Washington University in St. Louis
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NANOCOMPOSITE FERTILIZER FOR EFFICIENT PHOSPHORUS UPTAKE AND SUSTAINABLE AGRICULTURE

Biswas, Pratim, Raliya, Ramesh

Markiewicz, Gregory

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Technology Description

Engineers in Prof. Pratim Biswas' laboratory have developed a nanoparticle fertilizer that increases phosphorus uptake and plant yield while reducing environmental damage and strain on natural resources.

Increasing global food demand has prompted the large-scale use of fertilizers with essential nutrients (nitrogen, phosphorus and potassium, "NPK") to increase crop production. This depletes the natural supply of phosphorus and other nutrients. In addition, the phosphorus in traditional fertilizers is difficult for the plants to mobilize due to low solubility and large particle size (micron scale), leading to low plant yield as well as environmental problems from phosphorus run-off/pollution. This nanocomposite technology addresses these problems with a NPK-metal oxide delivery system that lowers the total quantity of phosphorus in the NPK fertilizer while more than doubling phosphorus uptake in the plant. This fertilizer is made through a single-step furnace aerosol reactor process and can be delivered in the soil or as a foliar spray. Furthermore, these nanoparticles (~100nm) can be optimized for specific types of plants by customizing their size and nutrient composition. By increasing the nutrient efficiency, this fertilizer has the potential to promote precision, sustainable and economically viable agriculture by boosting productivity while reducing phosphorus use.

Stage of Research

The inventors have demonstrated enhanced phosphorus mobilization in mung beans and increased plant growth in tomato and lettuce (both foliar spray and soil delivery).

Applications

- **Fertilizer** – soil and foliar/aerosol application for supplying nutrients (nitrogen, phosphorus and potassium, "NPK") to plants

Key Advantages

- **Increased phosphorus uptake**
  - >70% uptake of phosphorus (over 2x more than conventional fertilizer)
  - plant yield enhanced by 58%
- **Sustainable -** reduces environmental damage and limits use of natural resources
  - uses smaller quantities of fertilizer
  - reduces phosphorus run-off by >90%

    - no fillers that may be harmful to plant roots and stems
- **Customizable for specific plants –** can optimize nanoparticle size and fine tune composition of nutrients for different species of plants (e.g., mung beans, tomatoes, lettuce)
- **Single step aerosol synthesis –** furnace aerosol reactor process for bottom-up fabrication from molecular precursors does not require biological agents (fungus or microbes)
- **Precise delivery –** foliar spray (aerosol application) decreases phosphorus in soil and could increase plant yield

Publications

- Raliya, R., Tarafdar, J. C., & Biswas, P. (2016). Enhancing the mobilization of native phosphorus in the mung bean rhizosphere using ZnO nanoparticles synthesized by soil fungi. *Journal of agricultural and food chemistry*, 64(16), 3111-3118.

Patents

- Synthesis of nanocomposites and their use in enhancing plant nutrition (U.S. Patent Application, Publication No. US20190202750)

Website

- Aerosol and Air Quality Research Laboratory