PHOSPHORUS SORPTION AND MOVEMENT IN FINE SAND SPODOSOLS AND ENTISOLS

Davie M. Kadyampakeni[1], Peter Nkedi-Kizza[2], Kelly T. Morgan[1], and Arnold W. Schumann[3]
[1]University of Florida, Southwest Florida Research and Education Center, SR 29 N, Immokalee, FL 34142, USA.
[2]University of Florida, Soil and Water Science Department, 2181 McCarty Hall, P.O. Box 2169, Gainesville, FL32611.
[3]University of Florida, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850.

Introduction

Phosphorus is a critical nutrient in citrus production whose deficiency or excess can affect crop yield and quality.

Sound stewardship and management of P would help growers maintain high yields and conserve environmental quality .

Appropriate estimation of sorption coefficients and characterization of P movement would provide necessary information for sustainable environmental management.

Objectives

1) Determine the effect of supporting electrolyte on P sorption coefficient (K_D).

2) Evaluate the effect of sorption coefficients on prediction of P movement at 30 cm soil depths using HYDRUS-1D.

Batch Sorption Experiments

Sorption isotherms on the disturbed soil samples (0- to 15- and 15- to 30-cm) were determined using the batch equilibration procedure (Graetz and Nair, 2009).

In the fertilizer mixture, the initial concentrations were 10, 50 and 100 mg L^{-1} N, 5, 25 and 50 mg L^{-1} P, and 6, 32 and 63 mg L^{-1} K.

A 10 g air-dried soil subsample was placed in a centrifuge tube and equilibrated with 20 ml of 3 initial concentrations of P.

Models on Adsorption

Sorption isotherms for P that followed the Freundlich model were calculated using:

$$S_e = K_f C_e^N \quad [1]$$

Where S_e is the adsorbed concentration (mg kg^{-1}); C_e is the soil solution concentration at equilibrium (mg L^{-1}); K_f is the Freundlich sorption coefficient (mg^{1-N} kg^{-1} L^N) and N is the empirical constant related to adsorption phenomena (Bowman, 1982).

To find average linearized K_D for Equation 1, the integrated form of the equation was used:

$$K_D = \frac{\int_0^{C_{max}} N K_f C_{max}^{N-1} dC}{\int_0^{C_{max}} dC} = K_f C_{max}^{N-1} \quad [2]$$

Where K_D=sorption coefficient (L kg^{-1}); and C_{max} is the maximum concentration at equilibrium (mg L^{-1}).

Results

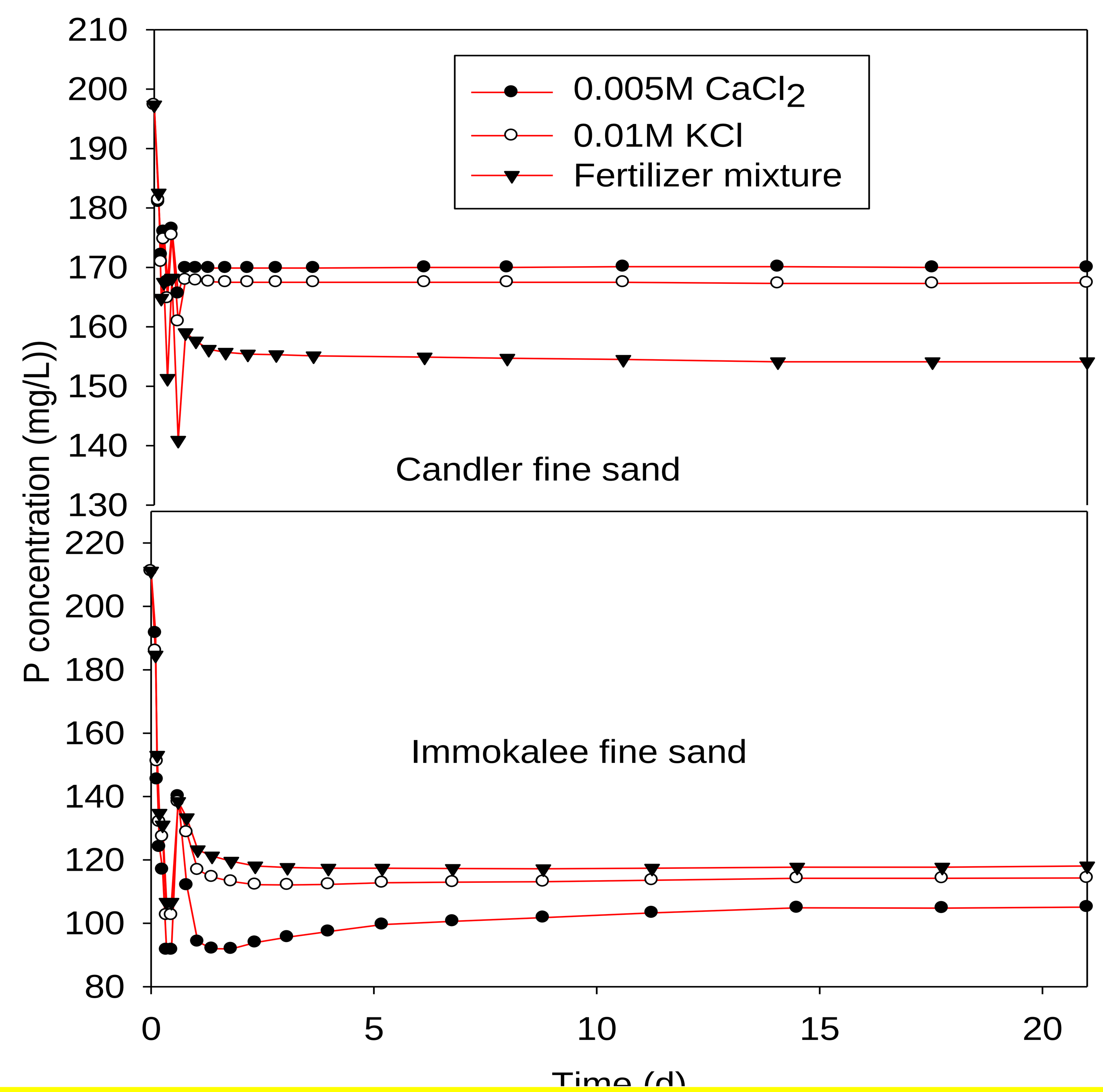

Fig. 1. Simulated P movement on Candler and Immokalee fine sand depending on K_D value at 30 cm soil depth

Results

Table 1. Linearized sorption coefficients for P in Immokalee and Candler fine sand

Soil	Depth (cm)	Supporting electrolyte	K_D (L kg^{-1})
Candler	0-15	0.01 M KCl	2.87 ± 0.43
Candler	15-30	0.01 M KCl	3.79 ± 0.87
Candler	0-15	Fertilizer mixture	1.73 ± 0.15
Candler	15-30	Fertilizer mixture	2.05 ± 0.89
Candler	0-15	0.005 M $CaCl_2$	3.46 ± 0.65
Candler	15-30	0.005 M $CaCl_2$	4.43 ± 0.50
Immokalee	0-15	0.01 M KCl	0.53 ± 0.11
Immokalee	15-30	0.01 M KCl	0.50 ± 0.19
Immokalee	0-15	Fertilizer mixture	0.45 ± 0.10
Immokalee	15-30	Fertilizer mixture	0.43 ± 0.20
Immokalee	0-15	0.005 M $CaCl_2$	0.75 ± 0.13
Immokalee	15-30	0.005 M $CaCl_2$	0.74 ± 0.32

Discussion and Conclusions

The results show that P adsorption in the top 0-15 cm was greater for Candler than Immokalee sand using the fertilizer mixture, 0.005 M $CaCl_2$ and 0.01 M KCl.

The sorption coefficients (K_D) for P estimated using 0.01 M KCl were similar to K_D values determined using fertilizer mixture for the two soils.

The K_D values of 0.005 M $CaCl_2$ as the supporting electrolyte were two- to threefold greater than the K_D of the fertilizer mixture.

The divalent Ca^{+2} resulted in overestimation of P sorption on Candler and Immokalee fine sand.

References

Bowman, B.T. 1982. Conversion of Freundlich adsorption K values to the mole fraction format and the use of SY values to express relative adsorption of pesticides. Soil Sci. Soc. Am. J. 46:740-743.
Graetz, D.A., and V.D. Nair. 2009. Phosphorus sorption isotherm determination, p. 33-37, In J. L. Kovar and G. M. Pierzynski, (eds.) Methods of P Analysis for Soils, Sediments, Residuals, and Waters 2nd ed. Virginia Tech Univ., Blacksburg, Virginia.