Graphite Nanoparticles to Enhance Growth and Reduce Nutrient Leaching in Lettuce Cultivation

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**The Problem:** Agriculture uses a large quantity of chemical fertilizers to produce crops. These fertilizers cause:
- Release of greenhouse gases
- Nutrient runoff into water bodies
- Rapid depletion of non-renewable resources such as phosphorus

**The Solution:** Combining fertilizers with carbon nanoparticles (CNP) can help reduce the amount of fertilizer applied, therefore reducing the amount of nutrients leached into the environment.

**Methods:**
- Lettuce was grown in a greenhouse on ASU campus, with five different fertilizer treatments in summer and twelve in the fall.
- Carbon nanoparticles were applied at a rate of 3,000 mg/kg of fertilizer.
- The treatments were: no treatment (NT), carbon nanoparticles only (CNP), 100% of recommended nutrients (NPK), 100% of recommended nutrients with the addition of carbon nanoparticles (N+C), variations of the recommended nutrient dose with and without CNP from 30-70%, biochar matching the carbon dose by weight (BM), biochar matching the % carbon of the CNP (BC), 50% of the recommended nutrients was then combined with the biochar for both mass and carbon content.
- Pre-Harvest: Initial soil samples, applied first fertilizer treatment
- Growing Period: Leachate from bottom of the pots was collected bi-weekly or as needed, plants were fertilizer once midway through growing season
- Post Harvest: Wet and dry weight of vegetable, analyzed leaf, root, and soil for nutrients
- Treatments done in replicates of six in summer and four in fall

**Nanomaterial Characterization:**
- Production: Electrochemical exfoliation process
- Size: 14-60 nm
- Material: 96% carbon, potassium, iron, and magnesium
- Raman: D band-1356 cm\(^{-1}\), G band-1574 cm\(^{-1}\)
- Matches closely with graphite spectra
- Toxicity: Acute and chronic LD\(_{50}\) tests performed and showed no toxic effects

**Future Work:**
- Changing the soil types to see if that will effect the interaction and benefit of the carbon nanoparticles with the lettuce
- Varying the dose of carbon nanoparticles to see if that will reduce nutrient leachate and enhance nutrient uptake
- Comparing the leaching and nutrient uptake of bamboo biochar with the carbon nanoparticles
- Analyzing yield, nutrient leaching, nutrients in soil, nutrients in tissue for the various fertilizer treatments

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