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Phosphorus and Zinc Management in Acid and Acid Sulphate Soils: Challenges and Solutions

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SUMMARY

Acidic and acid sulphate soils pose significant challenges to agricultural productivity due to the limited availability of essential nutrients like phosphorus (P) and zinc (Zn). Complexities of managing P and Zn in these soil types, highlighting the underlying chemical processes, constraints and potential solutions.

INTRODUCTION

Acidic and acid sulphate soils cover vast areas globally, especially in tropical and subtropical regions. These soils are characterized by low pH levels, high aluminum and iron concentrations, and low nutrient availability. Among the most limiting nutrients in these soils are phosphorus and zinc. Both nutrients are vital for plant growth, playing roles in energy transfer, nucleic acid synthesis, and enzyme activation.

Chemical Characteristics of Acid and Acid Sulphate Soils

pH and Aluminum Toxicity: The low pH of these soils exacerbates aluminum toxicity, making phosphorus less available for plant uptake.

Iron Dynamics: Acid sulphate soils have pyritic materials which, upon drainage, oxidize to produce sulfuric acid. This further reduces soil pH and affects nutrient solubility.

Phosphorus Management

Phosphorus Fixation: In acid soils, P readily forms insoluble compounds, limiting its availability. Management strategies include:

- Use of P fertilizers with slow-release properties.
- Incorporation of organic matter to improve soil structure and enhance P availability.
- Application of liming materials to raise soil pH and reduce aluminum toxicity.

Phosphorus Use Efficiency (PUE): Developing crop varieties with enhanced PUE can optimize P uptake and utilization, especially in P-deficient soils.

Zinc Management

Zinc Deficiency: Acidic soils often show zinc deficiencies due to reduced solubility at low pH and increased fixation by iron and aluminum compounds.

Zinc Fertilization

- Application of Zn-containing fertilizers or amendments.
- Foliar application of Zn can bypass soil constraints, ensuring adequate plant uptake.

Biofortification: Breeding crops with increased Zn uptake and translocation can address dietary Zn deficiencies in regions where these soils predominate.

Integrated Approaches for Nutrient Management

Soil Amendments: Incorporation of lime, gypsum, or other alkaline materials can ameliorate soil acidity and improve nutrient availability.

Crop Rotation and Cover Crops: Utilizing leguminous cover crops can enhance soil organic matter, nitrogen fixation, and overall soil health, indirectly benefiting P and Zn availability.

Precision Agriculture: Soil testing and targeted nutrient application can optimize P and Zn management, minimizing wastage and environmental impacts.

CONCLUSION

Managing phosphorus and zinc in acidic and acid sulphate soils requires a multifaceted approach, addressing both soil chemical properties and plant physiological responses. Sustainable solutions encompass soil amendments, nutrient-efficient crop varieties, and precision management practices. Continued research and adoption of integrated nutrient management strategies are pivotal for enhancing agricultural productivity and ensuring food security in regions affected by these challenging soil types.

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