Particulate matter and surface runoff transport of copper (Cu) from land to water ways

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Abstract

Copper (Cu) concentration has significantly increased in some citrus grove soils in South Florida due to repeated use of Cu based fungicides. Laboratory incubation and soil Cu characterization were conducted to examine the effects of Cu forms and availability in bulk soils, surface runoff water and particulate matter (PM). With an increase in external Cu inputs, soil pH decreased, which enhances Cu availability and movement. Most increases in soil Cu occurred in exchangeable- and oxide-bound fractions, which are positively related to an increase in total Cu concentration and negatively to soil pH. Copper concentration in PM obtained from surface runoff water or bulk soils was higher than that of bulk soils and availability of Cu in both bulk soil and PM was soil pH dependent. A greater proportion of organically-bound Cu was found in PM than that of bulk soils, especially from surface runoff water, which is consistent with the higher organic/inorganic colloid ratio in PM than in bulk soils. Chemical speciation studies also confirm the greater organic-Cu complexes in both bulk soils and surface runoff water. These results indicate the most Cu that accumulates in citrus grove soils and surrounding runoff water are highly mobile and bioavailable and thus may impact citrus production and the environment.

Influence of Wetland Vegetation on Stability of Accreted Phosphorus in the Everglades Stormwater Treatment Areas

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Treatment wetlands are utilized globally to reduce the amount of nutrients discharged into downstream water bodies. Sustainability of these wetlands depend on accumulation of stable (non-reactive) forms of retained nutrients.The importance of wetland vegetation in phosphorus (P) removal is well documented, however limited information is available on the role of different vegetation types on stability of accreted P.

We characterized soil P into reactive and stable pools and compared these pools between Submerged Aquatic Vegetation (SAV) and Emergent Aquatic Vegetation (EAV). By using operationally defined P fractionation scheme we determined inorganic, organic and residual P fractions, of which first two fractions constituted reactive forms, while residual P represented stable form.

Intact soil cores were collected from 44 sites across 3 cells of STA-1W (1 SAV and 2 EAV) and 4 cells of STA-2 (2 SAV and 2 EAV). Soil cores were divided into three layers- floc, RAS and pre-STA soil. Across the studied cells, SAV and EAV did not differ significantly in relative proportion of reactive and stable P pools. Reactive P constituted 75% of TP in floc sections of EAV cells and 62% of TP in SAV cells. In RAS, the reactive P was 64% of TP for EAV and 67% of TP for SAV cells. However, floc and RAS sections of EAV cells showed higher organic P fractions (50% and 40% of TP) compared to SAV (23% and 37% of TP). This suggested accrual of more recalcitrant P in EAV cells than in SAV cells. This information could be useful for STA management in selecting the optimum vegetation type or mix for further improving and sustaining P removal, given variable hydraulic and P loads in different sub-basins of STAs.

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Arsenic-resistant bacteria solubilized arsenic and phosphorus from insoluble minerals and enhanced plant growth

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Arsenic hyperaccumulator *Pteris vittata* L. (Chinese Brake fern) can accumulate up to 2.3% As in its dry biomass, making it a viable candidate for phytoremediation of As-contaminated sites. We assessed the ability of rhizobacteria in helping *P. vittata* and tomato to extract As and/or P from insoluble forms in soils and in enhancing their growth. Seven arsenic-resistant bacteria (ARB), which produced siderophore and were fluorescent, were isolated from the rhizosphere soils of *P. vittata* plants growing naturally in Florida.

The siderophores produced from rhizobacteria solubilized As from $FeAsO_4$/$AlAsO_4$ minerals, increasing As uptake by *P. vittata* from 18.1–21.9 to 35.3–236 mg kg^{-1} As in the fronds. The root biomass of *P. vittata* increased from 1.5-2.2 to 3.4-4.2 g dw/plant when amended with the bacteria in the growth medium. Among the 7 ARB, PG6 solubilized the most P (0.8 mg L^{-1}) from phytate and PG12 (9.05 mg L^{-1}) from FePO4 after 1 d of inoculation. Addition of spent medium from PG6 or PG12 to the growth medium of tomato supplied with phytate increased its shoot biomass by 1.7 times (0.04 g dw/plant) and in $FePO_4$ treatment by 2.3 times (0.22 g dw/plant) compared to controls after 7 d of treatment. Our results suggest that the bacterial isolates and their exudates can be used in improving arsenic phytoremediation by the fern and mineral uptake by crop plants.

Keywords: P solubilization, Arsenic resistant rhizobacteria, *P. vittata* rhizosphere, siderophores.

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Imidacloprid Soil-Drench Application in Young Citrus Trees of Florida: Sorption, Degradation, and Systemic Effects On Asian Citrus Psyllid

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Imidacloprid (IM) is a systemic neonicotinoid insecticide applied to young citrus trees as a soil drench to control Asian citrus psyllid *Diaphorina citri* (Kuwayama), vector of the bacteria believed to cause citrus greening disease. Processes to model fate and transport of IM in soil and plant were studied under laboratory and field conditions. The sorption study used Immokalee Fine Sand soils of Florida from three depths (0-15, 15-30, 30-45 cm) analyzing both A and E horizons. The 24 hours batch-slurry equilibrium showed low values for sorption partition coefficient or Kd, between 0.20 for E horizons, and 1.68 for A horizons (adjusted to organic carbon contents: log Koc of 2.19 and 2.38). The pesticide degradation showed zero-order trends for all depths, i.e., non-affected by the initial IM concentration of 10 mg per kg of soil. This resulted in half-lives ($t_{1/2}$) between 0.9 to 3.1 years, the highest and the lowest $t_{1/2}$ in E and A horizons, respectively, possibly due to differences in organic carbon and microbial activity. Also, column experiments using saturated soils and steady-state water flow showed IM breakthrough curves fitting the two-site model. This data suggested that IM was prone to leaching, but persistent in these soils. Following this lead, field experiments during summer 2011 on young unbearing citrus trees (<2 years old) evaluated IM soil-drench applications around the trunk with initial concentrations (0-15 cm depth) between 22.1 to 36.9 mg per kg of soil. IM showed almost complete leaching from all depths (0-75 cm) about *four* weeks after application with final concentrations between 0.1 to 1.1 mg per kg of soil. Nonetheless, young citrus trees with soil-drench treatments compared to control trees with no application showed effective systemic action of the active ingredient to control *D. citri* even six to eight weeks after application.