0.29 ±0.01	0.24 ± 0.02	0.07 ± 0.01

Mean ± standard Error

The content of calcium in the leaves of *Arachis hypogaea* significantly (P=0.05) decreased from 3.02mg/100g at 1.0% level of treatment to 1.57mg/100g at 5.0% level of treatment against that recorded at the control (3.49mg/l00g) treatment (Table 2). The Magnesium content of the crop significantly (P=0.05) decreased from 3.18mg/100g at 1.0% level of treatment to 1.92mg/100g at 5.0% level of treatment. The value of 4.20mg/100g was recorded at the control treatment (Table 2). The content of sodium decreased with increase in the concentration of Aluminum sulphate treated water (Table 2).The content of phosphorus significantly (P=0.05) decreased from 4.02mg/100g at 1.0%lcvcl of Aluminum sulphate to 2.24mg/100g at 5.0% level of Aluminum sulphate treated water (Table 2).The potassium content decreased from 2.69mg/100g at 1.0% level of Aluminum sulphate treated water to 1.97mg/100g at 5.0% level of Aluminum Sulphate treated water (Table 2).

The Zinc content of the crop increased from 0.28mg/100g at 1.0% level of Aluminum sulphate to 1.07mg/100g at 5.0% level of Aluminum sulphate treated water (Table 2). Similarly, the copper content of the crop decreased from 1.57mg/100g at 1.0% level of Aluminum sulphate to 1.04mg/100g at 5.0% level of Aluminum sulphate treated water (Table 2).The Iron content of the crop decreased from 0.4mg/100g at 1.0% level of Aluminum sulphate to 0.02mg/I00g at 5.0% level of Aluminum sulphate treated water (Table 2).The manganese content of the crop decreased from 0.92mg/100g at 1.0% level of Aluminum sulphate to 0.43mg /100g at 5.0%levcl of Aluminum sulphate (Table 2). The lead content of the crop decreased from 0.56mg/I00g at 1.0% level of Aluminum sulphate to 0.07mg/l00g at 5.0% level of Aluminum sulphate treated water (Table 2).

The reduction in some macronutrient (Phosphorus, Potassium, Calcium and Magnesium) and Micronutricnt (Copper, Iron, Lead and Manganese) elements in leaves *of Arachis hypogaea* as observed in this study may be due to the effect of Aluminum Sulphate in sandy soils with a low capacity to buffer pH change. This result agrees with the work of (Lazof *et al.,* 1994) that Aluminum toxicity is characterized by lower pH and destruction of the symplasm. Thus, this may interfere with nutrient absorption by the plant roots.

CONCLUSION

This showed that the use of Aluminum sulphate in irrigation water at higher concentration could increase the availabilly of toxic elements, specifically aluminum, as well as result in toxicity problem most especially to the test crop *Arachis hypogaea.* This study revealed that Alum treated water affects the growth performance *of Arachis hypogaea* 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 concentrations of Aluminum sulphate in Irrigation water could be toxic to plant growth.

ACKNOWLEDGEMENT

The authors wish to acknowledge the contributions from Dr. M. M. Etukudo of the Department of Biological Sciences, Faculty of Science, Federal University Otuoke, Bayelsa State and Mrs Omoruyi, Ufumwen for her assistance in data collection.

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