

Abstract

The natural and anthropogenic contamination of water by arsenic has become a major concern to the environmental and public health. Phytoremediation is an attractive alternative to ecologically friendly remove contaminants at a potential high efficiency and low cost. Absorption of As(III) and As(V) was evaluated by the measuring the content of arsenic in the roots, leaves and stems *Cassia fistula* grown under controlled conditions in a hydroponics system. After seeds were germinated, the plants were grown in Hoagland nutrition solution individually supplemented with 1, 2, 5 ppm of As(III) and As(V). After two weeks of exposure, samples of leaves, roots, and stems were analyzed by ICP-OES. The results show the highest average amount arsenic was present in the roots and leaves in the plants; the presence of arsenic is favored in a range of concentrations of 1-5 ppm. *Cassia fistula* shows a promising alternative for the removal of arsenic in contaminated water.

Methods

ICP-OES : The parameters using for the ICP-OES analysis were as follows:

Parameter	Setting
RF power	1500 W
Nebulizer	Gemcone (low flow)
Plasma Flow	15 L/min
Auxiliary Flow	0.2 L/min
Nebulizer Flow	0.55 L/min
Sample Flow	1.50 mL/min
Injector	2.0 mm Alumina
Spray Chamber	Cyclonic
Integration Time	10-20 seconds
Replicates	3

Wavelength Table: Selected wavelengths used for elemental analysis on ICP-OES

Elements	Wavelength(nm)
Na	589.592
Mg	279.077
P	213.617
S	181.975
K	404.721
Ca	315.887
Mn	259.372
Fe	238.205
Ni	231.604
Cu	327.39
As	188.979

Plant germination & Cultivation

Cassia fistula seed pods were obtained from nearby trees on The University of Texas Rio Grande Valley-Brownsville, TX campus. The seeds were washed, peeled, scarred and left soaking overnight in distilled water and treated with PHYSAN 20 fungicide. The golden shower seeds were germinated in sterilized paper towels that were dampened with water and placed in an incubator for about 2 weeks. After 2 weeks they were taken out and placed in a hydroponic system in Hoagland's nutrient solution for 1 week. Then contaminated with As(III) and As(V) for 2 weeks. After germination the golden shower seedlings were separated into leaves, stems, and roots.

Acid Digestion

Cassia fistula seedlings were separated into leaves, stems, and roots and placed in a Labconco Freeze-Dry System. After the samples were ground with a mortar and pestle each sample was weighed approximately 0.5g. The lyophilized samples were digested in 10mL of pure trace metal nitric acid. Samples were placed on a hot plate under a fume hood under gentle boiling until about 2mL of digested solution was left. Then 2mL of hydrogen peroxide was added and left to gently boil until sample was nearly dried out. Once sample was mostly dried with the hydrogen peroxide it was left too cool and diluted with 20mL of 5% nitric acid.

Results

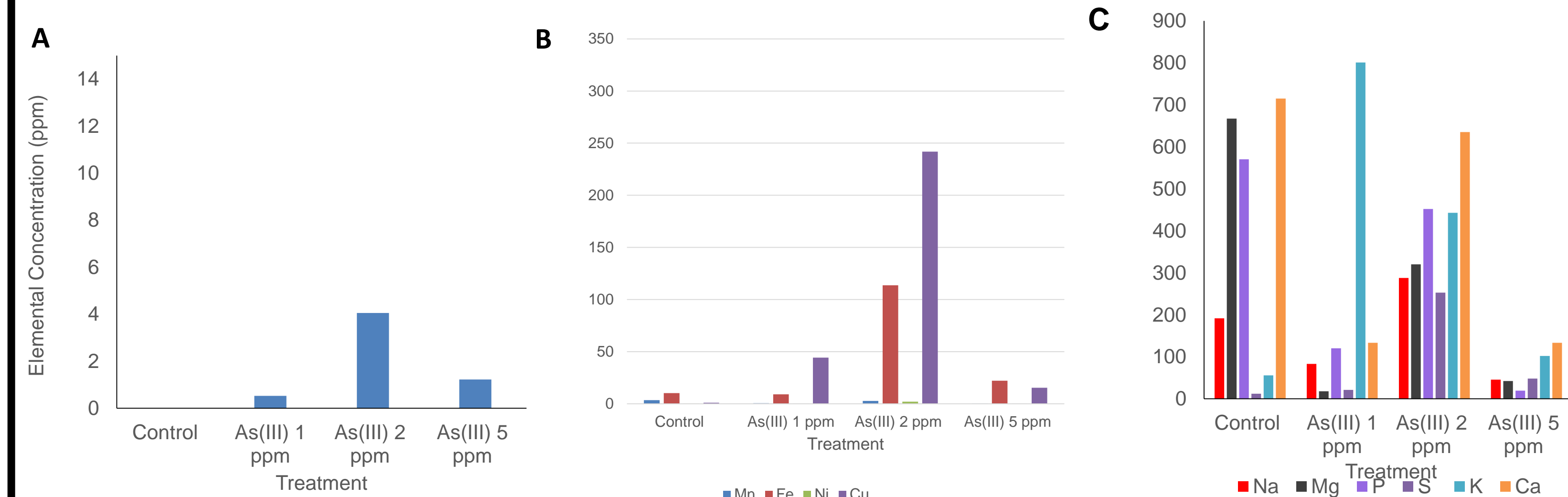


Figure 1: A. As(III) accumulated in roots of *Cassia fistula* (golden shower) seedlings. B. Concentration of macronutrient s accumulated in sunflowers after treatment with As(III). C. Micronutrients accumulated in Sunflowers after treatment with As(III).

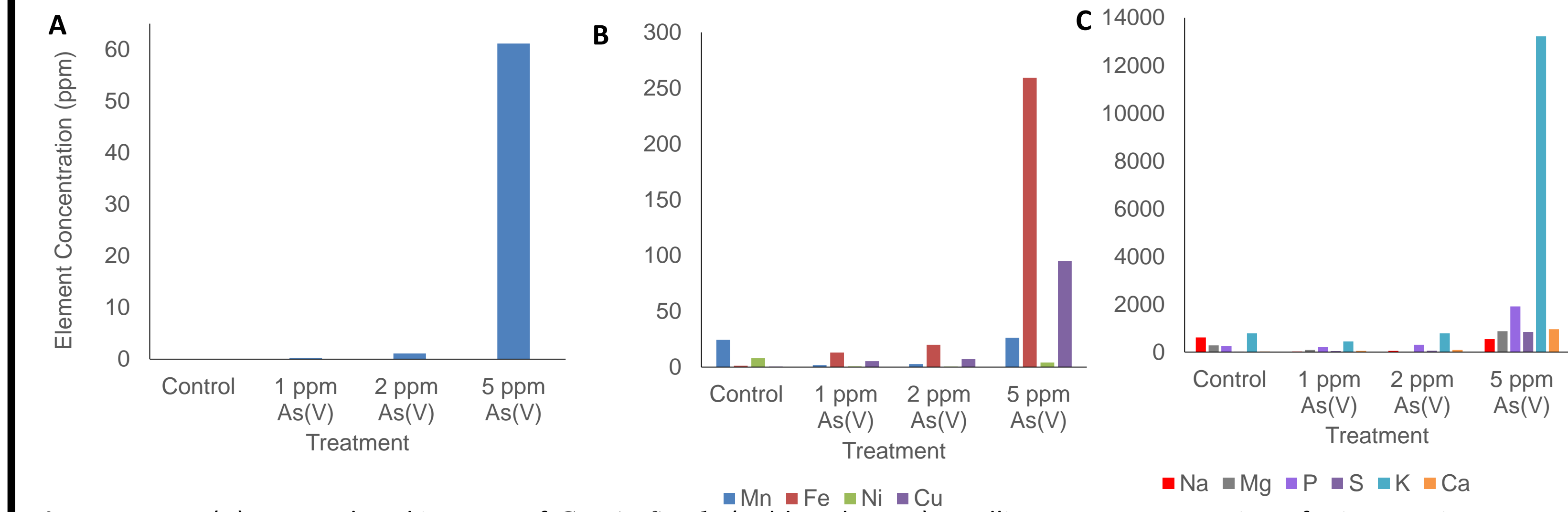


Figure 2: A. As(V) accumulated in roots of *Cassia fistula* (golden shower) seedlings. B. Concentration of micronutrients accumulated in *Cassia fistula* (golden shower) seedlings after treatment with As(V). C. Macronutrients accumulated in *Cassia fistula* (golden shower) seedlings after treatment with As(V).

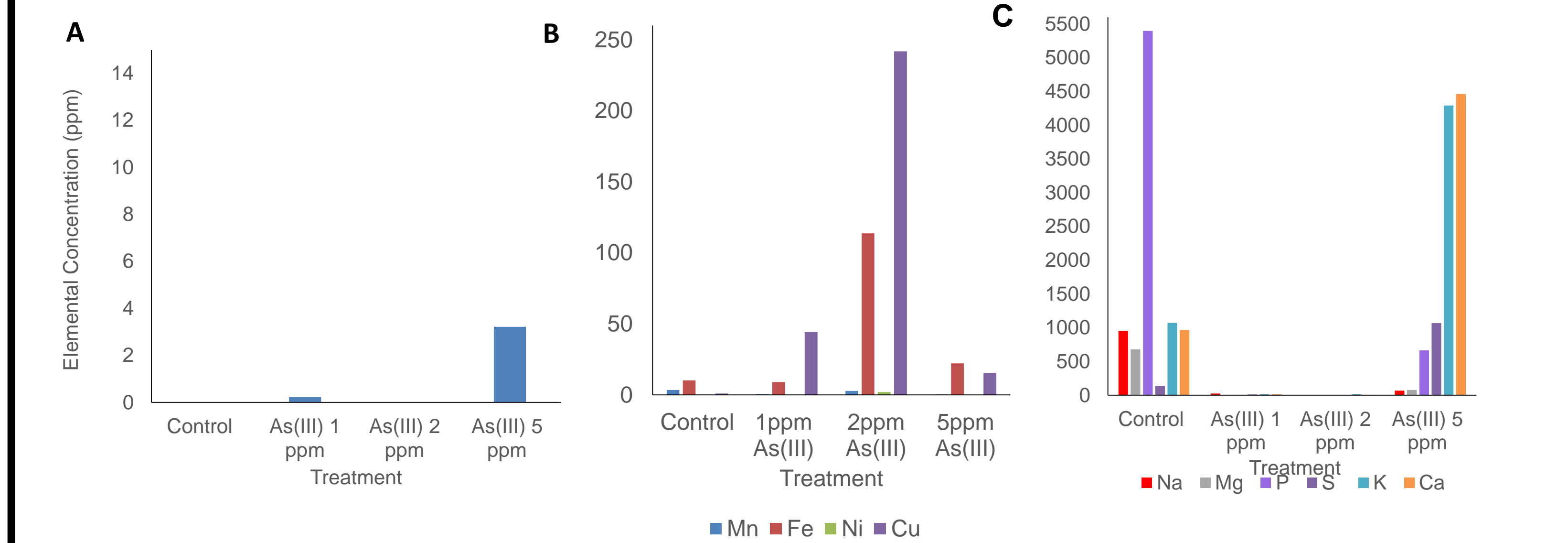


Figure 3: A. As(III) accumulated in Stems of *Cassia fistula* (golden shower. B. Concentration of micronutrients accumulated in *Cassia fistula* (golden shower stems after treatment with As(III). C. Macronutrients accumulated in *Cassia fistula* (golden shower stems after treatment with As(III).

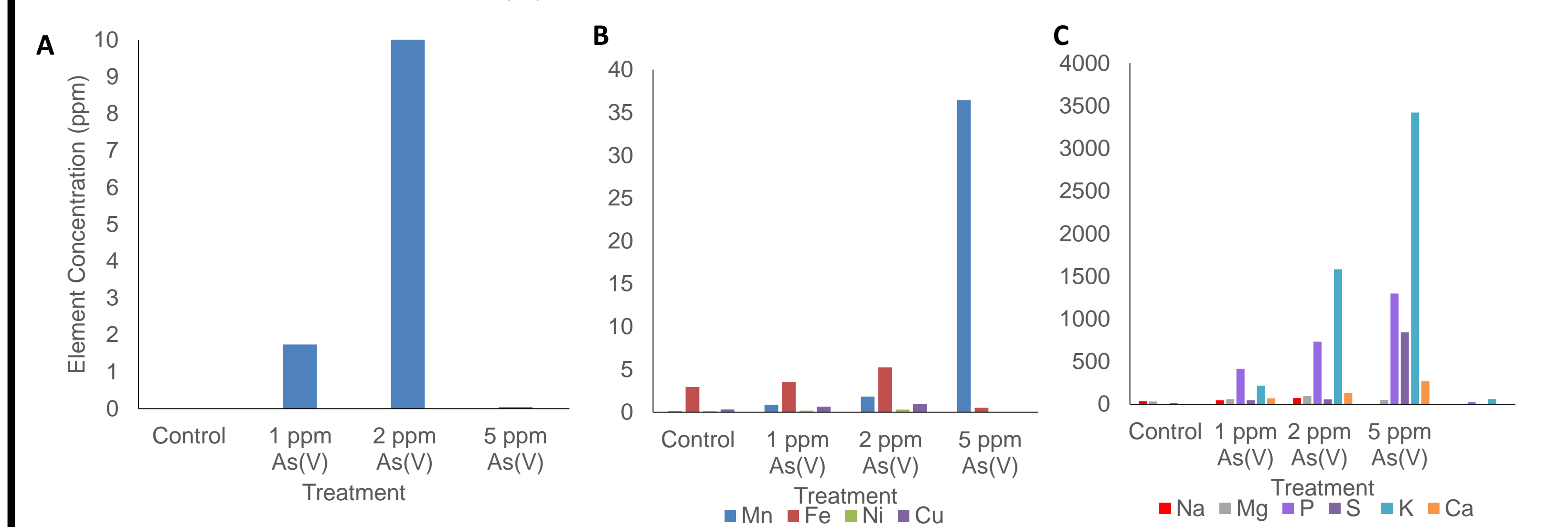


Figure 4: A. As(V) accumulated in Stems of *Cassia fistula* (golden shower. B. Concentration of micronutrients accumulated in *Cassia fistula* (golden shower stems after treatment with As(V). C. Macronutrients accumulated in *Cassia fistula* (golden shower stems after treatment with As(V).

Results

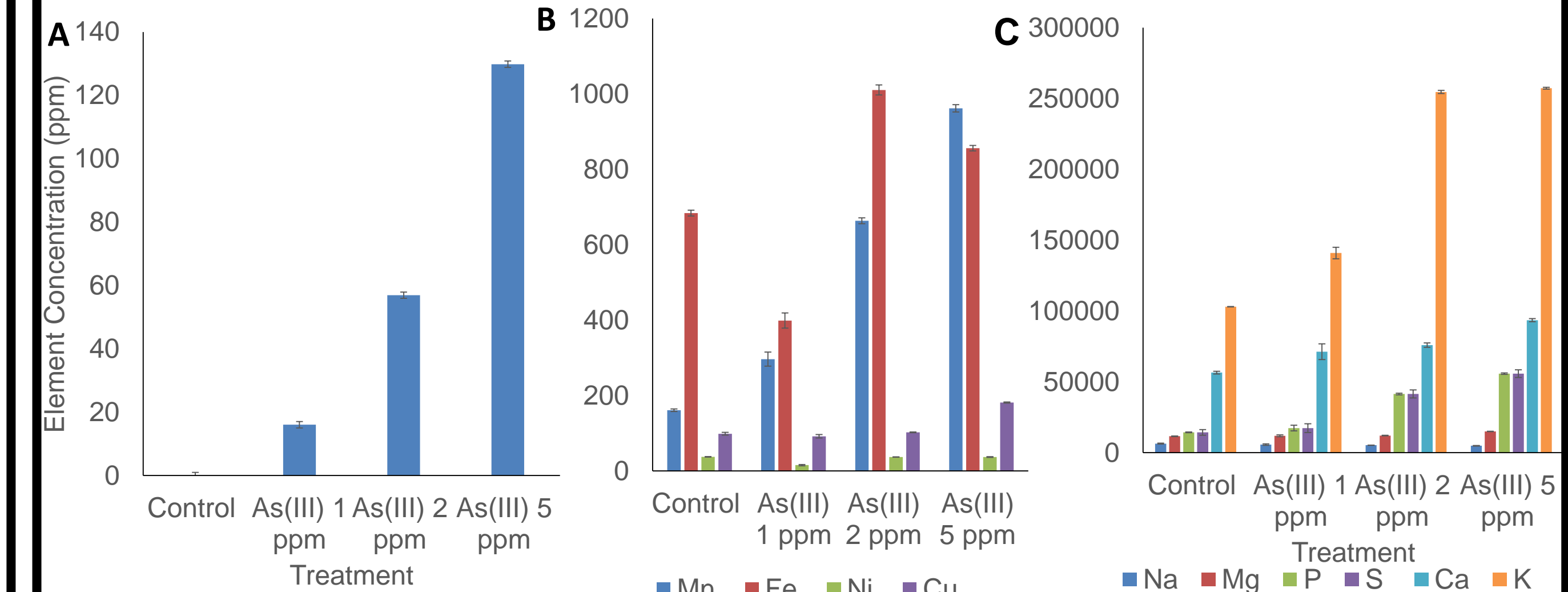


Figure 5: A. As(III) accumulated in leaves of *Cassia fistula* (golden shower. B. Concentration of macronutrients accumulated in sunflowers leaves after treatment with As(III). C. Micronutrients accumulated in *Cassia fistula* (golden shower leaves after treatment with As(III).

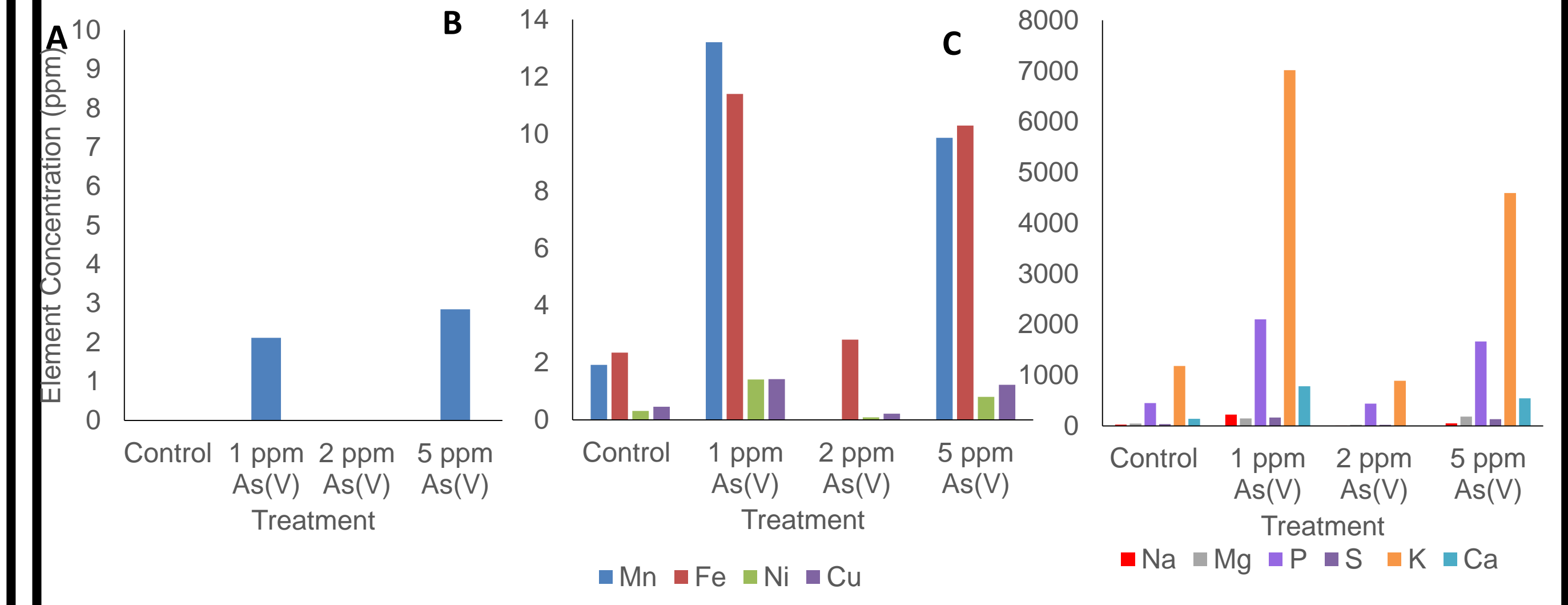


Figure 6: A. As(V) accumulated in leaves of *Cassia fistula* (golden shower. B. Concentration of Micronutrients accumulated in *Cassia fistula* (golden shower leaves after treatment with As(V). C. Macronutrients accumulated in *Cassia fistula* (golden shower leaves after treatment with As(V).

Discussion

- The uptake data shows a high absorption of 5ppm As(V) in the leaves, and roots. The high concentrations of arsenic in the leaves and roots demonstrates the mobility of As(V) throughout the plant. As well as an increase in the macronutrient's potassium and calcium. Figure 2A & Figure 6A demonstrate a high concentration of As(V) 5ppm in the *Cassia fistula* seedling root and leaves.
- As(III) was shown absorb a high concentration of As(III) in the leaves and roots. Figure 1 shows the results of As(III) in the plant was the highest at a 2ppm concentration in the plant root, and Figure 5A demonstrates a high absorption of As(III) 5ppm in the leaves. Figure 5B also demonstrates an increasing macronutrients potassium & calcium.
- The simultaneous increase of calcium and potassium levels in the seedlings as the As(V) and As(III) concentration increase can be a response to the heavy metal toxicity.
- Calcium and potassium are essential macronutrients

Acknowledgements

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