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Soil and Water Science

Research Brief

University of Florida Institute of Food and Agricultural Sciences

The Role of Amorphous Iron and Aluminum in Phosphorus Retention in Sandy Soils of the Suwannee River Basin

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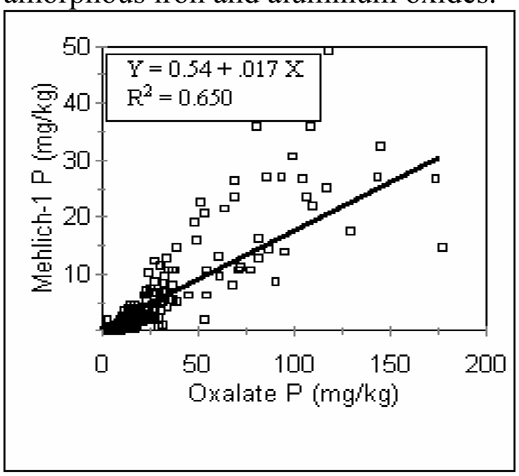
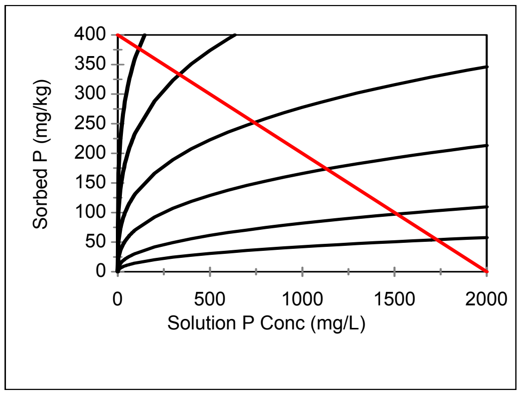
We are currently evaluating the potential for P leaching in sandy soils of the Suwannee River Basin. This area is home to a substantial dairy and poultry industry and wastes from these farming operations are being land applied. The ability of the soil to retain P against leaching is critical to maintaining water quality in this area.

Some of the most important components in soils that affect P retention are the amorphous oxides of iron and aluminum. These components can be quantified using an ammonium oxalate extraction procedure. The importance of these components in retaining P is indicated in the following figure in which Mehlich-1 P (a standard soil test procedure) is plotted against oxalate extractable P for soil samples taken from the Suwannee River Basin. In acidic soils, oxalate extractable P is made up largely of P bound by amorphous iron and aluminum oxides.

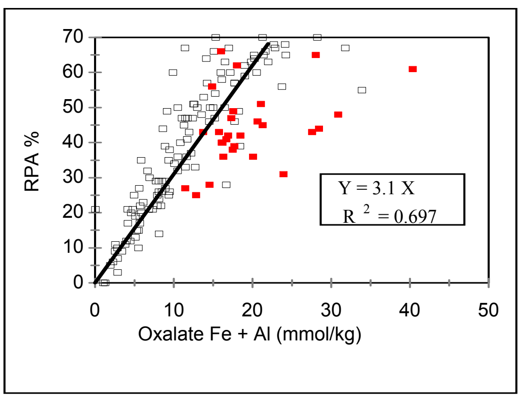


A commonly used measure of P retention in soil is the adsorption isotherm. This is simply a plot of the amount of P adsorbed by the soil vs. the amount of P in solution. The black curves in the following figure are adsorption isotherms for sandy soils that range in amorphous iron and aluminum content. The more iron and aluminum, the greater the P adsorption.



Multipoint isotherms like those in the above figure are time consuming to develop. However, we can obtain a significant amount of information from *single-point* isotherms. If a soil were exposed to an initial P concentration of 2000 mg/L, the amount of P adsorbed would be given by the intersection of the red diagonal line in the above figure and the soil's P adsorption isotherm. The slope of the diagonal line is determined by the soil-to-solution ratio, which for this example is 5g:1ml. The intercept of the diagonal line on the y-axis represents the maximum amount of P that can be adsorbed under these conditions, which is 400 mg/kg. The intercept of the diagonal line and the x-axis represents zero P adsorbed, i.e., all the P remains in solution. Taking 400 mg/kg as 100% adsorption, we can calculate the relative P adsorption, or RPA. For example, if the isotherm for a soil sample were to intersect the diagonal line at 200 mg P/kg of soil, its RPA would be 50%. In a previous Research Brief, SWS-03-02, a model for long-term P leaching in sandy soil was presented. One of the input parameters for that model was the RPA.

The third figure shows the relationship between P adsorption, as indicated by the RPA, and oxalate extractable iron and aluminum for soil samples with an RPA < 70%. The open squares were samples with Mehlich-1 P values < 30 mg/kg; the solid squares were those that exceeded 30 mg/kg. Some Mehlich-1 P values exceeded 260 mg/kg in the latter set. The tendency for samples with higher Mehlich-1 P values to have lower RPA values reflects the decrease in P retention capacity as P loading increases.



The independent variable in the figure is the sum of iron and aluminum. However, there is evidence in the literature to suggest that the reactivity of amorphous iron and aluminum oxides varies with the ratio of iron-to-aluminum. If so, this could explain some of the scatter in the data. One aspect of our study will be to determine the effect of iron-to-aluminum ratio on reactivity of amorphous oxides toward P.

This project will yield data which can be put into leaching models like that described in Research Brief, SWS-03-02, to predict the rate of downward movement of P in sandy soils. Such predictions will be useful for estimating how much P a soil can retain before posing a serious risk of contaminating ground and surface water.

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