Land Management Effects on Phosphorus Retention in Soils of the Everglades Agricultural Area

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INTRODUCTION

The histosols in the Everglades developed as seasonally-flooded sawgrass prairies, but a major shift in land use in the past century resulted in their conversion to agriculture. Phosphorus distribution and stocks in soils of the Everglades Agricultural Area (EAA) may differ between long-term land management practices, ultimately impacting water quality through nutrient regeneration resulting from soil oxidation.

Phosphorus fractionation schemes have been developed to assess P distribution in chemical fractions related to their degree of recalcitrance. The distribution of P within chemically-defined pools, such as inorganic and organic fractions, provides an indication of the potential stability of P, which may differ between land uses. The objectives of this study were to determine the soil-profile distribution of P and allocation between chemical fractions for multiple land uses of histosols in the EAA.

MATERIALS AND METHODS

The study site is located in the northern EAA at the Everglades Research and Education Center. The soil is classified as Dania muck (euic, hyperthermic, shallow Lithic Medisaprists) with depth to bedrock of approximately 45 cm.

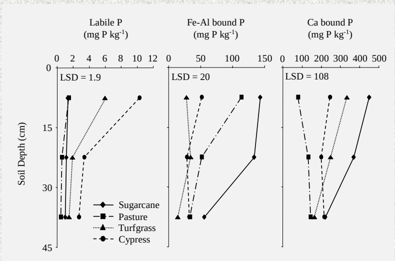
Four adjacent fields were utilized : a 16 ha field under perennial pasture for 100 years, a 16 ha field under sugarcane cultivation for 50 years, a 0.7 ha field planted to cypress for 19 years, and a 20 ha field under turfgrass for 60 years. Soil cores were taken to bedrock (0-45 cm) and sectioned into 0-15, 15-30, and 30-45 cm intervals.

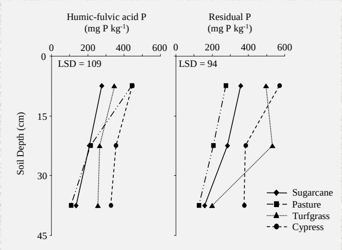
RESULTS

Soil bulk density did not vary between land uses but significantly increased with depth in the profile from 0-15 (0.44 g cm^{-3}) to 30-45 cm (0.53 g cm^{-3}). Soil pH did not vary with depth except for pasture, which increased from 5.3 at 0-15 cm to 6.8 at 30-45 cm.

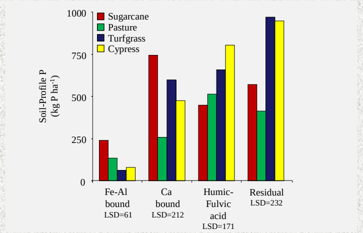
Throughout the soil profile, labile P constituted a total of 11.5 and 7.3 kg P ha^{-1} for cypress and turfgrass, respectively, which was significantly higher than labile stocks for sugarcane (2.7 kg P ha^{-1}) and pasture (1.6 kg P ha^{-1}).

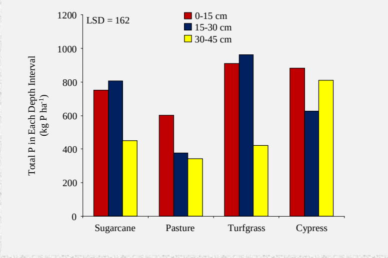
The total P stocks in the Fe-Al bound fraction were significantly higher than labile P but lower than the Ca-bound and organic P fractions, and were highest for sugarcane and lowest for turfgrass and cypress.





The Ca-bound fraction contained more P than other inorganic fractions due to high Ca levels in soil resulting from incorporation of limestone bedrock into soil by tillage. The P levels in organic pools were lower for sugarcane than other land uses. Total P stocks in the residual organic fraction were higher for turfgrass and cypress than sugarcane and pasture.





Soil total P in the entire profile of 0-45 cm averaged 2005, 1323, 2294, and 2317 kg P ha^{-1} for sugarcane, pasture, turfgrass, and cypress, respectively. The 0-15 cm depth retained more P than lower depth intervals. Sugarcane had a greater percentage of its total P in inorganic fractions (49%) compared to other land uses (28%).

CONCLUSIONS

Soil P storage varied with depth in the profile and between land uses, with the major factors affecting P stocks and distribution being fertilization and soil subsidence. Labile and Fe-Al associated P fractions comprised a relatively small percentage of the total soil P. Cultivation to sugarcane and long-term fertilization increased P retention in mineral-associated fractions, particularly the Ca-bound fraction.

The P retained in organic fractions may not be stable and in fact may pose a long-term eutrophication hazard due to runoff of the P generated by soil oxidation under current land uses. In contrast, the higher inorganic P stocks for cultivated soil indicates a more stable pool since the Ca-bound fraction is not affected by soil oxidation. In fact, tillage increased soil Ca levels and enhanced the potential for long-term P sequestration for sugarcane cropping.

Higher rates of soil oxidation of pasture soil and resulting lower P stocks appeared related to its low canopy cover which increased soil temperature and decomposition rates, and subsequent P loss from fields as runoff and leaching.