Effects of Mycorrhizae on Struvite Dissolution

Can plant-fungus mutualism increase the viability of a sustainable phosphorus fertilizer?

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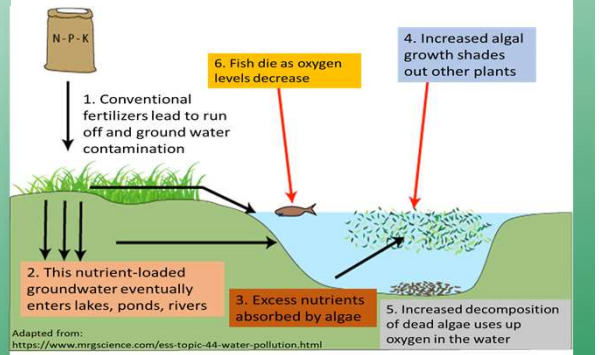
Project Goal

To determine effect of arbuscular mycorrhizal fungi (AMF) on struvite dissolution, as well as the effect of struvite, and its placement, on mycorrhizal colonization and plant phosphorus uptake.

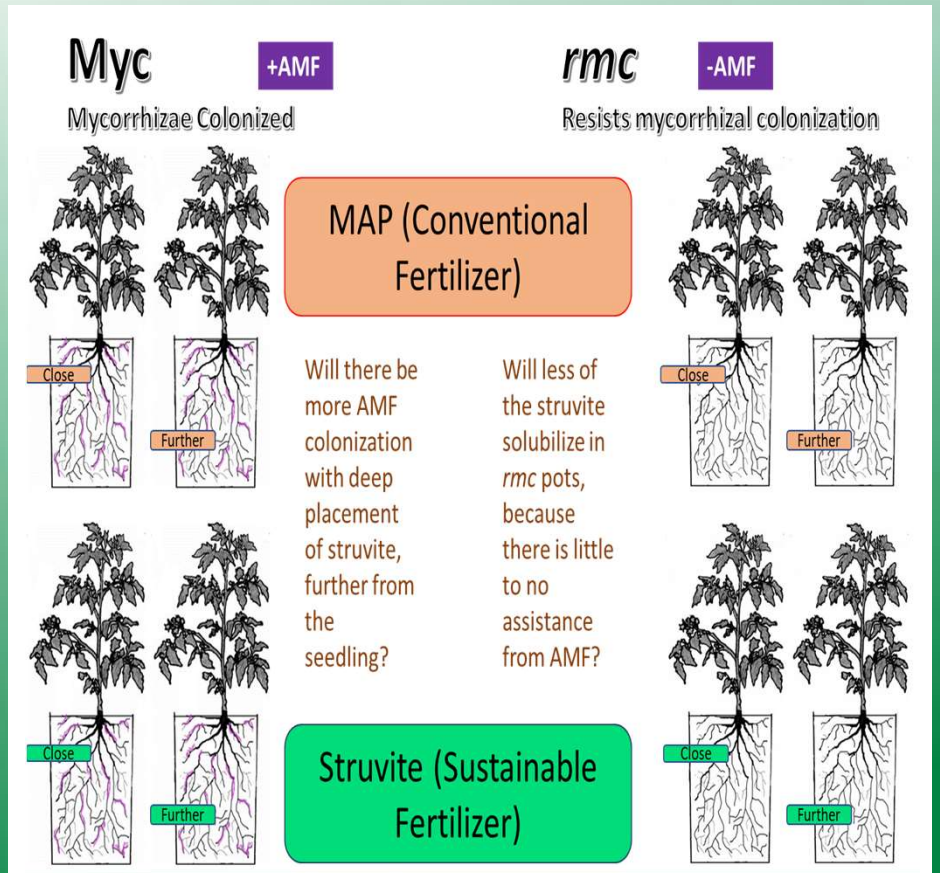
Background

- Phosphorus (P) is essential for all organisms
- In agriculture, P, nitrogen (N) and potassium (K) are applied in large amounts as fertilizer
- Monoammonium phosphate (MAP), a conventional fertilizer, is highly water soluble, causing high P and N concentrations in agricultural runoff, harming aquatic life



- Struvite ($NH_4MgPO_4 \cdot 6H_2O$), a waste-water derived product with potential for use as a P fertilizer; has low water solubility[1]
- Phosphorus in struvite is not as accessible to plants as it is in MAP
- Arbuscular mycorrhizal fungi (AMF) form mutualisms in which they receive carbon from plants in exchange for other nutrients
- AMF assist in P uptake by more thorough soil exploration, a higher P affinity than that of plant roots, modification of the rhizosphere through exudates, and hyphal storage of absorbed P[2]

AMF exude organic acids[3] which have been shown to significantly increase solubilization of struvite[1], which is needed to make P accessible to plants



Experiment Design

- Two *Solanum lycopersicum* (tomato plant) genotypes used, the wild-type, Myc, and a reduced mycorrhizal colonization mutant-type (referred to as *rmc*), which has very low rates of AMF association (<1%)[5]
- Pouch of fertilizer has close placement, or further placement, where the plant can not 'find' it as easily
- MAP v struvite for the additional question of whether struvite will increase mycorrhizal colonization

Hypotheses

- More struvite will have solubilized in pots with the Myc genotype
- Myc roots will show higher rates of AMF association in pots with struvite treatment than in MAP pots
- The Myc struvite deep placement pots will have higher rates of AMF association as well

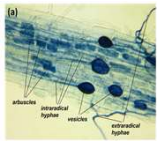
Metrics for Characterizing Struvite-AMF Interactions

Ascertaining Plant P Uptake

We will dry, grind, and acid digest the biomass, and use colorimetry to determine the P uptake of the plants.

Quantifying Struvite Dissolution

The 5x3" mesh pouches will be retrieved, and the remaining struvite dried and weighed to compare to the mass that was originally placed.



Calculating AMF Root Colonization

- De-pigment, and stain roots with trypan blue to make visible the arbuscules, hyphae, and vesicles (all parts of the AMF) that are present in the root[4]
- Under a microscope, AMF presence quantified by counting the number of roots with visible AMF structures, and making a percent

https://web.biologie.uni-bielefeld.de/systemoekologie/index.php/de/research-projects/mycorrhiza

Current Progress

- Plants are growing, with destructive harvest scheduled for the first week of August

Anticipated Outcome

- Significant impact of AMF on struvite dissolution could increase sustainability of nutrient management systems

Integrating AMF inoculation into use of struvite as fertilizer could mean reduced agricultural P runoff, reduced fertilizer applications, recycling waste product, and reduced dependence on diminishing phosphate rock reserves

References

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