Field Trial- Estimating phosphorus uptake and translocation by arbuscular mycorrhizal fungi in surface root mats

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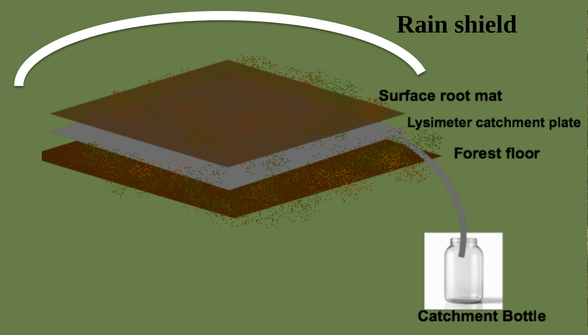
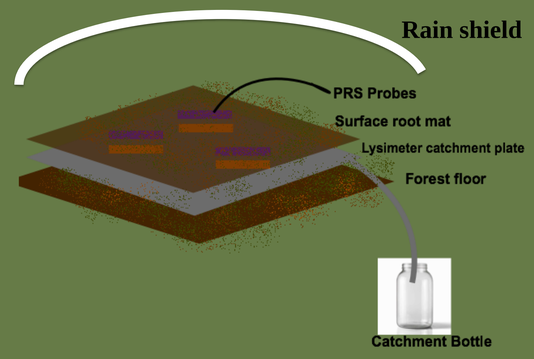
Study Site

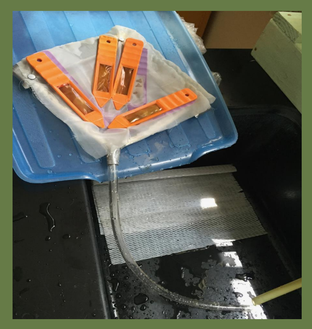
Introduction

- AM fungi play a major role in P uptake by foraging for P and delivering it to the root's cortical cells.
- Current forest productivity models are based on climate and nitrogen, but not phosphorus availability, causing the models to fail in tropical forests.
- **Our goal** was to correlate phosphorus uptake with AM hyphal lengths in surface root mats as a means of quantifying translocation.

Methods





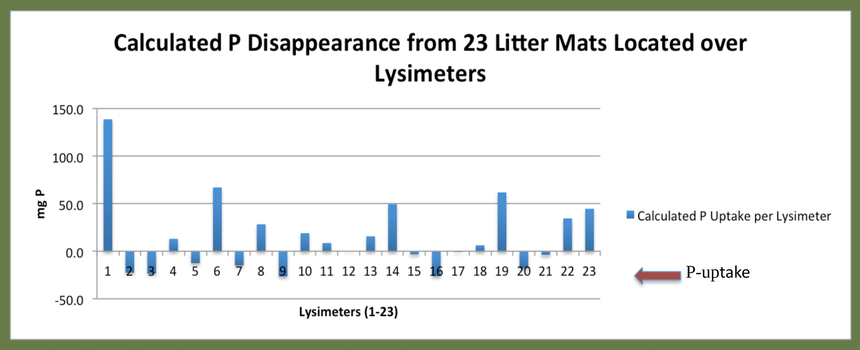


We deployed 24 zero tension lysimeters, half with PRS anion exchange probes, and placed each under an intact surface root mat.

After adding 500mL of water to measure initial P leaching rates from each mat, a non-radioactive P solution (KH_2PO_4) was applied, the resulting solution was collected in acid-washed plastic bottles, and vinyl rain shields were added to prevent leaching loss. AM fungi were allowed to take up P from the mats for 1-, 4-, and 8-day post-treatment, and then harvested; roots were then separated from litter.

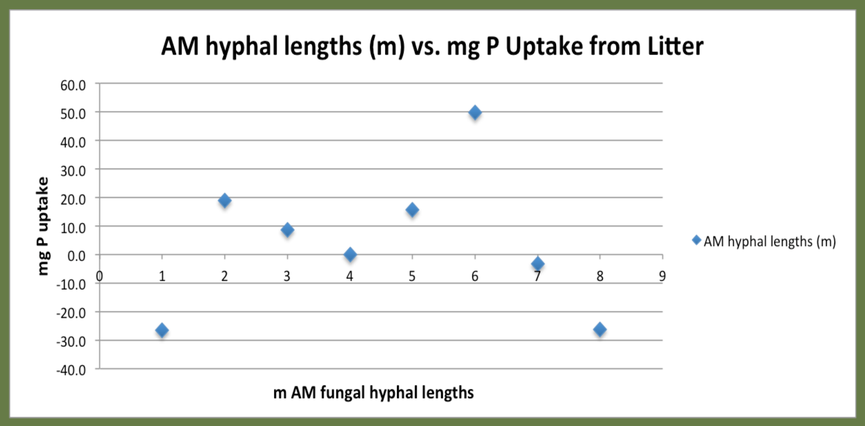
- AM hyphal lengths in litter determined using an agar film technique
- Root lengths were measured using a root scanner
- Litter was weighed, dried, and reweighed
- Litter & leachate P were measured at ORNL using a Lachat

Results

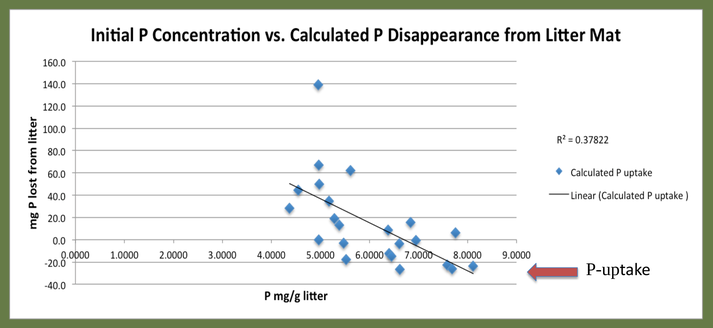


Calculated P disappearance from litter-root mats on 23 lysimeters. Lysimeters with negative values indicate P-uptake/translocation by AM fungi, while positive values indicate no uptake over time.

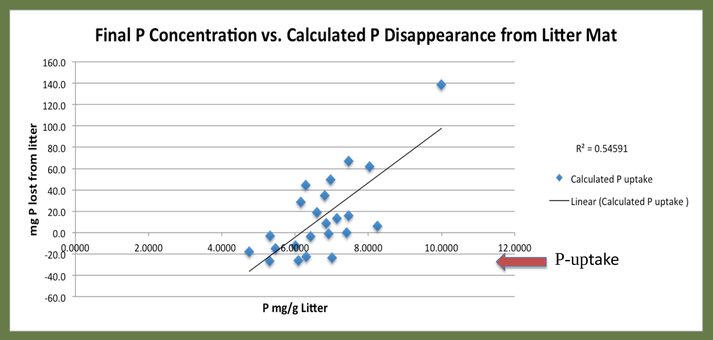
Examples of harvested root mats on the lysimeter plate.



The strongest relationship between P-uptake and AM hyphal length occurred at 4 days post-treatment (R^2=0.33, Pearson= -0.572). No relationship was found 1 or 8 days post-treatment.



Pre-treatment litter samples were collected next to the corresponding root mat & used to estimate initial P. Negative slope suggests that pre-treatment samples with high P concentrations were more highly decomposed, matching the decomposition stage of litter in the root mat. Lysimeters with well-matched litter showed P-uptake.



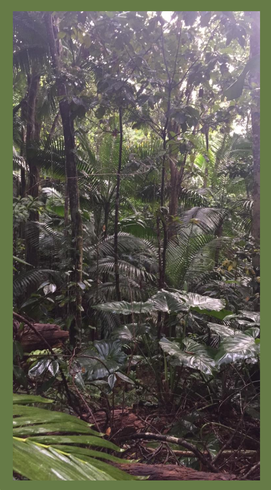
Positive slope is consistent with AM fungi lowering the final P concentration in the litter via uptake.

Conclusions

P uptake by AM fungi on 9 of 23 lysimeters is promising for an in-situ approach, and an improved model with a larger catchment plate, live AMF analysis (PLFA or RealTime PCR), and initial litter P samples collected within the mats may yield better results.

Some lysimeters showed increased P at 8 days, which suggests that it was either from P stored in the roots and transferred to the AM fungi, or coming from another source. An improved model would help to decipher this mystery.

No measurable uptake has been found through excising of roots and measuring uptake in vials, so our method appears to be more successful than other methods, and also avoids use of a radioactive ^{32}P tracer in the field.



El Yunque National Forest

Acknowledgements

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