PHOSPHOROUS TRANSPORT WITH WATER FLOW IN ACID, SANDY SOILS

by

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ABSTRACT: Literature dealing with phosphorous transport in acid, sandy soils was reviewed, and a mechanistic, single-component model was developed for describing P transport with multi-compartmental kinetic and instantaneous reversible and irreversible sorption, transformations of organic to inorganic P forms, and root uptake during steady and unsteady flow in saturated and unsaturated soils. The utility of the model was demonstrated with the use of one-site, parallel two-site, and sequential two-site P sorption models by comparisons to analytical solutions (where available), by sensitivity analyses, and by a comparison to experimental data.

A need exists to develop mechanistic, multi-component, P transport models which include competitive kinetic chemical interactions between P and other anions (organic as well as inorganic) for reaction microsites in the soil, and between P and Al, Fe, and Ca.

1.Introduction

When large quantities of P are regularly applied either as fertilizer or as wastewater to land surfaces with predominantly sandy soils, downward movement of percolating water to groundwater as well as overland flow during periods of shallow watertables may result in consequent lateral flow to local streams such that P undergoes transport to nearby lakes or estuaries. Subsequent contamination of surface waters with P may then result in eutrophication, anaerobiosis, and general deterioration of environmental quality. Substantial addition of P to surface water usually results in increased algal production (Webber 1981) and increased decomposition of organic matter which causes depletion of oxygen. Eutrophic conditions are generally associated (Webber 1981) with total P concentrations in excess of $20 \mu g\ l^{-1}$ in the water during the spring. P-induced eutrophication has been documented for the Great Lakes (Webber 1981) in the USA and Canada, Lake Okeechobee in Florida (Allen et. al., 1982), the Peel-Harvey Estuary in Australia (Hodgkin et. al., 1980), and for many other bodies of surface water.

Secondarily-treated municipal wastewater is commonly applied to land surfaces using rapid-infiltration, slow-infiltration, and overland flow methods of renovation. Land treatment by rapid infiltration is usually performed using sandy soils in order to maintain high infiltration rates. Unfortunately, such soils often have low capacity to retain P from infiltrating wastewater. Compared to agricultural fertilization practices, rapid-infiltration land treatment of P municipal wastewater is usually applied more frequently and in smaller quantities per application (Syers and Iskandar, 1981). During land treatment of wastewater, P is always applied at rates far in excess of crop removal (Syers and Iskandar, 1981). Movement of P with water in soils is thus largely dependent upon the rate and extent of removal by soil components (Syers and Iskandar, 1981). Using a simple model for predicting P removal by soils,