Optimizing the Rate of AVAIL® Co-Polymer for Enhancing Phosphorus Availability to Corn (*Zea mays*)

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Introduction

Phosphorus is an essential macronutrient needed to optimize and maintain crop production as a crucial component for root development, crop maturity, and seed development. World demand for phosphate fertilizer is expected to exceed 45 million tons in 2016 at a growth rate of 1.9% per year, and supplies are decreasing[1]. Plants take up phosphorus in water-soluble form, but with strong retention by soil solids, less than 40% of applied phosphate fertilizer is available for plant uptake[2]. Solubilization of P may be enhanced, with a claimed 10-15% increase in yield, by a polycarboxylic co-polymer, AVAIL®[3]. The co-polymer is derived from maleic and itaconic acids and presumably enhances phosphorus availability via competitive sorption on mineral surfaces specifically >Fe-OH and >Al-OH sites[3]. Increasing phosphorus fertilizer use efficiency will aid food security and improve water quality, while maximizing return on phosphorus fertilizer investments.

Objective

- To determine how the AVAIL® co-polymer affects dissolved phosphorus concentrations, phosphorus uptake, and corn growth in a soil amended with phosphate fertilizer at sub-optimal rates.

Materials and Methods

Experiments were conducted on samples of a *Goldsboro* soil that had been neglected of phosphorus fertilizer for 30 years. Samples were collected from the Peanut Belt Research Station in Lewiston-Woodsville, NC.

Greenhouse Experiment

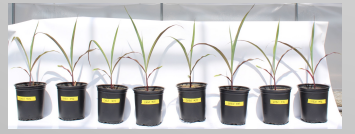
- Corn *(Zea mays)* was grown in a greenhouse with controlled temperature and watering. Varying rates of AVAIL® were applied to the P-deficient soil along with P at 50% of the recommended rate.
- AVAIL® treatments included 25, 50, 100, 150, 200% of the estimated polymer sorption capacity.

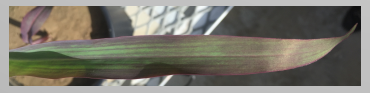
Soil Sorption Experiment

- Aqueous suspensions of soil samples were equilibrated in the laboratory with the same P and AVAIL® treatments used in the greenhouse, and dissolved P was measured colorimetrically.

Measurements

- Temporal trends in corn growth (height) and biomass at stage V4
- Above ground biomass concentrations of P and other nutrient uptake measured at the North Carolina Department of Agriculture - Agronomic Division Lab

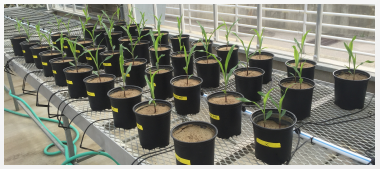




Experimental Approach

Laboratory sorption experiment
Effectiveness of AVAIL® on dissolved P in *Goldsboro* **soil**

Greenhouse experiment
Corn growth in soil treated with AVAIL® in **greenhouse**



Future research
Field plot experiments applying AVAIL® on various soil types and crops

Results & Discussion

Laboratory Experiment

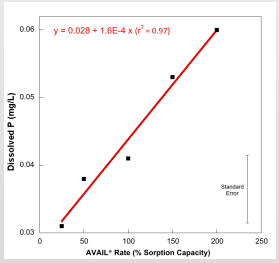


Figure 1. Positive linear relationship between AVAIL® input (as % of sorption capacity estimated from oxalate-extractable Fe + Al) and dissolved P concentration.

Greenhouse Experiment

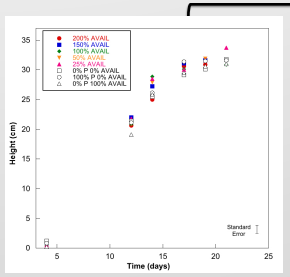


Figure 2. Corn grew at the same rate regardless of AVAIL® treatment, even with P applied at the recommended (soil test) rate (100% P-0% AVAIL).

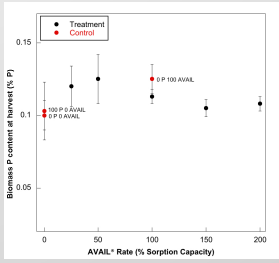


Figure 3. No significant ($p > 0.05$) differences were found between AVAIL® rates (or controls) and P content in corn tissue.

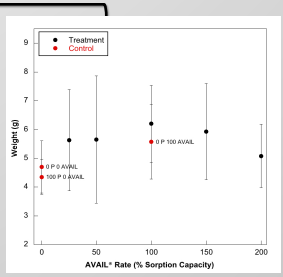


Figure 4. No significant differences found between AVAIL® rates (or controls) and above ground biomass of plants at harvest.

In the lab, a positive linear relationship ($r^2 = 0.97$) was observed between AVAIL® rates and dissolved P concentrations. However, there were no trends found between AVAIL® rates and corn growth or P uptake. There was also no sign of AVAIL® affecting uptake of other nutrients such as nitrogen and calcium (data not shown).

Conclusions

The AVAIL® co-polymer increased the concentration of dissolved P in our Goldsboro soil sample, but there was no significant response in th greenhouse in terms of plant height or P uptake. All plants, including that receiving 100% recommended rate of P, expressed purpling - a commo symptom of phosphorus deficiency. These observations imply that phosphorus rates as well as AVAIL® rates need to be optimized for a given soil an crop. Our greenhouse results, showing P deficiencies in all treatments, establishes a baseline for future research involving higher phosphorus input less P-deficient soils, additional crops and soil types, and different co-polymer configurations.

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