Effect of Humic Acid on Phosphorus Availability and Spring Wheat Yield

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Introduction

Humic substances in organic matter are known to help with crop growth when present in high enough quantities. Commercial humic acid (HA) is sometimes applied at low application rates (1 – 3 lb/ac) to enhance P or metal availability, yet growth responses are mixed. The objectives of this study were to 1) determine if available P concentrations increase in the presence of low rates of HA in Montana soil, and 2) determine the inter-actions between P fertilization and HA on crop yield

Methods

A calcareous silty clay loam was collected from the Montana State University Arthur Post Farm and a non-calcareous sandy loam collected from Red Bluff Experiment Station. Olsen P concentrations were 9.1 and 10.8 ppm for the calcareous (12% $CaCO_3$) and non-calcareous soil, respectively, and the soil test zinc (Zn) concentration was below the critical level of 0.5 ppm in the calcareous soil. Because HA can increase metal availability, no Zn was added to increase the chances of a growth response.

Soluble HA was obtained from two manufacturers (HA 1 and HA 2). Each HA was coated onto granular MAP at a concentration needed to supply an equivalent rate of 1.5 lb HA/ac by adding each to a plastic bag and shaking until the coating was visually complete.

Phase I

The goal of Phase I was to determine the effect of HA on soluble P concentrations in the vicinity of a MAP band. Plastic containers (15"x10"x5") were fitted with four ceramic lysimeters that had been glued to stainless steel syringes. Three of the lysimeters were installed 1 in. deep and 0.75, 1.5, and 2.25 in. away from the center line, and one was installed so that it would lie 1.5 in. below a fertilizer band. Each soil was added to 12 containers until the soil surface was 1.5 in. from the top of the container. Monoammonium phosphate (MAP) was applied 1 in. below the soil surface in a narrow band at a rate equivalent to 50 lb P_2O_5/ac. Soil water was extracted with a hand pump for P analysis prior to fertilizer addition, and at 4, 8, 16, and 32 d after fertilization. Each treatment was replicated four times.

Phase II

The goal of Phase II was to determine if HA causes an increase in wheat shoot biomass, grain yield, or P uptake. Each column (pot) consisted of a 2 foot, 8 in. diameter PVC pipe. Seven 'McNeal' spring wheat seeds were planted 1 in. deep in the two soils from Phase I, offset from the column's centerline by 0.75 inches. MAP, either coated with 1.5 lb HA/ac (of HA 2) or left uncoated, was band-applied 1.5 in. to the side of the seed at rates equivalent to 15 or 50 lb P_2O_5/ac. Each treatment was replicated four times. Each column was fertilized with 34-0-0 to attain an available N concentration of 165 lb/ac (including soil NO_3-N, plus N in the MAP). After emergence, each pot was thinned to 5 plants. Soil water contents were maintained near 90% of field capacity.

Results

Concentrations of P were over 100 fold lower in the calcareous soil than in the non-calcareous soil, likely due to formation of calcium phosphate minerals in the calcareous soil. There were no significant differences (P=0.05) in soluble P concentrations at 0.75 in. from the fertilizer band between HA treatments and the control for any time point for either soil (Figure 1). The only difference from this general finding was at Day 4 in the non-calcareous soil, when soluble P concentrations in both HA treatments were approximately 2.5 fold higher than the control. High natural variability in soluble P concentrations prevented these differences from being statistically significant. Although the HA 2 treatment appeared to have higher P concentrations than either HA 1 or the control at most time points, HA 2 concentrations were also higher before fertilizer application. The soluble P concentration in the calcareous soil 1.5 in. below the band was significantly higher in the HA 2 treatment than in the control at Day 16, yet this was the only significant difference at any of the four distances from the HA band, for either soil, and at any of the four time points (data not shown).

Fertilizer

Facts

Fertilizer ✔off

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Grain yields were greater (though not significantly) with increased P application rate, especially in the calcareous soil where 50 lb P_2O_5/ac produced approximately 30% more grain than 15 lb P_2O_5/ac for both the HA 2 treatment and control (Figure 2). This finding suggests that if HA significantly increased P availability in this soil, yield responses should have been observed. Instead, grain yields were almost identical between treatments for both P application rates, indicating that HA did not substantially affect P availability. Higher grain yields in the non-calcareous soil were likely due to higher concentrations of available nutrients and/or O.M. Shoot biomass was also not significantly affected by HA (data not shown).

Uptake of P was somewhat less for the HA 2 treatment than the control in the calcareous soil, and slightly higher for the HA 2 treatment in the non-calcareous soil, although again these changes were not significant (Figure 3). The study also found that Zn and iron uptake amounts were not increased by HA (data not shown), even though HA is a known 'chelator' and can therefore increase metal availability in soil.

Fertilizer Facts:

- Humic acid coated on MAP fertilizer at 1.5 lb HA/ac did not produce a consistent, significant effect on P solubility, P uptake, metal uptake, or spring wheat yield in either a calcareous soil or non-calcareous soil.

- Consultants and producers should use caution when purchasing humic acid products that claim to increase spring wheat yield at low rates.

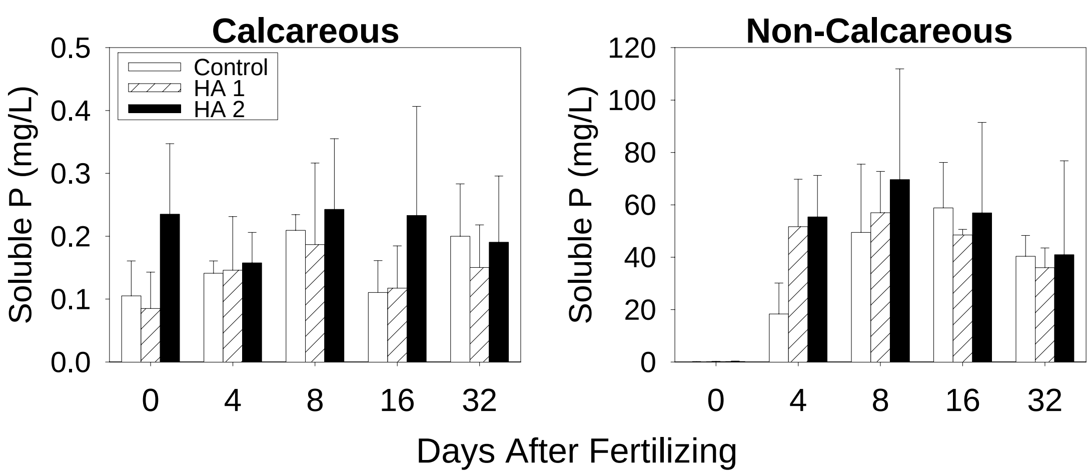

Figure 1. Soluble P concentrations 0.75 in. to the side of a MAP band that had been coated with a humic acid product (HA 1 or HA 2) or left uncoated (Control). Day 0 samples were collected immediately prior to fertilizer application.

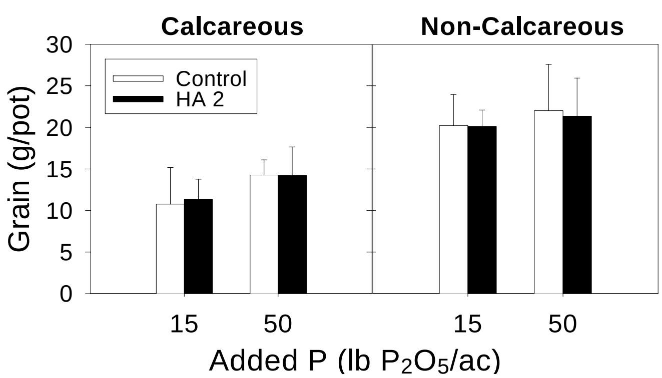

Figure 2. Grain yield response for two fertilizer rates in presence and absence of HA 2.

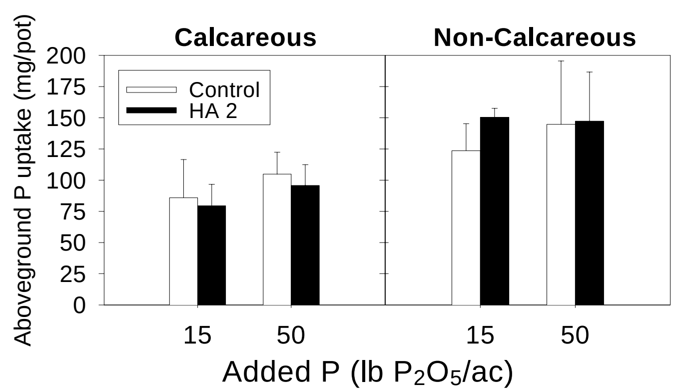

Figure 3. Aboveground P uptake for two fertilizer rates in presence and absence of HA 2.