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Enhancing Micronutrient Solubilization through Acidifying Microorganisms: Exploring Their Potential in Fertilizer Granule Coating.

Vinicius Ferraz Majaron[1], Ricardo Bortoletto-Santos[2], Rodrigo Klaic[3], Denise Bevilaqua[4], Sidney José Lima Ribeiro[4], Cristiane Sanchez Farinas[5], Cauê Ribeiro de Oliveira[5], Wagner Luiz Polito[1]

[1]University of São Paulo (*São Carlos Chemistry Institute*) , [2]University of Ribeirão Preto, [3]Federal University of São Carlos, [4]São Paulo State University, [5]National Nanotechnology Laboratory for Agribusiness (Embrapa Instrumentation)

e-mail: vinicius.f.majaron@gmail.com

Fertilization is essential to provide suitable conditions for plant development and crop productivity, but the environmental cost of fertilizers is a drawback for achieving sustainable agriculture. A potential alternative is the use of unprocessed (raw) nutrient sources such as mineral oxides (ZnO, MnO, CuO) as fertilizers. However, these low-reactivity sources are not readily available to plants. In light of this, this project aimed to develop a bioactive coating material containing microorganisms that enabled the release of different nutrients from unprocessed nutrient sources. To achieve this, the coating material composed of maize starch, mineral oxides (ZnO, MnO, CuO), and a microbial source (Aspergillus niger or Aciditiobacillus thiooxidans) was applied to monoammonium phosphate (MAP) granules, serving as a model fertilizer. Our results revealed that the bioactive coating did not affect phosphorus (P) release, as it did not create a physical barrier. However, the acidifying capacity of both microorganisms significantly enhanced oxide solubilization. The presence of Aspergillus niger or Aciditiobacillus thiooxidans promoted local acidification, and the bioactive coating material with Aspergillus niger achieved solubilization of Cu, Zn, and Mn up to 10.9%, 14.6%, and 34.3%, respectively, within 42 days of soil incubation. This phenomenon suggests that the organic acids produced by Aspergillus niger chelate cations, reducing soil immobilization and thereby increasing their solubilization. This innovative system can effectively supply nutrients to plants using inexpensive and low-reactivity nutrient sources, with the advantage that it can be applied simultaneously to currently used fertilizer granules in a single delivery, facilitating adoption by producers.