Copper-based Nanovaccines for Disease Control in Plants

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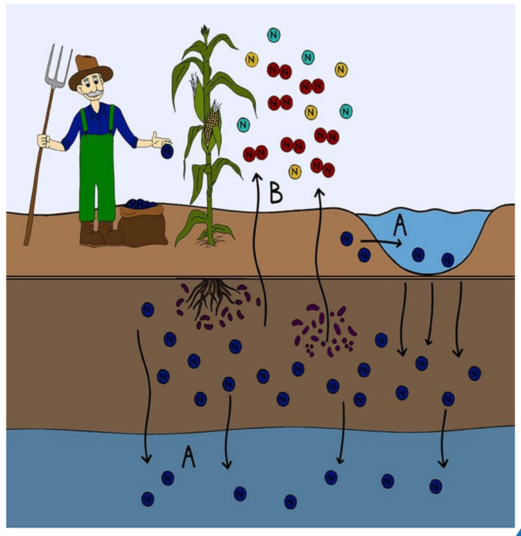
Introduction

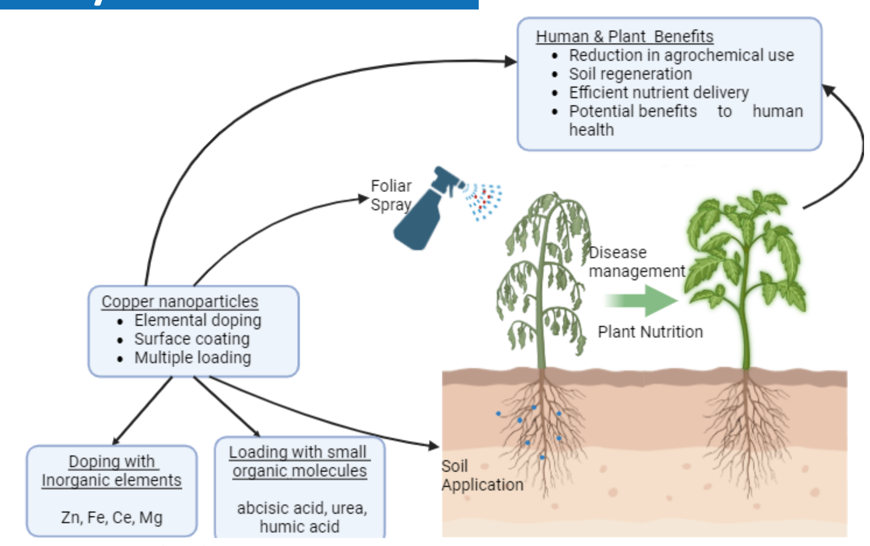
Problems with conventional fertilizers:

- Excessive use, with low uptake efficiency
- Negative environmental impacts
- Over-use of fungicides and pesticides lead to chemical toxicity
- Detrimental effects on human health



Solution: Nanofertilizers/Nanostimulants

- Reduced soil leaching
- Lower dosage needed
- Can be tailor-made
- High bioavailability
- Enhanced uptake
- High dispersibility
- Better efficiency



Scheme 1: Adapted from **Bekah *et al* (2024)**. *Nanostimulants and nanofertilizers for precision agriculture: Transforming food production in the 21st century.* Chemosphere. Submission in Progress

Methodology, Results and Discussion

Synthesis

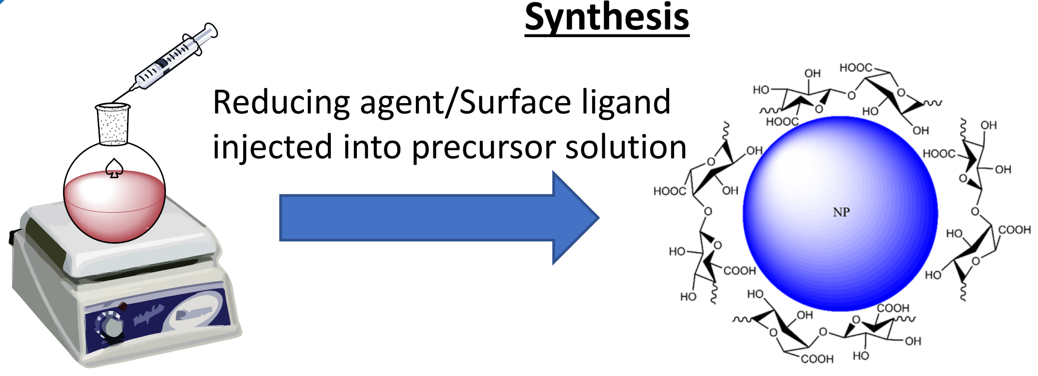


Figure 1: "Small" (<100 nm) CuO/CuS NP

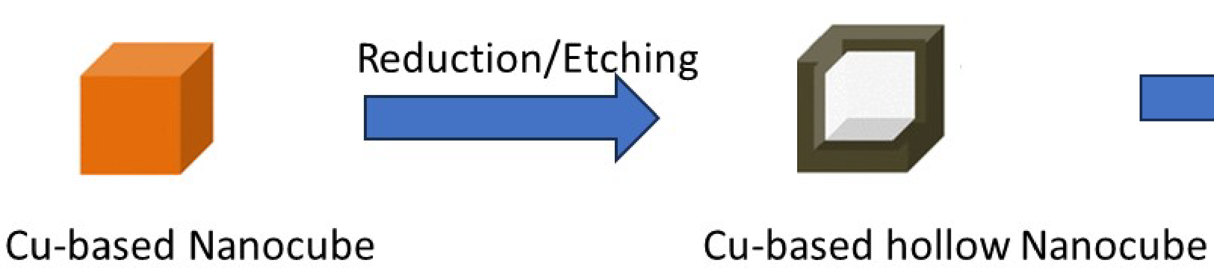


Figure 2: Hollow nanocubes

Characterization

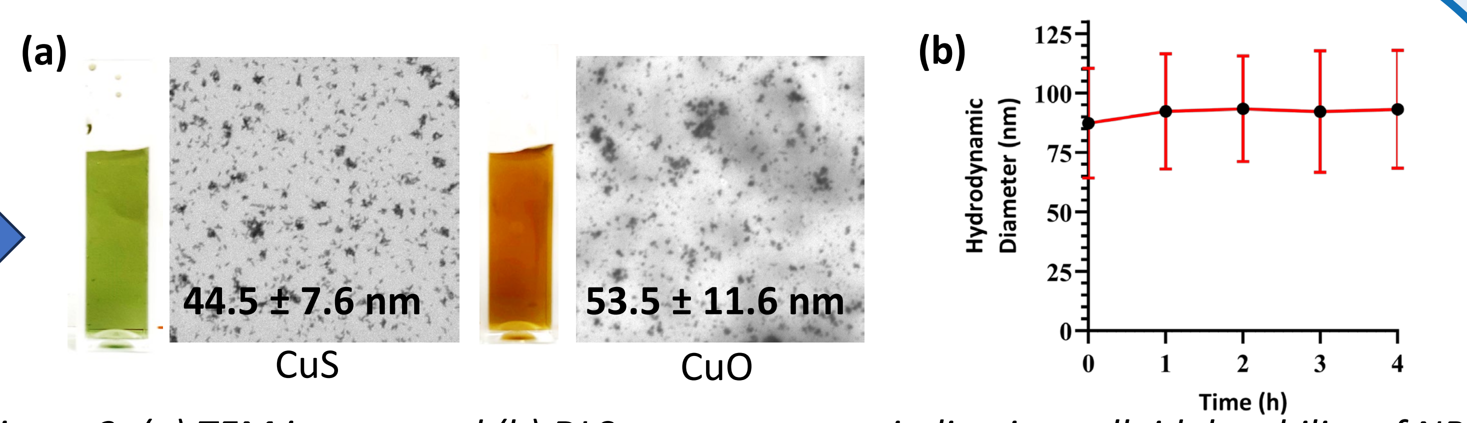


Figure 3: (a) TEM images and (b) DLS measurements indicating colloidal stability of NP

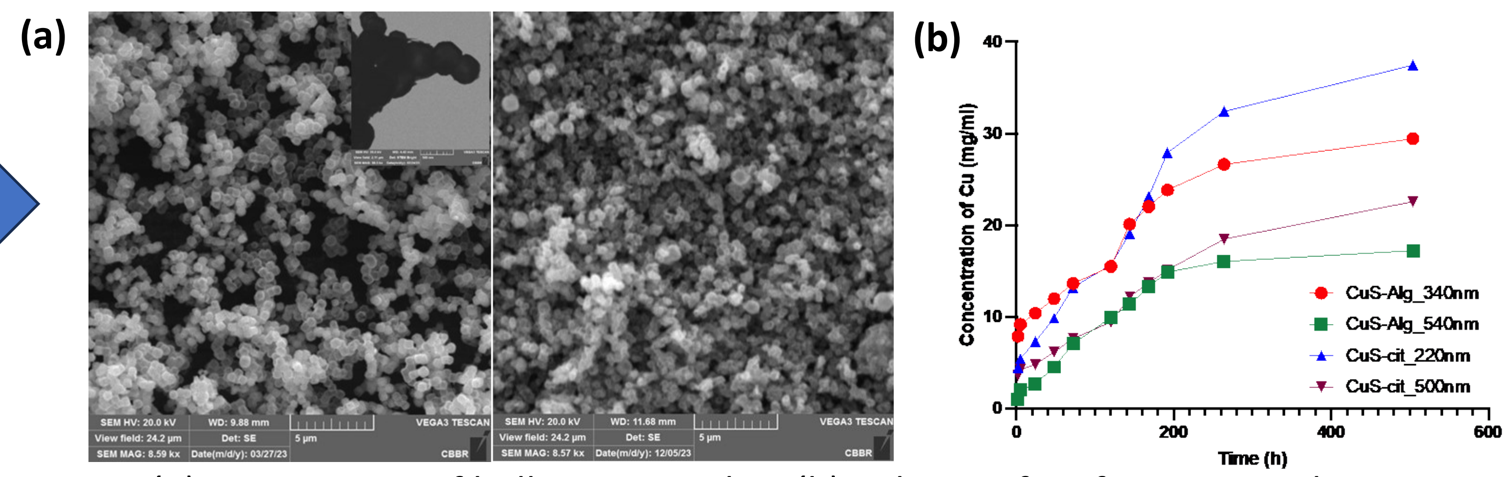


Figure 4: (a) SEM images of hollow nanocubes (b) Release of Cu from nanocubes in water

Nanoparticle Toxicity

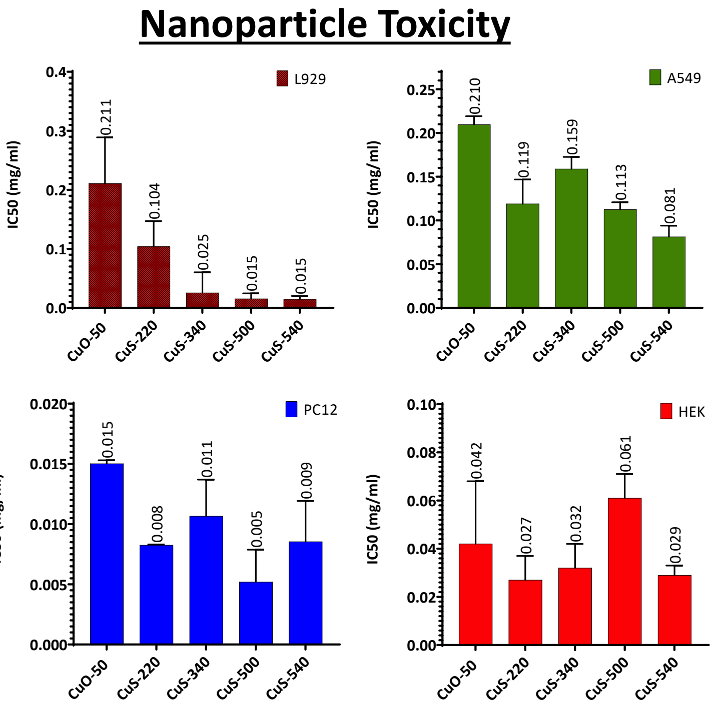


Figure 5: IC50 values for various Cu-based NPs types (CuO & CuS) and sizes (50, 220, 340, 500 and 540 nm) on L929, A549, PC12 and HEK cells based on live/dead assay.

Figure 6: Foliar spray of tomato plants with nanoparticles at 1 mg/mL in greenhouse. Half were infected with Ralstonia solanocearum as confirmed by "ooze test"

Greenhouse Trials with Tomatoes

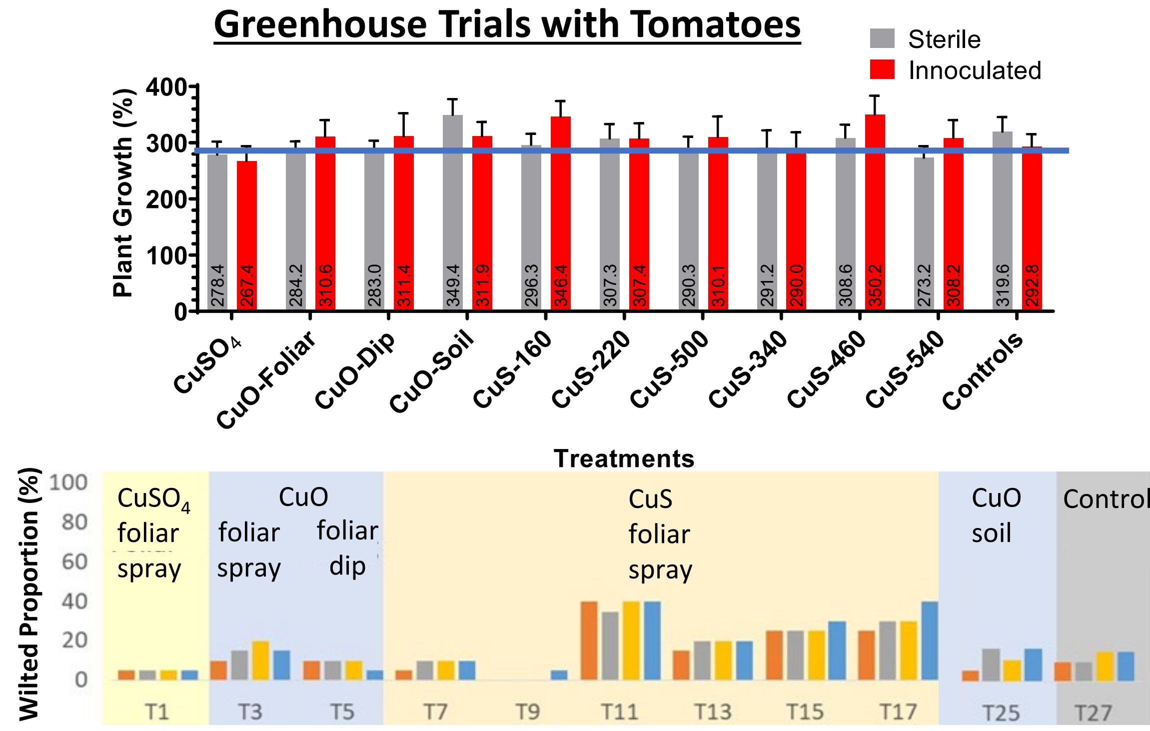


Figure 6: Selected results from greenhouse trials indicating differences in plant height (top) and proportion (in %) of plants showing signs of wilting (bottom). Smaller nanoparticles were more effective

Conclusion/Future Work

- Nano-sized alternatives to conventional fertilizers represent a promising alternative to conventional systems for disease management
- Cu NP of various sizes and surface coatings synthesized and tested on a variety of cells to obtain IC50
- Preliminary results from greenhouse trials indicate an optimal size to maximize effectiveness v/s pathogens.
- Next step will be to repeat greenhouse trials as well as investigate effects of NP doping and multi-element loading.

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