Physiological and biochemical effects of copper nanoparticles in bell pepper (*Capsicum annum* L.) plants

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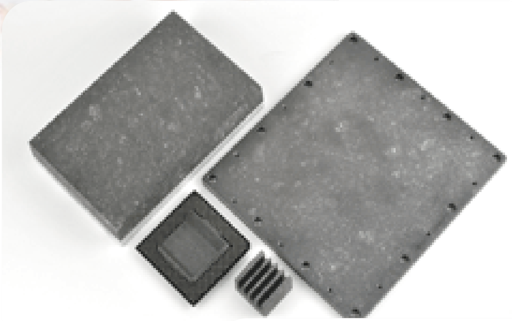
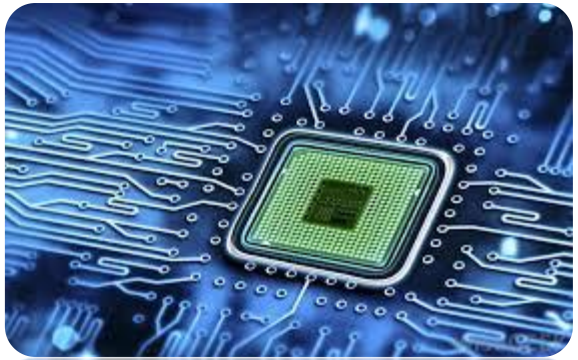
INTRODUCTION

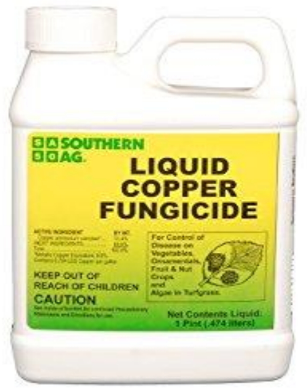
Properties of Nanomaterials

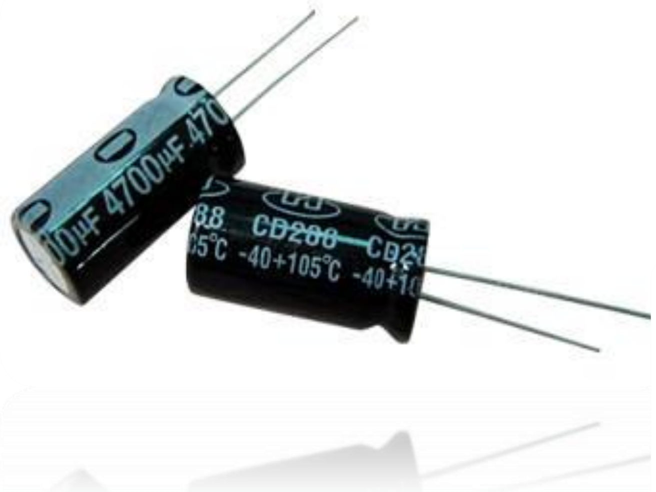
- Materials with at least 2 dimensions between 1 nm and 100 nm.
- Size range between individual molecules and the corresponding bulk materials
- High surface energy
- Quantum confinement
- High redox activity

Applications of Copper NPs



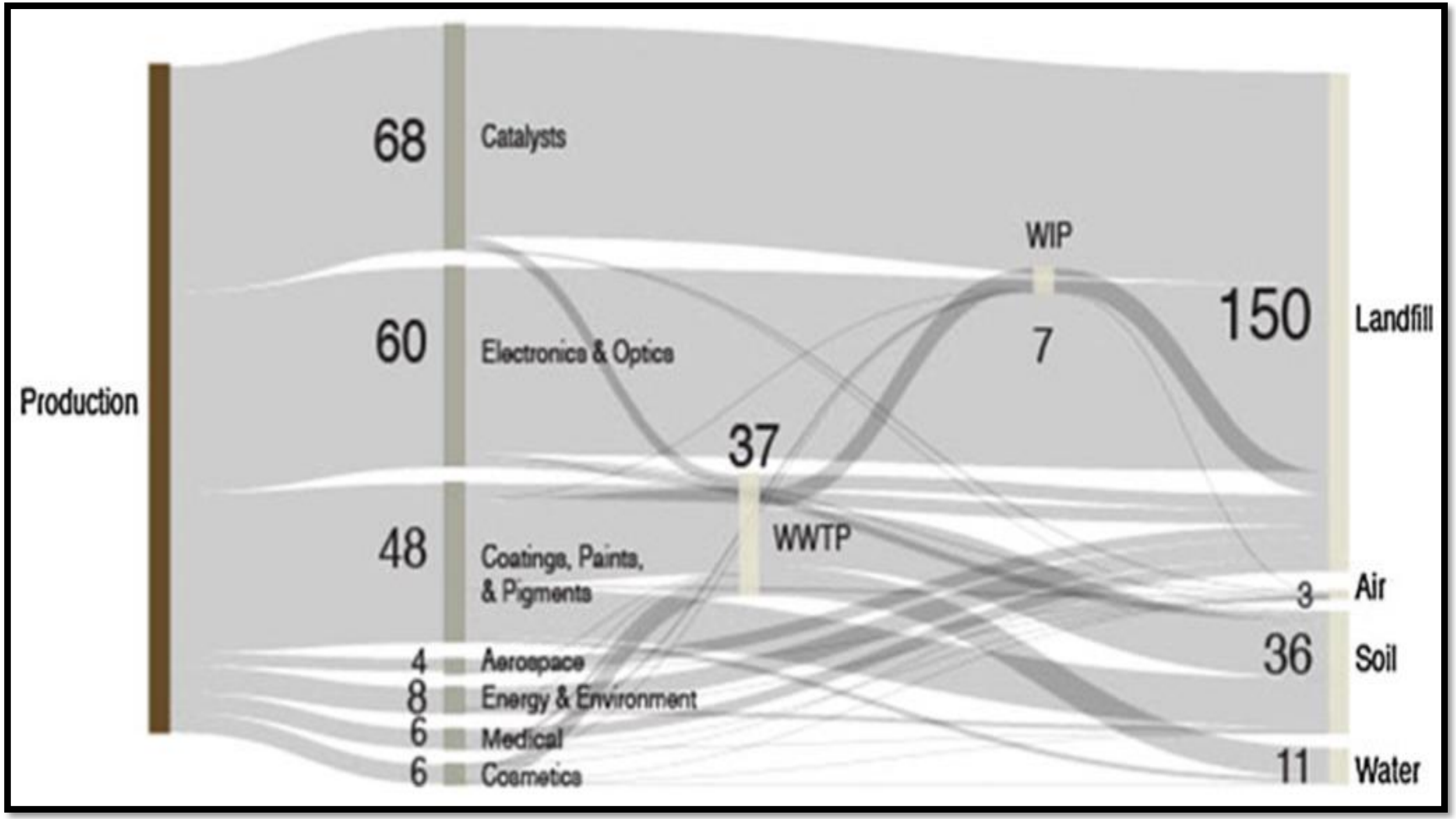






https://www.azonano.com/article.aspx?ArticleID=3271

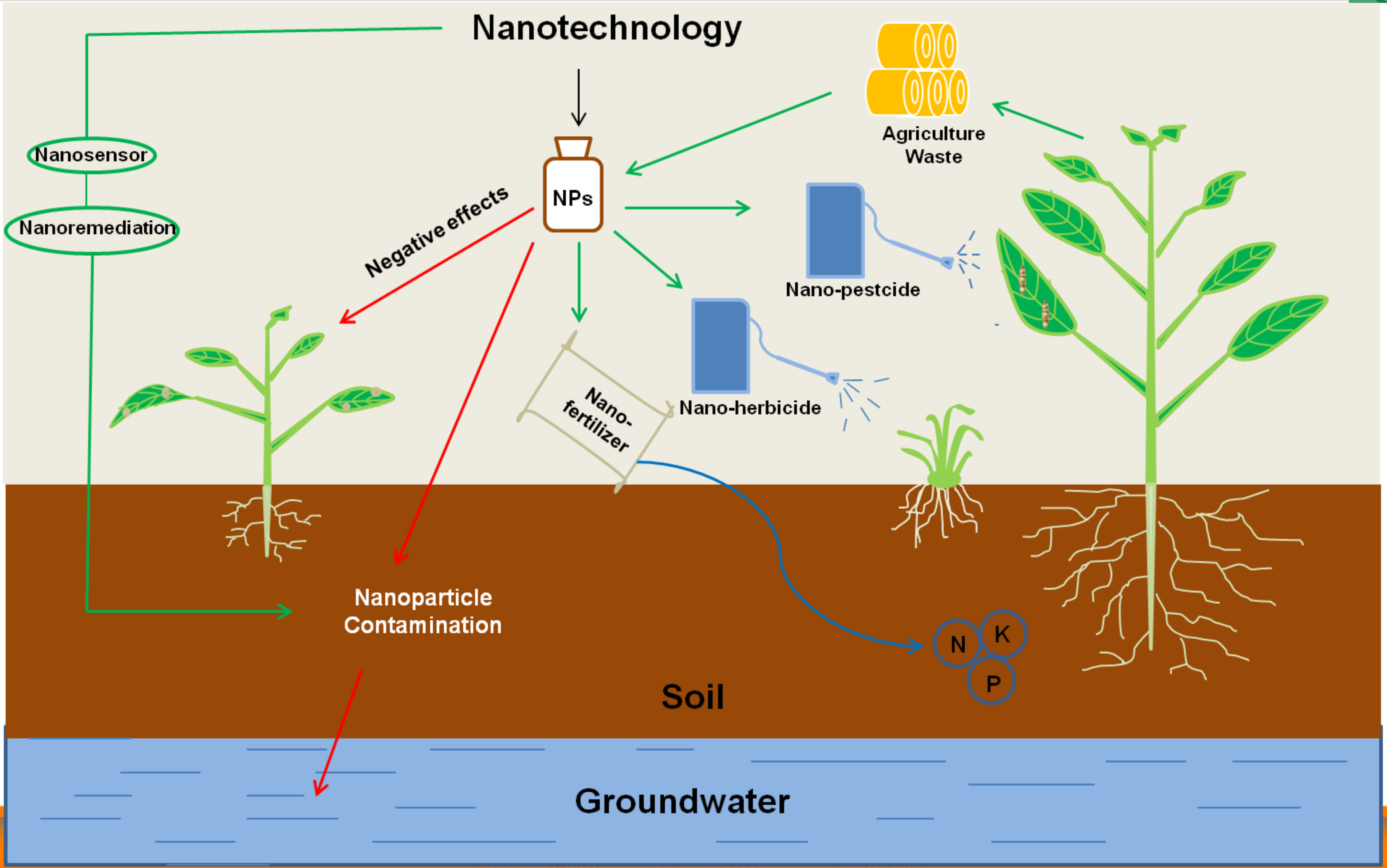
Global flows for Cu and oxides of Cu (metric tons/yr) in 2010



Keller, Arturo A., Suzanne McFerran, Anastasiya Lazareva, and Sangwon Suh. "Global Life Cycle Releases of Engineered Nanomaterials." *Journal of Nanoparticle Research* 15, no. 6 (2013): 1-17.

Application of NPs in agriculture

UC CEIN



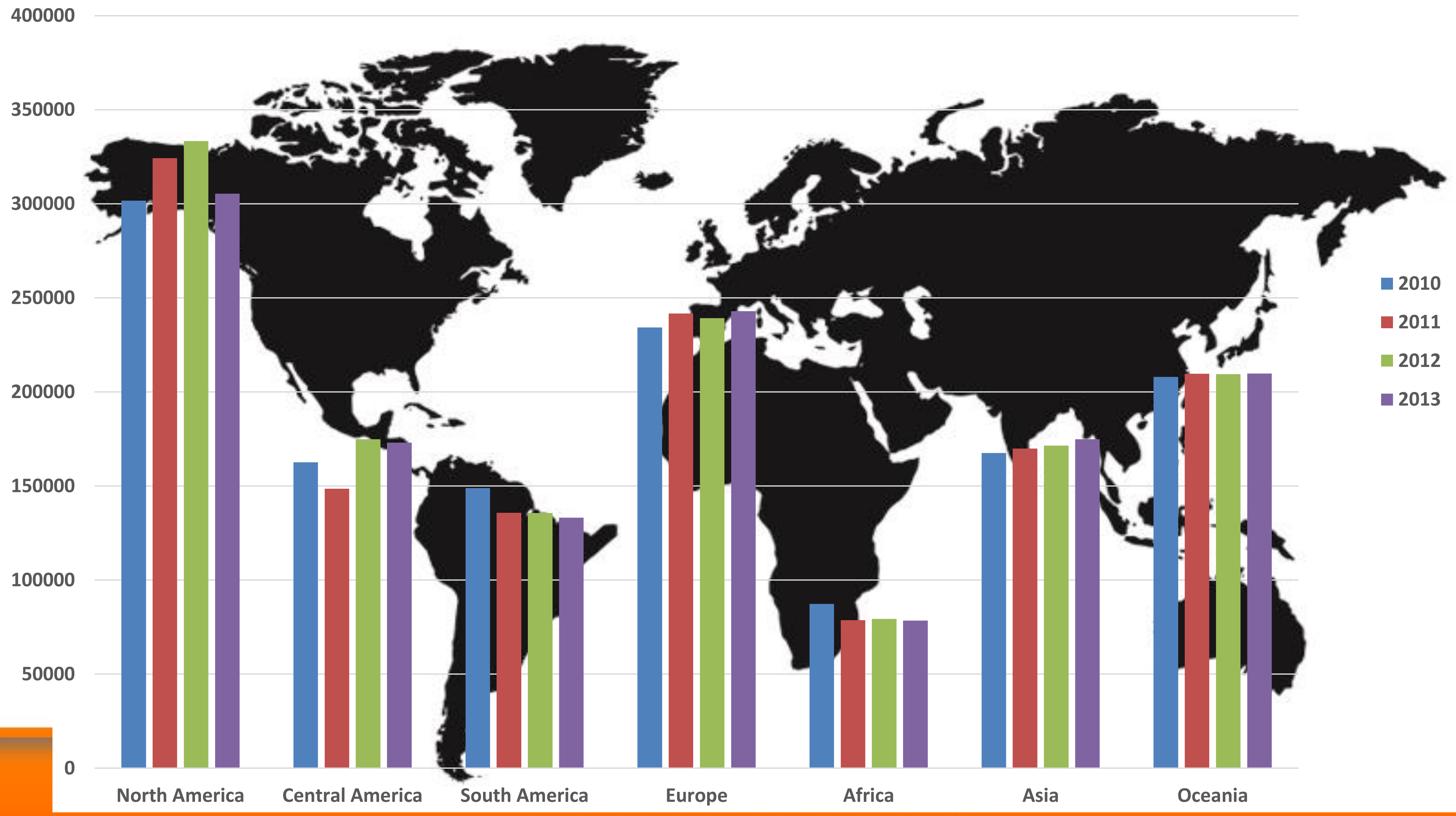
Hong, J., Peralta-Videa, J.R. & Gardea-Torresdey, J. 2013, "Nanomaterials in agricultural production: benefits and possible threats?".

Bell pepper plants *(Capsicum annum* L.*)*

- *Capsicum annuum L.*
- Chilli or pungent flavor attributed to the chemical *capsaicin* 8-methyl-N-vanillyl-6-noneamide
- Rich in anti-oxidants like carotenoid, sugars, vitamin C
- Average consumption 10.6 lbs/person/ year
- 46,500 acres of land cultivated to produce 1535 million lbs
- 60% of the nations bell peppers grown by California
- Average yield 33,000 lbs/acre

https://authoritynutrition.com/foods/bell-peppers

Bell pepper world production, yield, hg/ha



http://www.fao.org/faostat/en/#data/QC

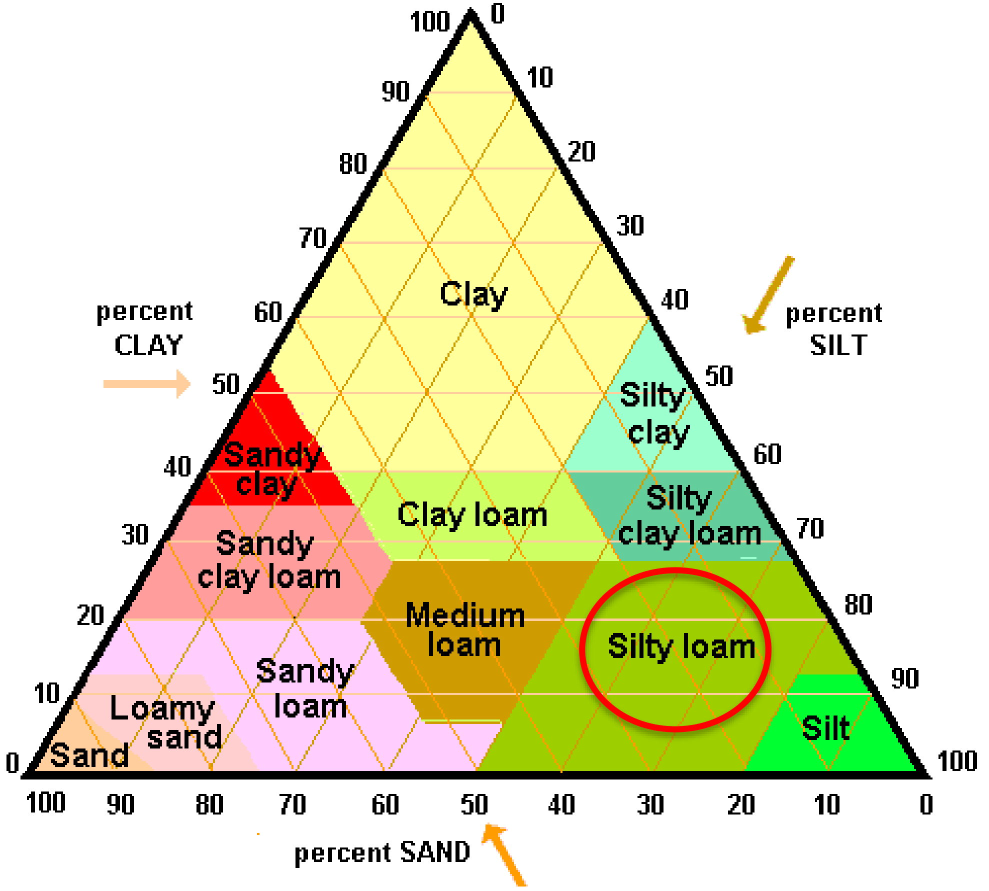
Research objective

- Effect of contaminant particle size on the growth and physiological parameters of bell pepper plant
- Effect of exposure period (45 vs 90 days) on the elemental concentration of plants

METHODOLOGY

Soil

- Soil collected Socorro, TX (N 31° 40.489’, W 106° 17.198’, elevation: 1,115 m asl).
- Soil characterization conducted on Malvern Mastersizer Hybrid 2000G
  - Sand : 19.7 %
  - Silt : 64.92 %
  - Clay : 15.38 %
- Natural soil : silty loam



Preparing pots in the lab for seedling transplantation

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Plant growth stages

Seedlings growing

Plants 10 days post transplantation

Seedlings ready for transplantation

Freshly transplanted seedlings

Plant growth stages

Plants 30 days post transplantation

Fully matured plants, 90 days post transplantation

Plants 45 days post transplantation, flowering

Plants 60 days post transplantation, fruiting

Gas exchange measurement: CIRAS-3 portable photosynthesis system

Harvesting

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UTEP

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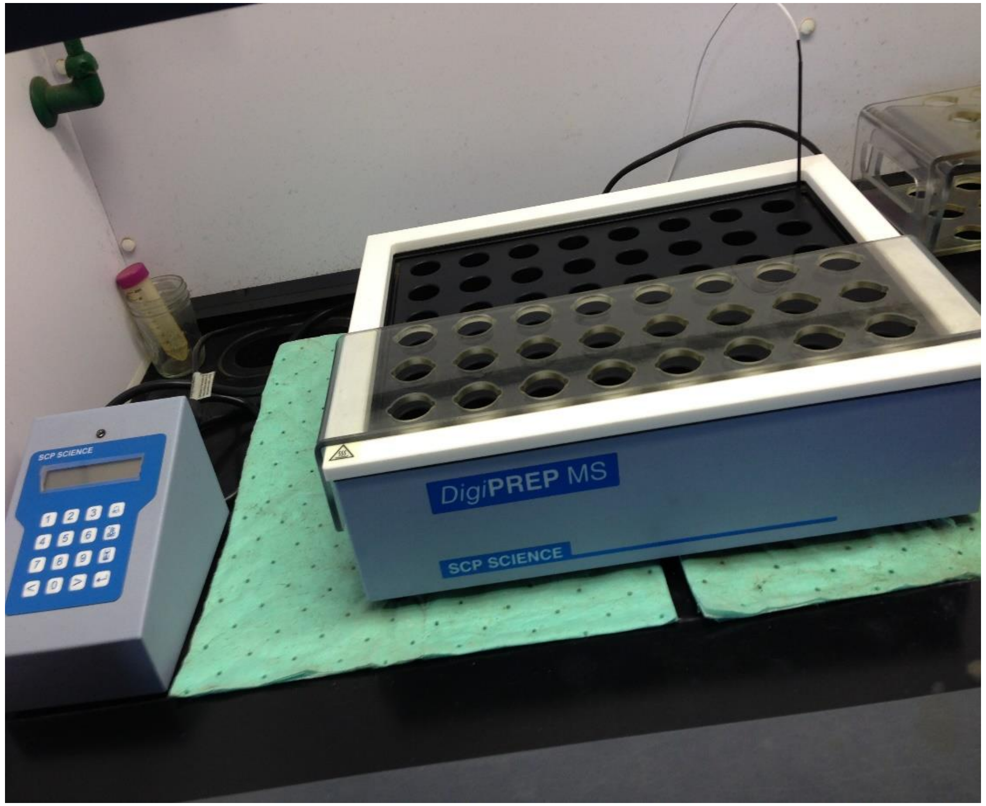
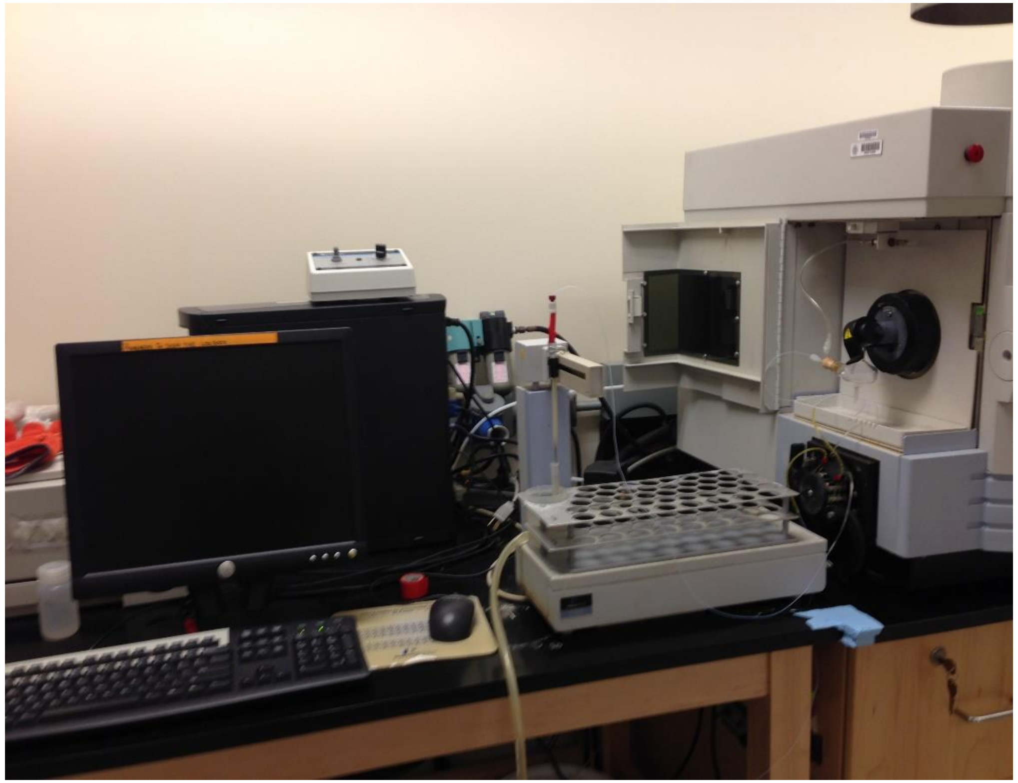
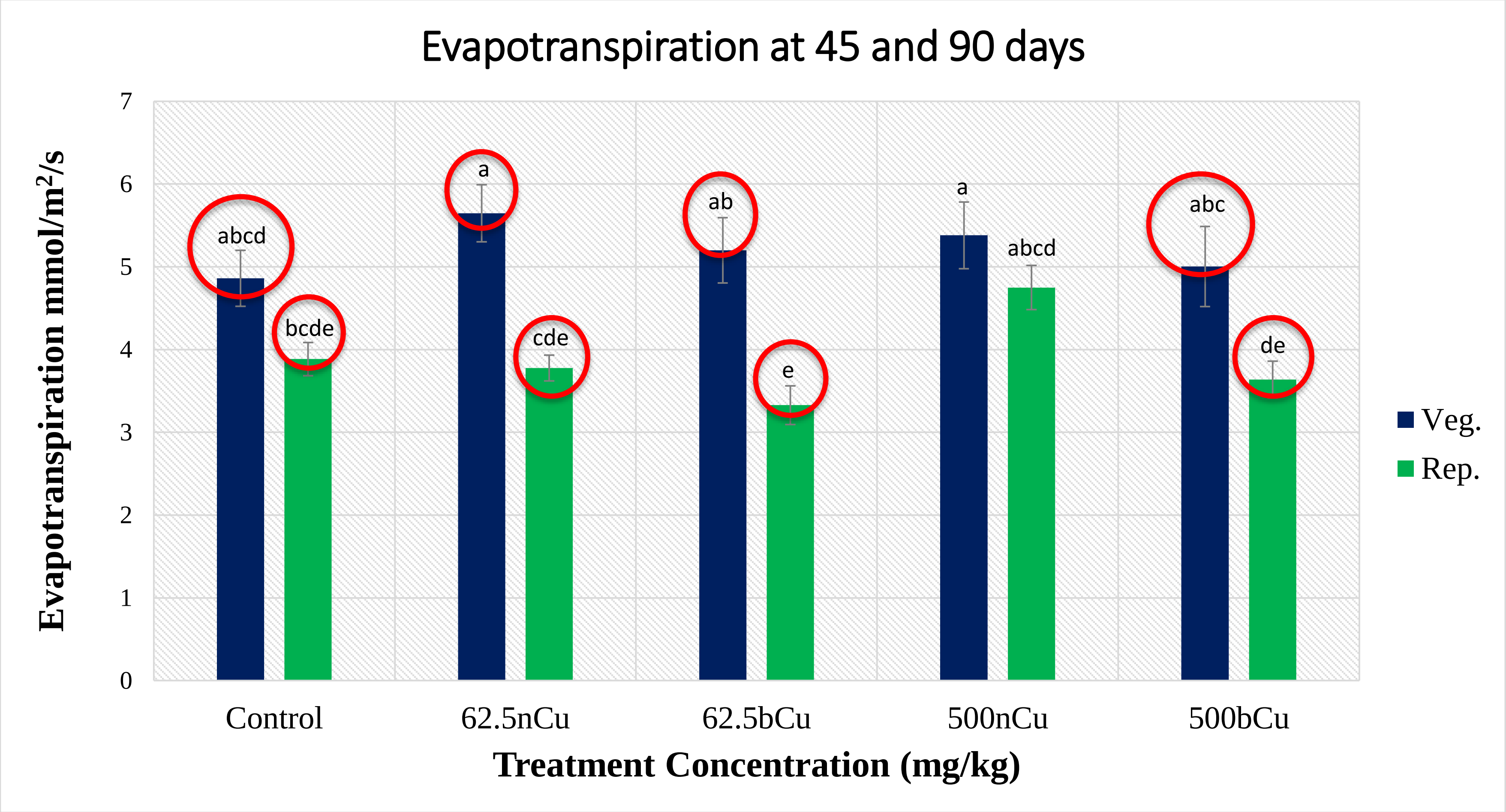
Acid digestion and sample analysis on the ICP-OES



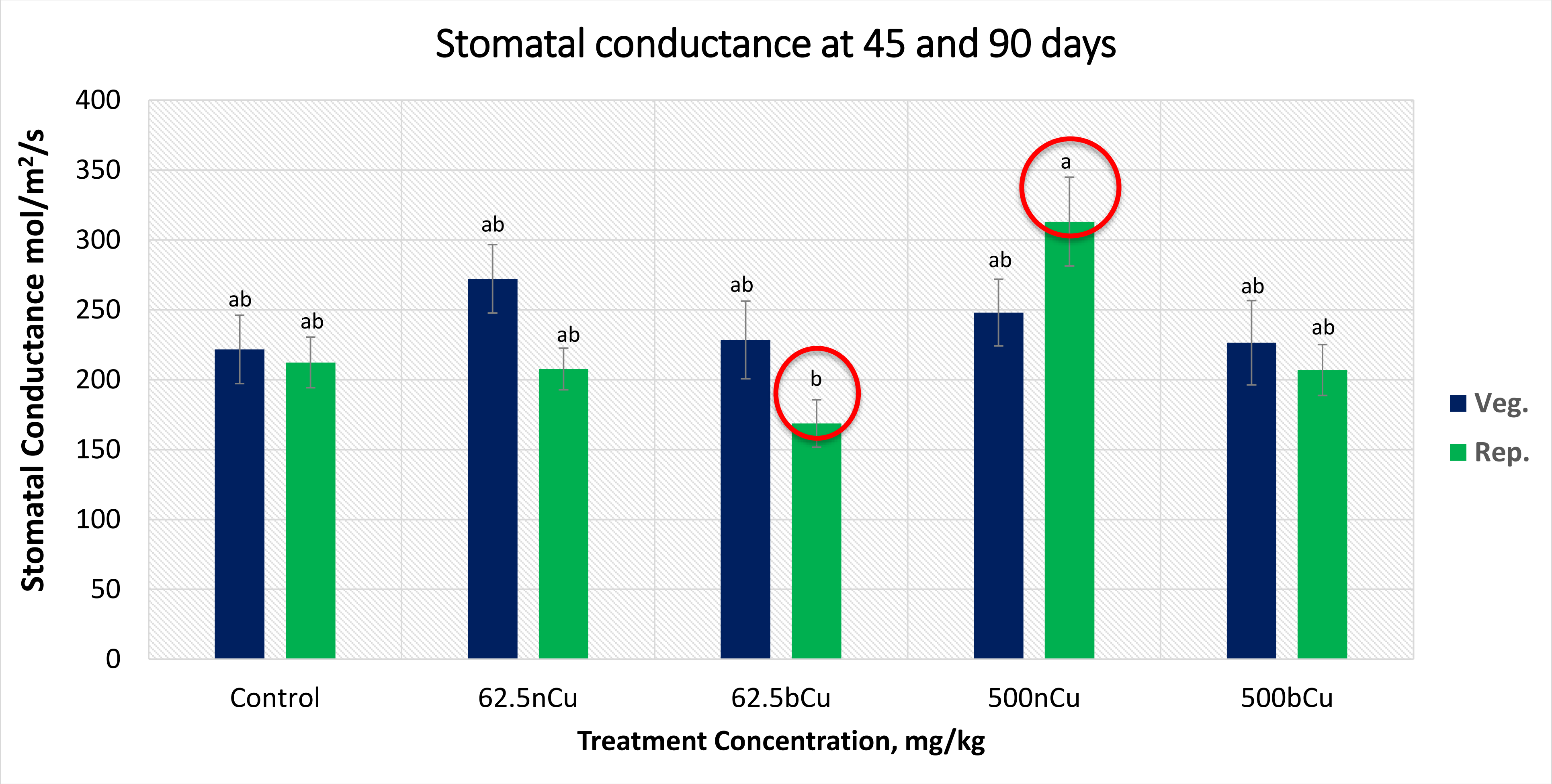


RESULTS

Comparison of the evapotranspiration (ET) between vegetative stage and reproductive stage study



Comparison of the stomatal conductance between vegetative stage and reproductive stage study



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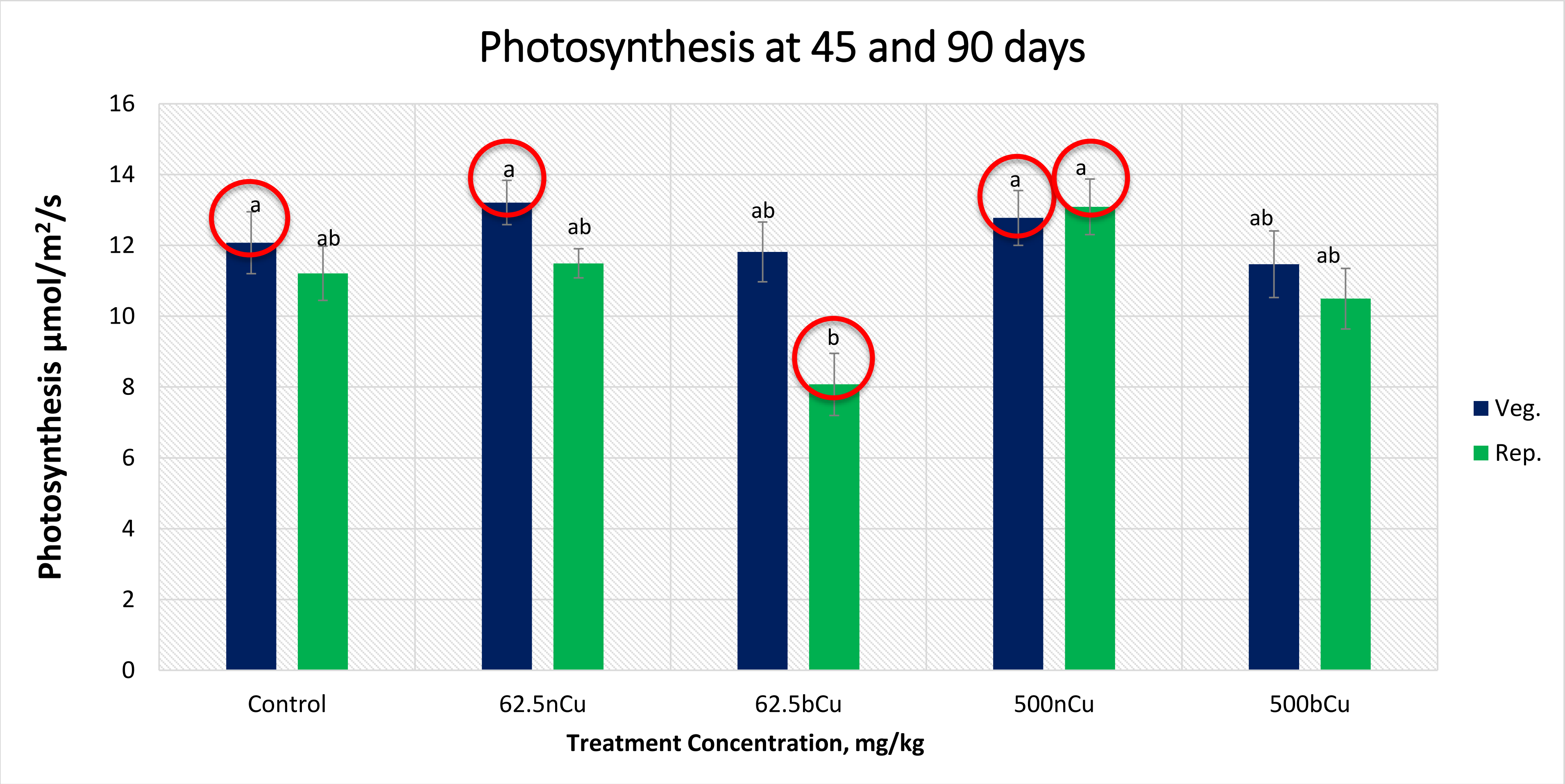
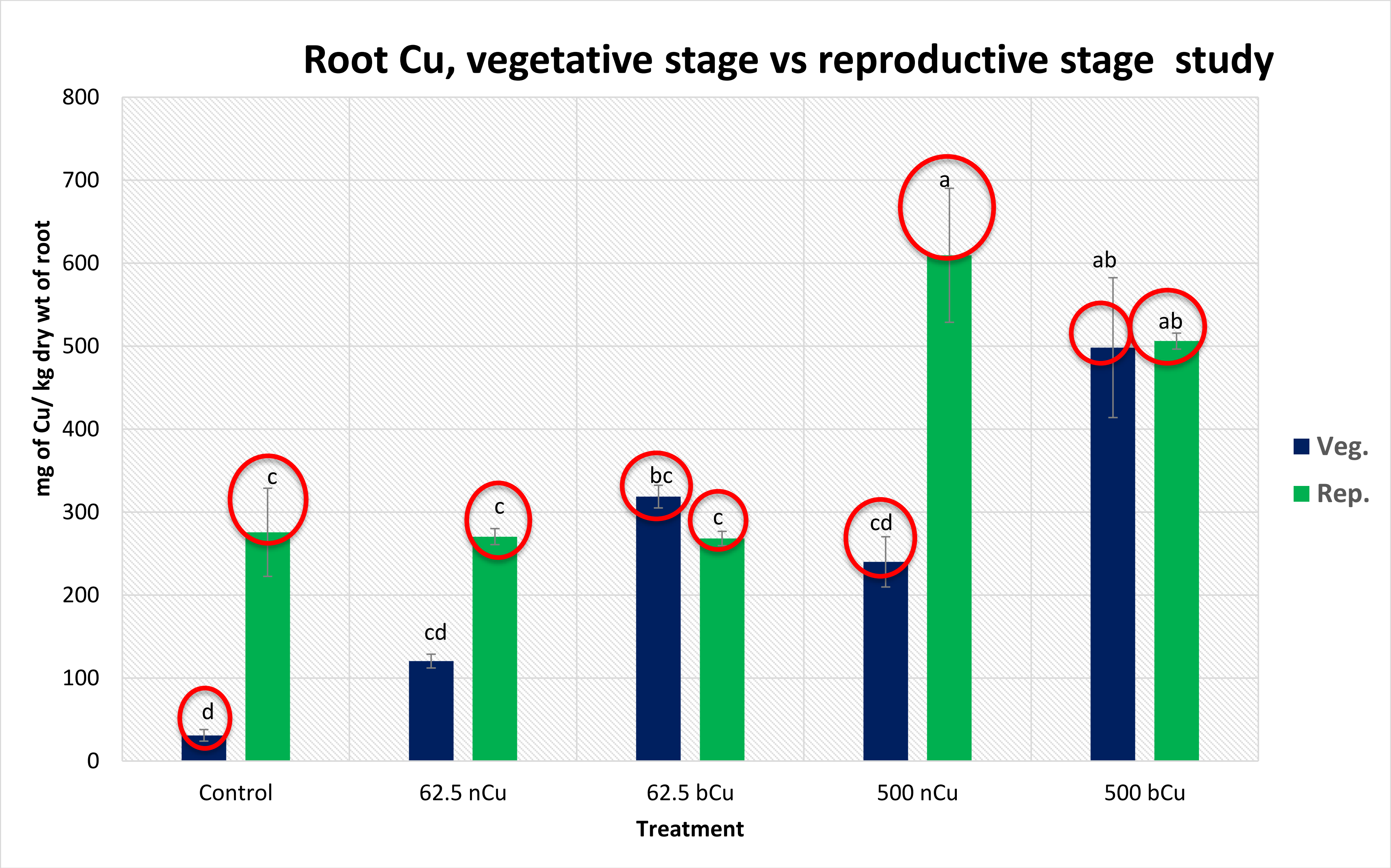
Comparison of the photosynthesis between vegetative stage and reproductive stage study



Elemental analysis, comparison between treatments and controls



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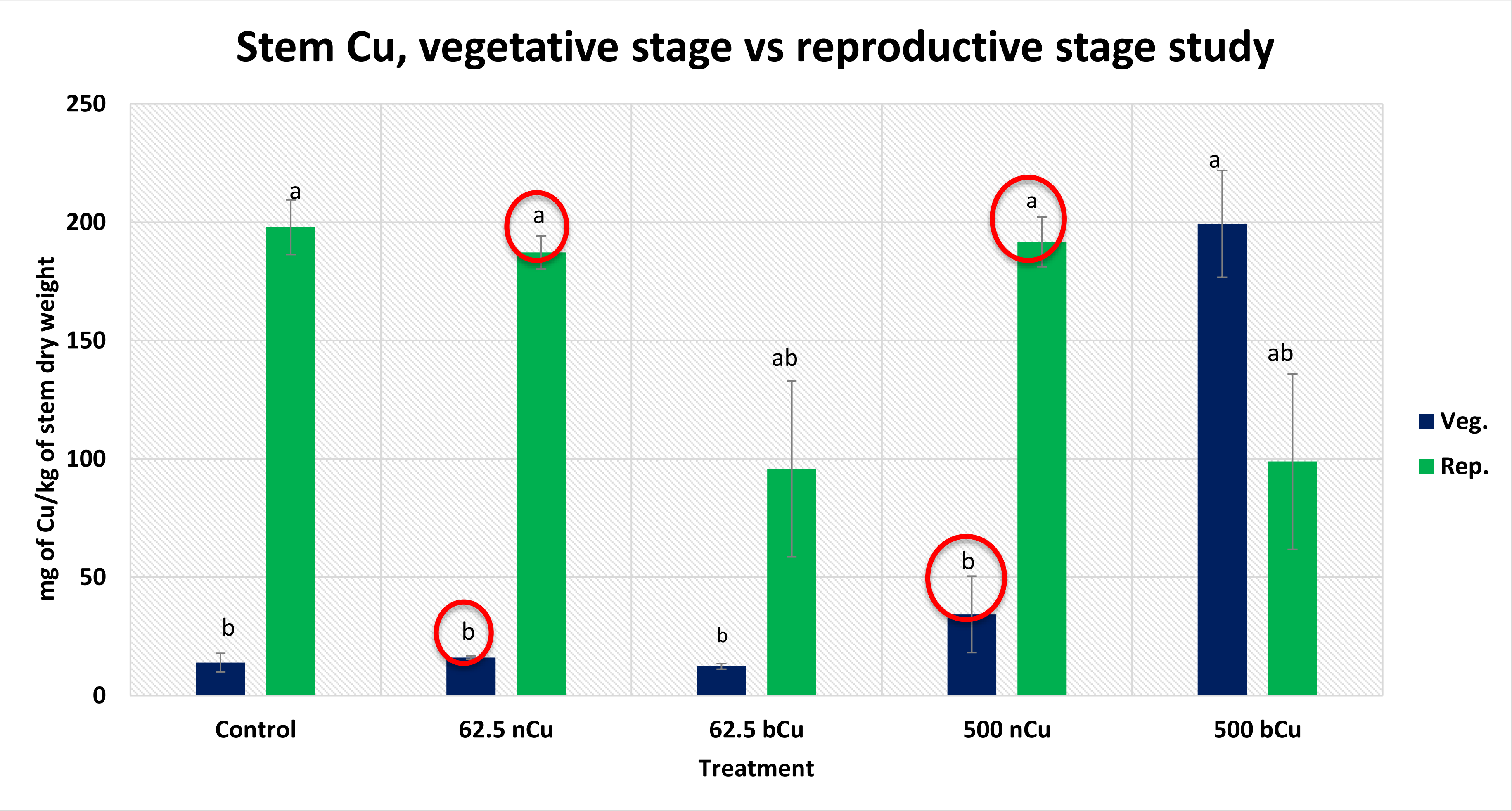

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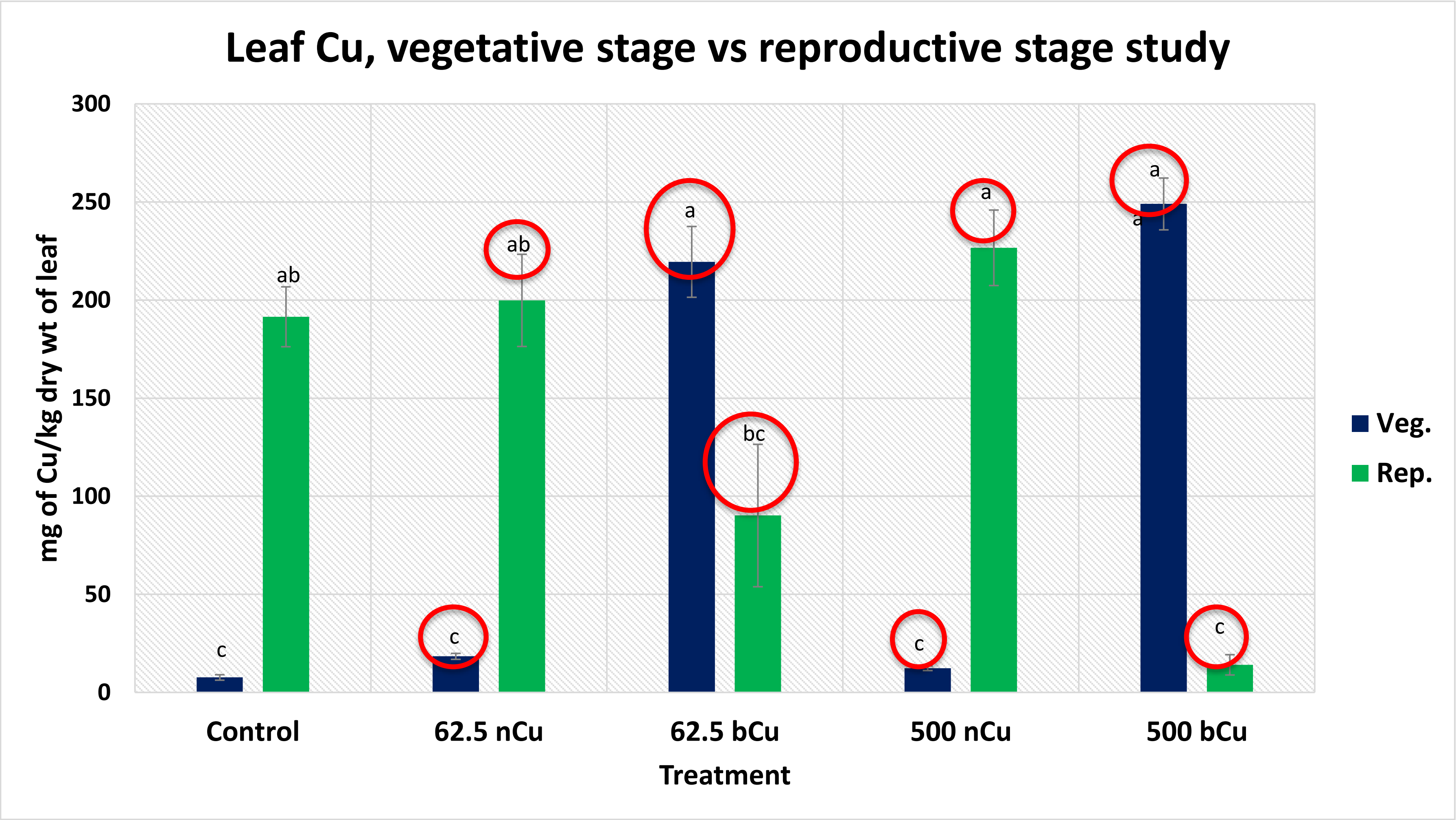

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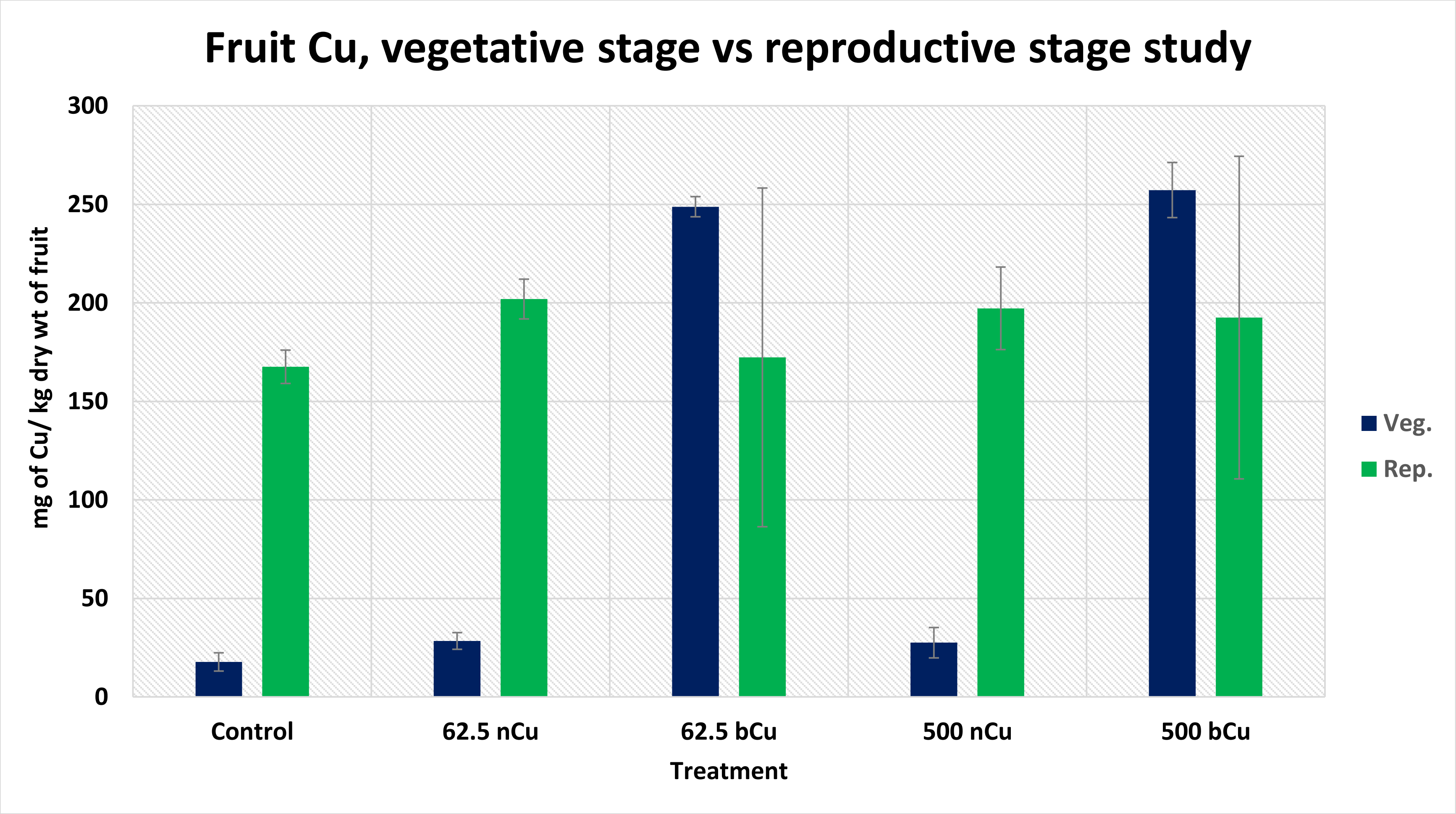
Elemental analysis, comparison between treatments and controls



Summary and concluding remarks

- 45 day study had significantly higher evapotranspiration measurements as compared the 90 day study, except at 500 nCu treatment.
- The stomatal conductance and photosynthesis were significantly lower at 62.5 bCu treatment as compared to select other treatments at the concentrations studied.
- For the 90 day study, root Cu was significantly high at both nCu and bCu 500 mg/kg concentrations compared to control. For the 45 day study, root Cu was significantly high at both bCu concentrations compared to control.
- In the stem tissue, nCu significantly increased the Cu concentration at the 90 day time point compared to the 45 day treatment interval.
- The leaf Cu was significantly higher at 45 day exposure period for bCu treatments as compared to the nCu ones. The concentration of Cu in the fruit tissue was not significantly affected under treatments.

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Thank you for the attention.

Questions ?