(Format No. 3)

SUMMARY OF DOCTORAL THESIS

Name: ZAHOOR AHMAD

Title: Effect of Saline Irrigation on Phosphorus Leaching and Bioavailability
(塩水灌漑がリンの溶脱と生物利用特性に及ぼす影響)

Nitrogen (N), phosphorus (P), and potassium (K) are not only important in agriculture, but these nutrients also play a vital role in aquaculture from an environmental point of view. Continuous application of different bio-wastes in agricultural fields has increased the concentration of N and P in many freshwater bodies, creating severe environmental concerns. Phosphorus desorption is of great interest from the standpoint of plant nutrition and water quality. Because P is considered to be relatively immobile in the soil system, less attention has been paid on P fate in soil. On other hand, one of the principal experimental variables which affect the results of P sorption-desorption studies is the ionic composition, both species and concentrations, of the contacting solution. Attempts to quantify and explain solution effects on P sorption arising from different salt concentrations and cation species have relied upon concepts of solubility of phosphate compounds believed to form in soils or the sorption of P at a dominantly negatively charged surface. In spite of the realization that ionic species, concentrations and their compositions affect P sorption and/or desorption but most of the salt related studies are confound to Cl^- (anion) in association with other cations. While, the comparative study of the effects of anions (associated with respective cations) on P fate in the soil has been the interest of very few researchers. Therefore, current study was designed with the objectives (i) to evaluate the comparative effect of cations and anions on P release (ii) to evaluate the interactive effect of anions (Cl^- and SO_4^{2-}) on P release and (iii) to compare the inorganic P release from different P sources induced by these ions. To achieve our goals a number of studies were conducted. In first experiment, soil was subjected to one salt and nine subsequent water extractions and different P fractions were measured. Four salt types NaCl, Na_2SO_4, KCl and K_2SO_4 were used at the rate of 0.5 M. Test soil (1 g) was amended with livestock compost manure (Po); KH_2PO_4 (Pi) or $Ca(H_2PO_4)_2$ (Pic) at the rate of 1mg kg^{-1}. Phosphorus fractions, biological available P (extracted with $NaHCO_3$), Fe and Al associated P (extracted with NaOH), and Ca associated P (extracted with HCl) were measured. Results of the study showed that, irrespective of P sources, P release was substantially increased from salt-pretreated soil as compared to the non-saline soil. Sulphate salts released more P in subsequent water extractions than Cl^- and a synergistic effect was observed between Na and SO_4 ions. Phosphorus release decreased for salt types as Na_2SO_4> NaCl> K_2SO_4> KCl and for P sources as livestock composted manure ≈ KH_2PO_4 > Control > $Ca(H_2PO_4)_2$, respectively. Biological available P was greater from the soils pre-treated with Cl^- than SO_4^{2-} salts while P sources did not differ significantly. Second study was carried out in green house where soil was salinized by adding NaCl and Na_2SO_4 salts (75 $mmol_c$ L^{-1}) and P was amended at the rate of 100 kg ha^{-1} in the form of composted livestock manure, KH_2PO_4 and Po (50 kg ha^{-1}) + Pi (50 kg ha^{-1}) (Pc) along with the control. Irrespective of salt types, application of P sources enhanced the wheat (*Triticum aestivum* L.) growth and P uptake as compared to the control. Combined P source (Pc) gave higher shoot and root dry matter than P sources applied alone. Chloride salt suppressed shoot and root dry matter severely than SO_4^{2-} salt. Phosphorus uptake and recovery (%) increased in the pots amended with Pc. Chloride salt was also toxic for plant P uptake and recovery than the SO_4^{2-} salt. Third study evaluated the leachability and phytoavailability of P, N, and K from a sandy loam soil amended with animal, poultry, and sludge composts when applied on a total P–equivalent basis (200 kg ha^{-1}) under Cl^- (NaCl) and SO_4^{2-} (Na_2SO_4)-dominated irrigation water (60 $mmol_c$ L^{-1}). Results showed that the concentration of dissolved reactive P (DRP) was higher in leachates under SO_4^{2-} than Cl^- dominated irrigation water. Compost amendments differed for DRP leaching in the pattern: sludge > animal > poultry > control. Maize (*Zea mays* L.) growth and P uptake were severely suppressed under Cl^- irrigation compared with SO_4^{2-} and non-saline treatments. All composts were applied on a total P-equivalent basis, but maximum plant (shoot + root) P uptake was observed under sludge compost amendment (73.4 mg DW^{-1}), followed by poultry (39.3 mg DW^{-1}), animal (15.0 mg DW^{-1}), and control (1.2 mg DW^{-1}) treatment. Results of this study reveal that irrigation water dominated by SO_4^{2-} has greater ability to replace/leach P, other anions (NO_3^-), and cations (K^+). Variability in P release from different bio-composts applied on a total P equivalent basis suggested that P availability is highly dependent on compost source.