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Phytoremediating Capability of Amaranthus Polygonoides Under Zinc Application

KEYWORDS: Zinc, Amaranthus polygonoides, extinction coefficient, FTIR

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ABSTRACT *Effect of zinc on the organic content was investigated in Amaranthus polygonoides plants grown in pot culture experiment with zinc treatment of different concentration. Zinc was applied to the soil in the form of zinc sulphate. The control leaves were sampled at 30th, 45th, 60th day and the stems were sampled at 60th day after sowing analysed by IR. Intensity variations were observed with the age of greens and with different concentrations (50,100,150,200,250(mg/kg)). From the present investigation, it was concluded that the 50-100 mg/kg level of zinc in the soil was beneficial for the growth of plants. Above 150mg/kg the zinc level proved to be toxic by decreasing extinction coefficient value. The results indicated that the 50-100 mg/kg zinc level can be applied to soil for increasing the organic content.*

1. INTRODUCTION

Heavy metals have an important role to environmental pollution as a result of human activities. Heavy metals are elements with high relative atomic mass (usually greater than 6 g/cm3) such as Zn, Ni, Cd, Pl, Al, Mo, Cu, Sn, etc [1]. The amount of these heavy metals in our environment increases as a result of industrialization [2]. All the heavy metals at high concentration have strong toxic effects and are regarded as environmental pollutants [3].phytoremediation is defined as the use of plants to remove pollutants from environment or to render them harmless [4]. Zinc is one of the essential elements for many physiological processes in plants, but its higher concentration, makes it toxic [5].Heavy metals are not biodegradable and tend to accumulate in biological systems. The environment has been found to absorb pollutants or clean up itself by natural biological/biochemical activities hence the increasing use of plant to remediate to the environment. Plants can accumulate and magnify trace pollutants like heavy metals to a level that is toxic to lives [6]. An excess of these metal ions or of soluble metal chelates may induce a series of biochemical and physiological alternations in plants, such as deficiency of essential nutrients [7], inhibition of photosynthesis [8]. Many trace metal elements such as iron, manganese, copper, zinc, and molybdenum are essential to biological growth in small quantities, which are optimum for plant growth [9]. If the concentrations of these metals are lower than that of the optimum range, then it leads to deficiency of these elements. These elements are also toxic to organisms if present at concentration even slightly above the optimum levels.

2. MATERIALS AND METHODS:

The present investigation has been carried out to find out the effect of zinc, a heavy metal pollutant on growth of organic content and chlorophyll of leaves and stems of Amaranthus polygonoides.

2.1 Pot Culture Experiments:

The pot culture experiments were conducted under green house condition in polythene coated pots.

Fig2.1. Control greens

Fig2.2. Different concentration of zinc treated plant.

Each pot contained 2 kg of air dried soil. Zinc was applied to soil with different concentration (50, 100, 150, 200 and 250 mg/ kg soil) in the form of zinc sulphate. The pH of soil was 6.4 .The leaves samples were collected at 30th, 45th, and 60th day after sowing (DAS) and the stems were collected at 60th DAS. The organic content of the plants were estimated using FT-IR by calculating extinction coefficient value.

2.2 Sample Collection:

The control leaves samples were collected at 30th, 45th, 60th day's after sowing. Zinc treated leaves were collected at 45th day after sowing. The control and zinc treated stems were collected at 60th day after sowing. The leaves and stems were thoroughly washed to remove clay, sands, dusts and associated algae. The leaves and stems samples were shade dried and dried in oven at 60°C for four hours to remove moisture content. Dried samples were ground into fine pow-

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der using agate mortar. Then FT-IR spectrum was taken using KBr pellet technique in the region 4000-600cm-1. The organic content of the leaves and stems were estimated by extinction coefficient value.

3. RESULTS AND DISCUSSION:

The extinction coefficient 'K' of prominent absorption bands for different ages of control leaves, zinc treated leaves and stems of Amaranthus polygonoides plants were given in table 1, 2 and 3.A very strong absorption band at 3412,3419 cm-1 due to presence of bonded N-H/C-H/O-H stretching of amines and amides. [10]. The absorption band at 2920, 2924cm-1are due to stretching vibrations of –CH2 groups indicates the presence of aliphatic CH groups in these compounds [11] and of the chlorophyll groups [12] .Band at 1735 cm-1 shows the characteristics of C=O stretching indicates carbonyl groups [13].bands at 1642 and 1624cm-1 shows C=O stretching phenyl ring amino acid-I and N-H bending of amine [14]. A symmetrical stretching of NO2 group results in strong absorption band at 1630 cm-1 indicates the presence of amines (protein) [15]. The 1242 cm-1 band in all samples predict the presence of ester carbonyl group. The absorption bands at 1100-1000 cm-1 region indicate several modes such as C-H deformation or C-C stretching, pertaining to carbohydrates. The bands at 1312-1318 cm-1 show amide III band components of proteins collagen [16]. The absorbance band at 837-721 cm-1 represents C-H in plane and out of plane bending for the benzene ring. From the above discussion it results that the bands 3420, 2920, 1637, and 1321 confirm that the plant contains all the organic compounds, amino acids, amides, carbohydrates and chlorophyll, and also the organic content of leaves and stems were increased above the control level at lower concentration (50 - 100mg kg-1) and decreased further with an increase in the zinc level (150-250 mg kg-1). Similar results can be obtained in radish plants, chilly, marigold, mustard and pigeon pea [4, 17] under zinc application.

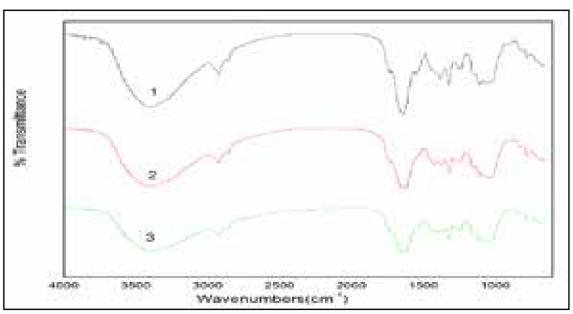

Fig 3.1 FT-IR spectra of control green leaves
1, 2, 3- FT-IR spectra of control greens leaves analysed at 30th, 45th , and 60th DAS respectively.

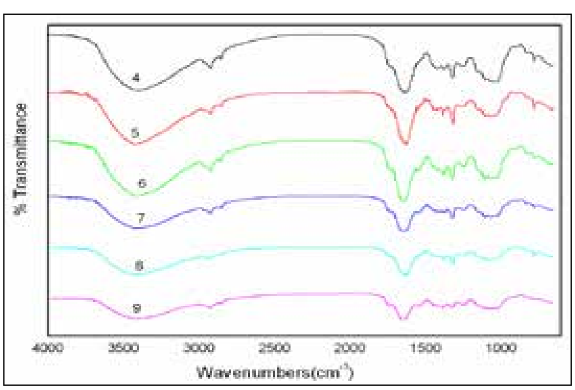

Fig3.2.FT-IR spectra of zinc treated green leaves
4,5,6,7,8,&9-FT-IR spectra of green leaves analysed at 45th DAS with zinc application of 0,50,100,150,200,250 mg/kg respectively.

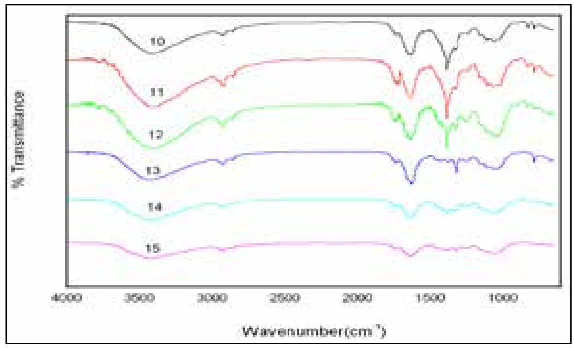

Fig3.3.FT-IR spectra of zinc treated green stems
10,11,12,13,14,&15-FT-IR spectra of green stems analysed at 60th DAS with zinc application of 0,50,100,150,200,250 mg/kg respectively.

The changes of total organic constituents in control, different treatment of zinc applied plants can be calculated by extinction coefficient (K) using the relation.

K= DA/m cm2/mg

Where D-optical density of absorption band, log (I0/I); A-Area of the pellet (cm2): m-mass of the sample in the pellet (mg).

Table 3.1. Extinction coefficient (K) values of prominent absorption bands for control greens (A.polygonoides) leaves at different sampling days

Spectrum number of Fig 1.	Sampling days	Extinction coefficient 'K'(cm2/mg)			
		Frequency (cm-1)			
		3412	2920	1642	1318
1	30	0.6863	0.1117	0.4399	0.0963
2	45	0.3386	0.0430	0.2503	0.0861
3	60	0.2033	0.0395	0.1822	0.0799

Table3.2.Effect of zinc on 'K' of prominent absorption bands for greens (Amaranthus polygonoides) leaves analysed at 45th DAS.

Spectrum number of Fig 2.	zinc applied in soil (mg/kg)	Extinction coefficient 'K'(cm2/mg)			
		Frequency (cm-1)			
		3412	2920	1642	1318
4	0	0.3386	0.0430	0.2503	0.0861
5	50	0.3922	0.0632	0.3189	0.1104
6	100	0.3893	0.0557	0.3054	0.1038
7	150	0.2375	0.0389	0.2453	0.0729
8	200	0.1593	0.0284	0.1705	0.0649
9	250	0.1504	0.0274	0.1591	0.0331

Table3.3.Effect of zinc on 'K' of prominent absorption bands for greens (Amaranthus polygonoides) stems analysed at 60th DAS

Spectrum number of Fig 2.	zinc applied in soil (mg/kg)	Extinction coefficient 'K'(cm2/mg)			
		Frequency (cm-1)			
		3419	2924	1624	1317
10	0	0.1206	0.0335	0.1183	0.0996
11	50	0.1371	0.0517	0.1297	0.1082
12	100	0.1310	0.0420	0.1268	0.1061
13	150	0.1084	0.0169	0.1033	0.0546
14	200	0.0783	0.0133	0.0561	0.0133
15	250	0.0388	0.0107	0.0280	0.0076

4. CONCLUSION

Zinc levels at 50-100 mg kg-1 in the soil the organic content are increased in A. polygonoides. Further increase of zinc

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level in the soil (150-250 mg kg-1) the organic content were decreased. From the present investigation, it was concluded that the 50-100 mg kg-1 level of zinc in the soil was beneficial for the growth of polygonoides plants. The level of zinc in the soil above 150 mg kg-1 proved to be toxic. The results indicated that the 50-100 mg kg-1 zinc level can be applied for increasing the organic content of plants.

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