Int. J. of Sustainable Water and Environmental Systems
Volume 3, No. 1 (2011) 53-58

Phosphorus-Sorption Characteristics of Calcareous Soils in Arid and Semi Arid Regions

Kholoud Mashal [a]*, Mohammed Al-Qinna [a] , Jwan Ibbini [a]

[a] *Department of Land Management and Environment, Hashemite university , Zarqa, Jordan*

Abstract

Understanding of phosphorus (P) sorption and desorption by soils is important for water quality. The objectives of this study are to: (1) estimate P-sorption parameters of calcareous soils; and (2) determine the factors affecting P sorption and the relation between equilibrium P concentration at zero-net P sorption (EPCo) and soil parameters. In this study selected samples of calcareous soils ($CaCO_3$ % 34-60) were collected from the Al-Hashemiya area. Phosphorus sorption isotherms covering a wide concentration range of phosphate (0-500 mg/L phosphate) were determined at room temperature by batch experiments. The results indicate that as the P concentration in solution increased, the slope of the sorption isotherm changed abruptly. The abrupt change in slope of the sorption isotherms suggests that P precipitation at the carbonate surface began to dominate the process as concentrations increased beyond that of the point of inflection. Sorption isotherm results showed that these soils best fit Freundlich isotherm. Both Pearson correlation matrix and stepwise regression models indicated that Fe-oxide and soil cation exchange capacity (CEC) are the most significant effective ($P<0.05$) predictors on P availability and occurrence in calcareous soils, while carbonate content, soil pH, EC, and OM content were insignificant on P availability.

Keywords: *phosphorus, sorption, Freundlich, CEC, desorption*

1. Introduction

Phosphorous (P) is an essential nutrient used to build cell molecules like phospholipids and the backbone of nucleic acids (DNA and RNA), and it is involved in energy transformation (ATP). Although P requirement is less than nitrogen and carbon, P is normally a limiting growth factor [1]. Phosphorous enter the biosphere through geochemical transformation (weathering of rocks), and anthropogenic activities like mining, agricultural activities, discharge from industrial and wastewater treatment plants, and runoff from residential areas [2]. Human activities has clearly affected the global P cycle, it was reported that an increase from about 10-15 Tg P year^{-1} in pre-industrial times to 33-39 Tg P year^{-1} till the beginning of the second millennium leading to phosphorous accumulation in different ecosystems [3].

Phosphorous is generally considered to be highly immobile nutrient in soil due to fixation on soil particles and organic matter [4]. Though, P mobility has been reported under certain subsurface conditions and land use. For example, P loss can be enhanced when the soil is characterized to have high P concentration and low P sorption capacity [5]. Excess P is subject to leaching in the subsurface reaching groundwater and then surface water causing deterioration of water quality [6,7,3].

Eutrophication is a world wide problem in aquatic systems result in response to nutrient enrichment with P and N in surface water. Algal growth is triggered creating massive growth called bloom, and then adverse effects begin to appear such as increase turbidity and low light penetration. Decomposition of dead algal cells leads to foul odors and depletion of dissolved oxygen (hypoxia). Moreover, build up of algal toxins have negative effects on macrophytes (higher plants), leads to fish kills and decreases aquatic biodiversity. In general eutrophication leads to changes in water quality, disrupts ecological balance and ecosystem stability, affecting the human use of water resources [1]. A long term study in the Canadian lakes showed evidence for the direct role of P inputs in controlling eutrophication [9]. The United States Environmental Protection Agency (US-EPA) has guidelines for P concentrations not to exceed 0.05 mg L^{-1} for streams entering lakes and reservoirs and not to exceed 0.025 mg L^{-1} in the lakes and reservoir water [10].

In subsurface soil P is present under different geochemical forms including soil solution, organic matter, and exchangeable phase. Other forms are found to be bound to Ca and/or Fe and Al, or can be in the residual phase [11]. Those forms have different mobility, bioavailability and chemical behaviors in soils under certain conditions [12, 13].

Information on P release rate from calcareous soil in Jordan is scars. As Jordan located in the Arid and semiarid regions, where land and water resources are limited and natural phosphate deposits are found in the country [14]. Furthermore, due to increasing demand on water in agriculture, wastewater reuse is practiced threatening to increase P availability in soils and groundwater [15]. Studying the factors affecting sorption and desorption are significant for long term monitoring and planning of P inputs and outputs in the area to mitigate the

* Corresponding author. Tel.: +962799501948
E-mail: kholoudmashal@hotmail.com; kmashal@hu.edu.jo

DOI: 10.5383/swes.03.01.009