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Soil and Water Science Research Brief

SOIL PHOSPHORUS ACCUMULATION IN AN ALLEY CROPPING SYSTEM ON AN ULTISOL

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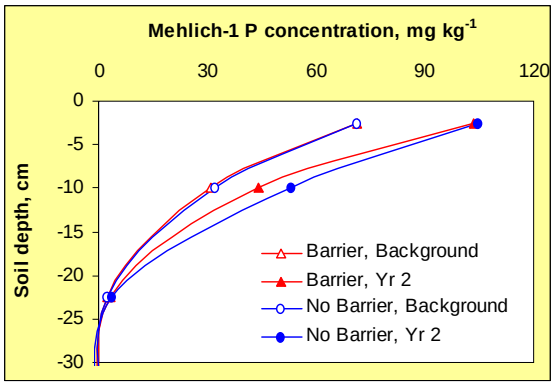
Loss of phosphorus (P) from agricultural land can result in water quality degradation of streams and lakes. Phosphorus loss can occur through both surface runoff and subsurface leaching depending on landscape and soil characteristics. This is recognized in the Florida P-Index, a P loss assessment tool, which includes both runoff and leaching as P transport factors.

In this study, we measured P concentrations to a 1m depth before and after two years of fertilization in an alley-cropping system of pecan (*Carya illinoensis*) trees intercropped with cotton (*Gossypium* sp.). This study is part of a larger study of nutrient dynamics in this system. The soil is an Ultisol (Red Bay sandy loam) with a clay layer (Bt) at a depth of 20-25 cm. This site is located at the West Florida REC in Jay, FL (30°47 N, 87°13 W). Pecan trees are 50 yrs old, spaced 60 ft (18.24 m) apart. Cotton was planted in 16 rows per alley (north to south). A 3-9-18 fertilizer blend was applied to test plots at a rate of 104 lbs P per acre (117 kg P per ha) in mid- 2002 and 2003, according to standard fertilizer practices for the research station.

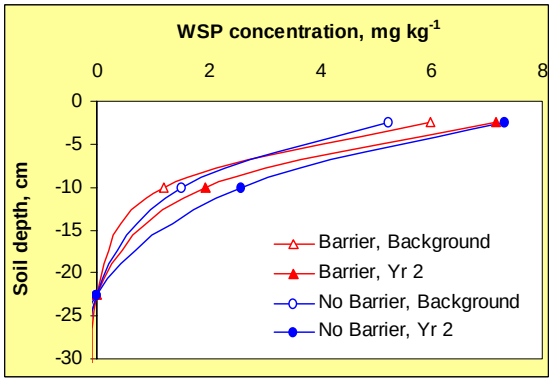
The pecan/cotton alley-cropping system was divided into “barrier” and “non-barrier” plots. Barrier plots featured a 1m-deep polyethylene liner along both sides of the alley, to inhibit belowground competition between cotton and pecan roots.

Soil samples were collected by bucket auger at successive depths (0-5, 5-15, 15-30, 30-50, 50-75 and 75-100 cm) at random points in alleys of barrier and non-barrier plots in the winter of each year, following cotton harvest. This arrangement thus created three soil sampling periods: Background, prior to 2002 fertilizer application (Background), Year 1 (2003), and Year 2 (2004). Soil samples were analyzed for various nutrients, including Mehlich-1 P, Water Soluble P (WSP) (at 1:10 soil:water ratio), and P Saturation Ratio (PSR). PSR is a measure of relative P availability based on soil properties, and is calculated as Mehlich-1 P / Mehlich-1 (Fe + Al).

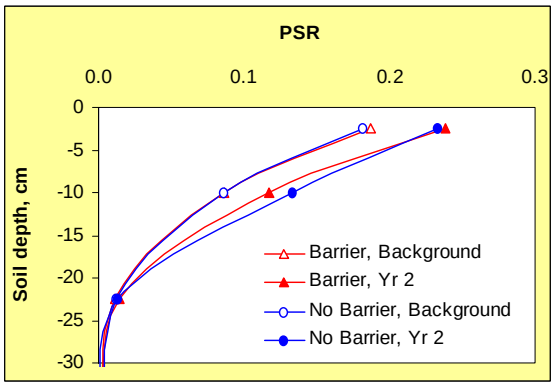
Both Mehlich-1 P and WSP concentrations increased from 2002 to 2004 after fertilizer application in treatment areas. Prior to 2002 mid-year fertilization, Mehlich-1 P and WSP concentrations were similar in the soil profiles of barrier and non-barrier plots.



Mehlich-1 P concentrations in topsoil after fertilizations during two growing seasons, were greater for both barrier and non-barrier treatments, but minimal for all treatments below a depth of 25 cm.



WSP concentrations followed a similar trend, though at a much smaller scale, since P is less soluble in water than in Mehlich-1 extractant. Extractable P concentrations (Mehlich 1 or WSP) in the soil profile were minimal below 25 cm due to the presence of clay layers capable of retaining added P.



The P Saturation Ratio increased in the surface horizon (0-5 cm) from 2002 to 2004 after fertilizer application, a trend similar to that seen for Mehlich-1 P and WSP.

Overall, Mehlich-1 P, WSP and PSR increased slightly in surface horizons from 2002 (initial sampling) to 2004 (final sampling) after fertilizer application.

Summary and Conclusion

Phosphorus fertilization over a two-year period increased the Mehlich-1 P and WSP concentrations in the surface soil. Apparently, any P reaching the clay layer (Bt) was bound with sufficient energy that it was not extractable by water or the Mehlich-1 extractant. This suggests that leaching of P to the ground water would not be a problem in soils such as Ultisols. However, the amount of P potentially lost in runoff could increase due to the fertilization. Two applications of fertilizer in the alley-cropping system have increased the average concentrations of Mehlich-1 P from 71 to 104 mg kg^{-1} in the surface soil and WSP from 5.6 to 7.3 mg kg^{-1}. Repeated fertilizer applications for a long period could, therefore, create a potential environmental problem from surface runoff, even for a highly P retentive soil such as the Ultisol in this study.

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