

Abstract

Phytoremediation provides a cost-effective, non-invasive technique to remove contaminants from the soil and groundwater. Sunflowers are fast growing and have a showed effective at removing various pollutants from soil, including lead and other heavy metals. Health issues related to arsenic are mainly attributed to exposure of arsenite, whereas arsenate is much less toxic. The common sunflower *Helianthus Annuus* was the species used to remove both arsenic (III) and As(V) ions from hydroponics solutions. In the present study sunflower seeds were germinated for a week, placed under the sun for a day and subsequently placed in a nutrient solution to aid the growth of the plant. After one week of growth in the nutrient solution the sunflowers were transferred to nutrient solution contaminated with either arsenite or arsenate (at concentrations of 1 ppm, 3 ppm and 5 ppm arsenic). The capacity of the sunflowers to absorb and store arsenic was determined based on a dry mass biases. The sunflower plants were dried and digested in nitric acid and analyzed with a Perkin Elmer Optima 8300 Inducted-Coupled Plasma Optical Emission Spectroscopy (ICP-OES) for arsenic, macronutrient and micronutrient content. The samples analysis were performed based on three different section of the plants, which were roots, stems and leaves.

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 of ICP-OES:

Element	Wavelength
Ag	328.028
As	188.979
Al	396.153
B	249.677
Ba	233.527
Ca	317.933
Cd	228.802
Cu	324.752
Fe	259.939
Mg	285.213
Mn	257.610
Ni	231.604
Sn	189.927
Pb	220.353
Zn	213.857

Digestion: Acid Digestion Method:

Acid digestion to dissolve sample into solution for ICP-OES analysis

5ml of Nitric Acid were added to sample powder on hotplates until evaporation point. When solution reduces to 1ml, samples were taking off and 2ml of Hydrogen Peroxide were added until evaporation point on hot plates. When solution reduces to 1ml or almost nothing 20 ml of 3% Nitric Acid were added, samples were cool down and placed on special tubes for ICP-OES analysis.

Results

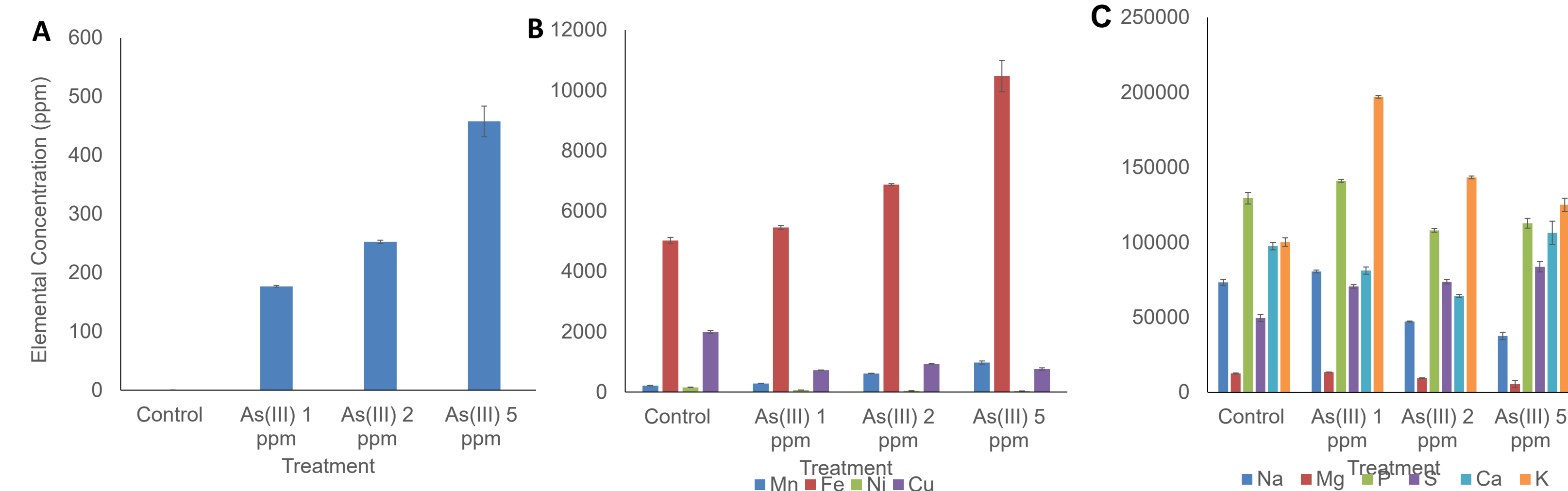


Figure 1: A. As(III) accumulated in roots of Sunflowers. B. Concentration of macronutrients accumulated in sunflowers after treatment with As(III). C. Micronutrients accumulated in Sunflowers after treatment with As(III).

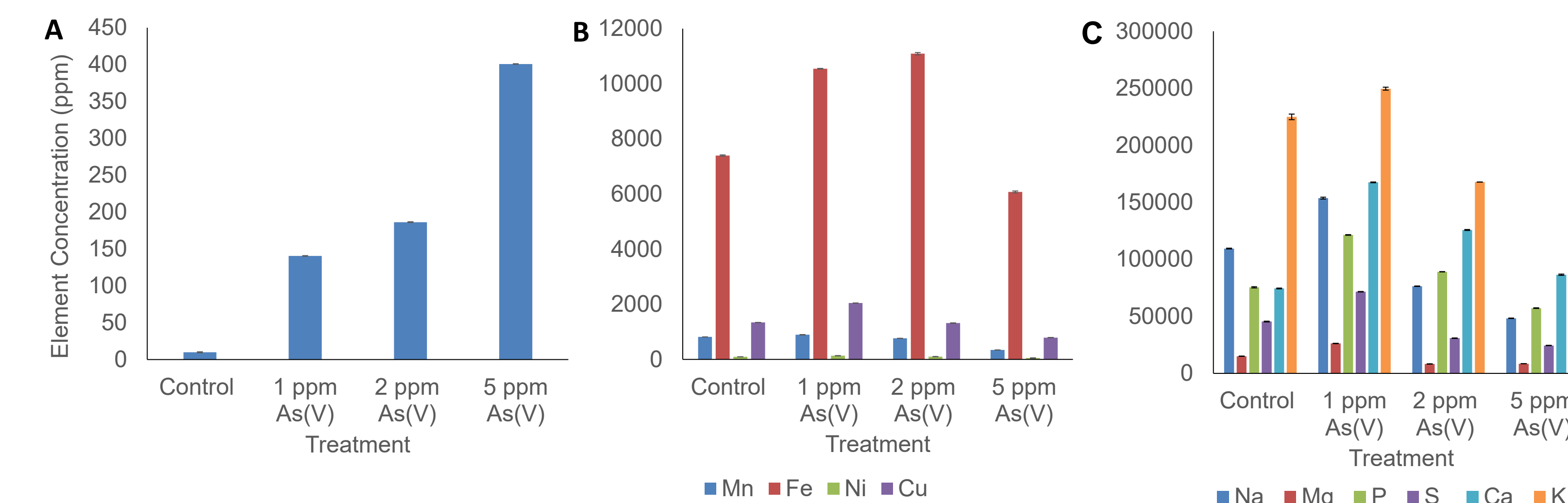


Figure 2: A. As(V) accumulated in roots of Sunflowers. B. Concentration of macronutrients accumulated in sunflowers after treatment with As(V). C. Micronutrients accumulated in Sunflowers after treatment with As(V).

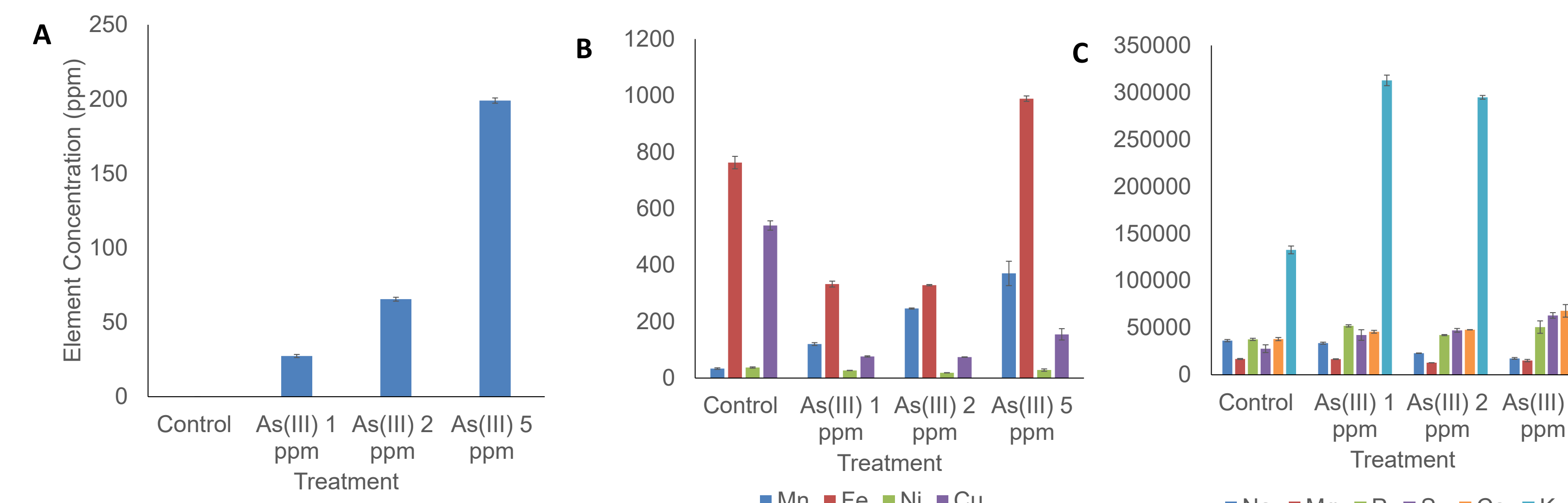


Figure 3: A. As(III) accumulated in Stems of Sunflowers. B. Concentration of macronutrients accumulated in sunflowers stems after treatment with As(III). C. Micronutrients accumulated in Sunflower stems after treatment with As(III).

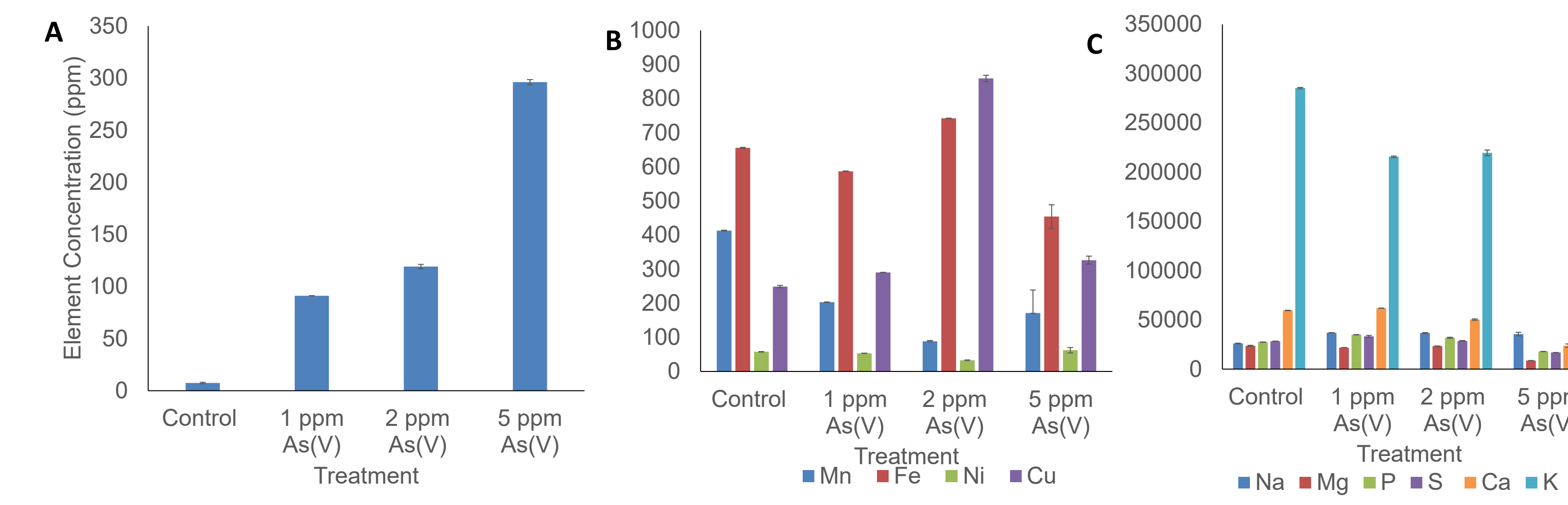


Figure 4: A. As(V) accumulated in Stems of Sunflowers. B. Concentration of macronutrients accumulated in sunflowers stems after treatment with As(V). C. Micronutrients accumulated in Sunflower stems after treatment with As(V).

Results

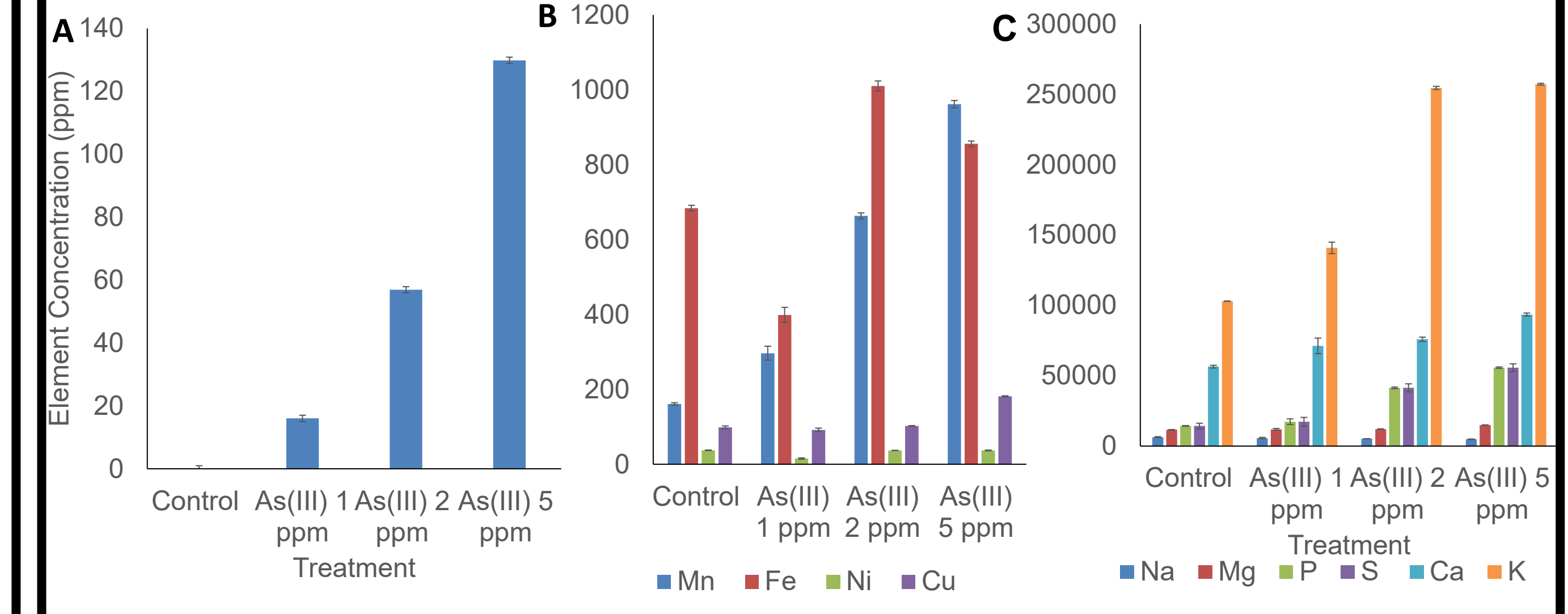


Figure 5: A. As(III) accumulated in leaves of Sunflowers. B. Concentration of macronutrients accumulated in sunflowers leaves after treatment with As(III). C. Micronutrients accumulated in Sunflowers leaves after treatment with As(III).

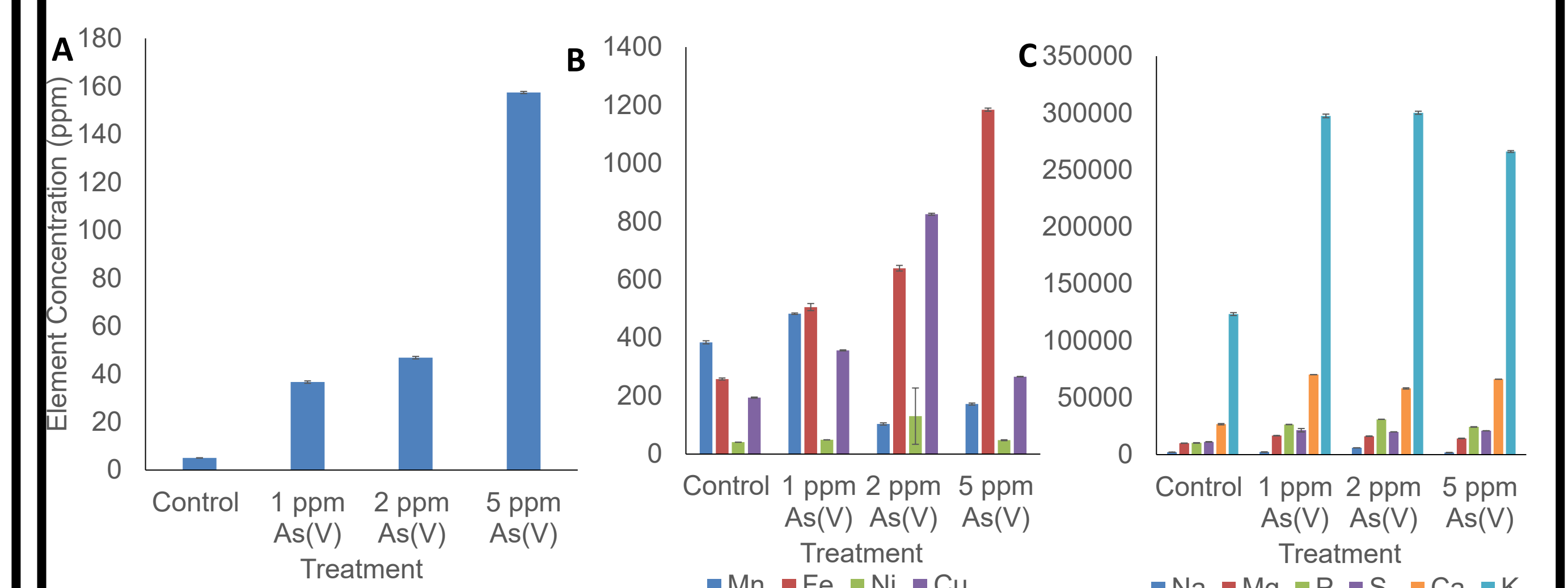


Figure 6: A. As(V) accumulated in leaves of Sunflowers. B. Concentration of macronutrients accumulated in sunflowers leaves after treatment with As(V). C. Micronutrients accumulated in Sunflowers leaves after treatment with As(V).

Discussion

Control and Contaminated Plants:

- Variation in accumulation of micronutrients and macronutrients after the treatment.

1 ppm, 3ppm, 5ppm As (III) Plants (Roots):

- 150 – 470ppm of As was absorbed.

1 ppm, 3ppm, 5ppm As (III) Plants (Stem):

- 45- 220ppm of As was absorbed.

1 ppm, 3ppm, 5ppm As (III) Plants (Leaves):

- 20 -130 ppm of As was absorbed.

1 ppm, 3ppm, 5ppm As (V) Plants (Roots):

- 150 – 400ppm of As was absorbed.

1 ppm, 3ppm, 5ppm As (V) Plants (Stem):

- 55- 300ppm of As was absorbed.

1 ppm, 3ppm, 5ppm As (V) Plants (Leaves):

- 30 -160 ppm of As was absorbed.

Roots:

- Recorded the highest absorption of Arsenic (V) and (III).

Acknowledgements

This project was supported by the National Institute of General Medical Sciences-award number 1R25GM100866 (RKD and JGP). The USDA IFSEEN program, the UTRGV Deans office of the College of Science, The UTRGV high scholars, the Welch Foundation, and the UTRGV RISE program for their support through their grants.

