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Lead Effect on the Mineral Composition in *Sansevieria roxburghiana* Schult. and Schult. f.

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Abstract: The present investigation reported that mineral levels in plant *Sansevieria roxburghiana* Schult. and Schult. f. (Agavaceae) exposed to different lead (Pb) concentrations from 60, 120, 180, 240 and 300 mg/l under hydroponics for 40 day duration. Pb accumulation (13, 24, 55, 71 and 98 mg/kg DW) was reported in different concentrations. Results showed that the decrement in mineral levels sodium (598±0.3 to 454±0.2 mg/100g DW), potassium (18±0.2 to 6±0.4 mg/100g DW), calcium (245±0.3 to 122±0.2 mg/100g), zinc (0.14±0.5 to 0.7±0.4 mg/100g DW), copper (0.65±0.2 to 0.44±0.1 mg/100g DW), manganese (0.55±0.2 to 0.25 ±0.1mg/100g DW) and iron (2±0.3 to 0.73±0.4 mg/100g DW). Pb accumulated to a greater degree in plants resulted in oxidative stress, as evidenced by increased concentrations of malondialdehyde. This result clearly indicates potential lead toxicity affects the nutritive status of *Sansevieria roxburghiana* plant.

Keywords: Lead, Minerals, Nutritional potentiality, Oxidative stress, *Sansevieria roxburghiana.*

1. INTRODUCTION

Industrialization has led to the increases several heavy metals like Cd, Pb, Zn, Cu, and Hg in the soil environment. High levels of heavy metals in the soil adversely affect plant growth. Among heavy metals; lead is an element that is easily accumulated in soil and sediments. The level of Pb in the environment is currently of great concern. Although lead is not an essential element for plants, it is absorbed and accumulated due to different man made polluted activities [1]. The absorption of metals from the soil by plants is influenced by a variety of factors, including pH, temperature, soil ions, cation exchange capacity of soil, organic matter content of the soil, the type and concentration of metal and the species of plant [2].

The action of metals is seen at the whole plant level in reduced growth, and at the organ level in leaf symptoms. At a smaller scale, the effects of metals can be seen as cellular symptoms. Symptoms, both macro and micro cellular, and growth effects are side effects of the direct mode of action. Each metal has a different mode of action. However, in general, metal toxicity has been shown to reduce photosynthesis, affect enzyme and protein production and utilisation, alter nutrient transport and has negative effects on cellular functioning [3, 4].

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Sansevieria roxburghiana Schult. & Schult. f. (Agavaceae), called chaga in Telugu and *Marul* in Tamil, Indian bowstring hemp in English is an herbaceous perennial plant with short fleshy stem and stout rootstock, occurring in eastern coastal region of India, also in Sri Lanka, Indonesia and tropical Africa. In India, this plant has been traditionally used for several medicinal purposes. There are 16 essential nutrients in these plants. These are carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), sulphur (S), zinc (Zn), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo) and chlorine (Cl). These nutrient elements have to be available to the crops in quantities as required for a yield target. Any limiting or deficient nutrient (or nutrients) will limit crop growth [5]. These are helpful for the plant in photosynthesis and plant structure, stomatal function, enzyme activation, C4 metabolism *etc.*

The objective of this study is the levels of heavy metal lead influence on selected minerals such as sodium, potassium, calcium, manganese, iron, copper and zinc in *Sansevieria roxburghiana,* a medicinal plant.

2. MATERIAL AND METHODS

2.1 Plant material

Sansevieria roxburghiana was collected from Sri Venkateswara University, India. Botanical identification of the plant was done by K. Madhava chetty, Assistant professor, Department of Botany, Sri Venkateswara University, India.

2.2 Experimentation

Sansevieria roxburghiana plants (60 day-old plants) were hydroponically grown with 0, 60, 120, 180, 240 and 300 mg/l for 40 days period grown in Hoagland's medium (Hoagland and Arnon, 1950)[6]. The experiment was repeated for three times with six replicates. For the experimental procedure, plants were maintained with 16-h photoperiod (PAR 200 μmol m^{-2} s^{-1}, temperature 25 ±1°C, relative air humidity 50 - 60%). The nutritional solution was changed every 7 days and aerated every day.

2.3 Determination of lead and mineral nutrients

Harvested plants were successively oven-dried at 105^0C (for 30 min) and at 80^0C until they reached stable weight. These dry materials were analyzed for mineral nutrients (Pb) lead, calcium (Ca), sodium (Na) copper (Cu), iron (Fe), potassium (K), manganese (Mn) and zinc (Zn) quantities. The biomass of the oven-dried plant tissues was measured using an electronic scale. Then, the tissues were ground into a fine powder, digested in to a HNO_3 and $HClO_4$ solution (3:1; v/v), and heated at 120^0C for over 3 h. All measurements were performed using an atomic absorption (Analyst 200, Perkin Elmer, UK) [7, 8].

2.4 Data analysis

The significance of differences between the means of the treatments was evaluated by one way analysis of variance followed by Pearson correlation test at the significance level of $P<0.05$. The statistical SPSS version 12 was used for the analysis.

3. RESULTS AND DISCUSSION

Pb accumulation from 60-300 mg was 13, 24, 55, 71 and 98 mg/kg DW. Pb accumulation to a greater degree inhibited the mineral nutrition. However, changes was found in root and shoot length also. Pb accumulation of the treatments with different doses indicates that the Pb uptake is dose dependent (Table-1).

Table-1. Accumulation levels of Pb in *S.roxburghiana*

Pb supplemented (mg/l)	Pb accumulated (mg/kg DW)
Control	00
60	13
120	24
180	55
240	71
300	98

The mean concentration levels of mineral found in *Sansevieria roxburghiana* were summarized in Table -2. The mineral content shows potassium, zinc, manganese, copper and iron were main constituents of the watery mucilage part of this plant. Pb application significantly decreased in mineral content of treated plants when compared to controls. Mineral contents of all samples were reduced to Na (454±0.2), K (6±0.4), Ca (122±0.2), Zn (0.7±0.4), Cu (0.44±0.1), Mn (0.25 ±0.1) and Fe (0.73±0.4) from controls. Vast differences were established in Fe and K. These differences could probably be the result of lead toxicity. The ion balance in a cell is tightly linked with plant acclimation to heavy-metal phytotoxicity [9]. Furthermore, this is confirmed according to the Pearson correlation analysis, the significance was obtained as $P < 0.05$ (Table 2).

Table 2.Variations in mineral composition under 60-300 mg lead concentrations.

Critical Pb^{2+} activity caused decrease in K concentration in shoot of cowpea [10]. Ca concentrations in shoots of *A. gangeticus* with Pb were agreed with that of other workers. For

Mineral	Variation in mineral composition under different lead concentrations				
	60 mg Pb	120 mg Pb	180 mg	240 mg	300 mg
Sodium	592±0.3	557±0.5	520±0.4	476±0.3	454±0.2
Potassium	15±0.1	12±0.2	10±0.1	8±0.2	6±0.4
Calcium	240±0.3	213±0.2	180±0.3	166±0.3	122±0.2
Zinc	0.13±0.5	0.11±0.5	0.9±0.5	0.6±0.5	0.7±0.4
Copper	0.61±0.2	0.58±0.1	0.52±0.2	0.48±0.5	0.44±0.1
Manganese	0.52±0.2	0.49±0.2	0.41±0.2	0.37±0.2	0.25±0.1
Iron	1.98±0.3	1.62±0.3	1.16±0.5	0.94±0.3	0.73±0.4

Values are mean ± SD of six replicates

example, Ca concentrations decreased in grain, straw and roots of rice, shoot and root of radish and leaf, stem and root of Indian spinach due to Pb application [11]. The calcium content of *Sanseviera roxburghiana* is comparable to those of *Boerhavia diffusa*, *Commelina nudiflora* and soybeans [12]. Zinc content of shoots and roots of *A. gangeticus* and roots of *A. oleracea* decreased significantly with increasing rate of Pb application showing a negative relation between Pb and Zn [2].

Copper deficiency or excess can have a negative impact on plants. Similar decrease was observed in rye plants according to Szatanik-kloc et al 2014.The Cd contamination decreased the nutrients in the order of Zn > Mn > Na for *Phaseolus vulgaris* [13].

Table-3.Mineral composition effected by lead for 40 day period *Sansevieria roxburghiana*

Minerals	mg dw/100 g (Controls)	Reduced mg/kg dw/100 g	% ge Varied
Sodium	598±0.3	454±0.2	75.9
Potassium	18±0.2	6±0.4	33.3
Calcium	245±0.3	122±0.2	49.7
Zinc	0.14±0.5	0.7±0.4	50.0
Copper	0.65±0.2	0.44±0.1	67.6
Manganese	0.55±0.2	0.25 ±0.1	45.4
Iron	2±0.3	0.73±0.4	36.5

Values are means ± SD of six replicates

Mineral composition effected by lead for 40 day period *Sansevieria roxburghiana* was reported in table-3.The optimally balanced mode of mineral ions plays a central role in plant metabolism [14]. However, no consensus exists with regard to the effects of Pb on mineral absorption because there are inconsistent results due to discrepancies and interactions between heavy-metal ions and plant tissues.

4. CONCLUSION

Lead application in our study significantly decreased mineral conntent of *S.roxburghiana*. The reductions of minerals were of *S.roxburghiana* were Na (75%) K (33%) Ca (49%) Zn (50%) Cu (67%) Mn (45%) and Fe (36%), when compared with control (Table 3). A decrease in all minerals up to 120 mg lead was not affected severely but from 180–300 mg lead concentrations showing a drastic decrease in minerals of shoots of *Sansevieria roxburghiana* under Pb application.

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