Tolerance of biofuel tree species to metal toxicity of textile effluent under arid environmental conditions

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Abstract

Heavy metal contamination in soil is a serious environmental concern throughout the world. In Pakistan, effluents from various industrial sources are being directly released into the environment, thus contributing towards metal contamination of water and soil. Keeping in view the considerable significance of tree species to act as metal sequester, two native tree species; *Jatropha curcas* and *Pongamia pinnata*, which have potential to produce biofuel, were assessed for growth under metal-contaminated soil in a greenhouse under natural temperature and light. Six months old samplings from a local nursery were acclimatized in pots containing sandy loam soil 8 weeks before being exposed to effluent from a textile dying industry. The treatments comprised of 0, 20 and 40 ml/L of effluent. Based on atomic absorption spectrophotometry, the effluent contained metals exceeding permissible limits given by USEPA (As=1.0 µg/L, Pb=0.5 mg/L, Cr=1.0 mg/L and Cd =0.1 mg/L), which were As (48 µg/L), Pb (42 mg/L), Cr (41 mg/L) and Cd (0.33 mg/L). Based on different growth parameters, *P. pinnata* showed a better performance for shoot and root length under both treatments, but *J. curcus* exhibited its potential for collar diameter and biomass production at 20 ml/L effluent. Based on metal accumulation in plants biomass, *J. curcus* showed better potential to accumulate metals in the shoots than roots as compared to *P. pinnata*. However, greater root biomass of *P. pinnata* might allow it to sequester more metal. Thus the two species differed for their metal tolerance, with *P. pinnata* being an excluder while *J. curcus* as an accumulator. Being biodiesel and non-food plants both *J. curcas* and *P. pinnata* may be used to grow in metal-contaminated soils to mitigate soil pollution.

Key words: Textile effluent; *Jatropha curcus, Pongamia pinnata,* growth, metal accumulation

Soil Types Moderate the Impact of Oxygen Fertilizer and Biochar on Reducing Nitrous Oxide Production

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Reducing Nitrous oxide (N_2O) production from agricultural soil is an urgent need of the present time. Nitrous oxide production depends on soil properties and/or added treatments, such as nitrogen fertilizer, biochar etc. Biochars prepared from corn stover and pine bark residue, and oxygen fertilizers (calcium peroxide and magnesium peroxide) were used in this study to reduce N_2O production from two dominant soil types of Florida. Sandy soil (MS) with low organic carbon (11.6 g kg^{-1}) and sandy clay loam soil (OS) with high organic carbon (339 g kg^{-1}) were collected from Plant Science Research and Education Unit, near Citra, FL, and Everglades Research & Education Center, Belle Glade, FL, respectively. Treatments included: (i) Soil without N fertilizer (S); (ii) S+ 0.10 g N kg^{-1} soil as ammonium nitrate (S+N); (iii) S+ Corn Stover biochar (CB) @ 5 g kg^{-1} (S+CB); (iv) S +N+CB; (v) S+ Pine Bark biochar (PB) @ 5 g kg^{-1} (S+PB); (vi) S+N+PB (vii) S+N+ calcium peroxide @ 5 g kg^{-1} (S+N+CPO); (viii) S+N+ magnesium peroxide 5 g kg^{-1} (S+N+MPO). The study was conducted in the completely randomized design with three replications by incubating the soils with treatments for 22 (MS) and 24 (OS) days. In general, N_2O production was greater from OS than MS at the end of incubation period in this experiment. The least cumulative N_2O produced from both the soil (51 µg g^{-1} MS and 17802 µg g^{-1} OS) when treated with CPO. In MS, CPO and MPO with N significantly reduced N_2O production by 99% and 98%, respectively, while CB with N increased N_2O production by 201% compared to only N treated soil. Contrarily, both oxygen fertilizer and biochar reduced the N_2O production from OS with N treatments. Though the extent of reduction (7-25%) depends on oxygen fertilizer and biochar types. Thus, the impact of oxygen fertilizer and biochar in reducing N_2O production depends on inherent soil properties. In future, the selection of biochars or oxygen fertilizers for reducing N_2O production should be based on intended soil properties.

An Environmental Phosphorus Monitoring Tool for Soils of the Eastern and Midwestern USA

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The loss of legacy phosphorus (P) from agricultural fields due to over-application of fertilizers and manures could result in eutrophication of receiving water bodies. To evaluate P loss risk, a practical approach, the soil P storage capacity (SPSC), has been proposed to estimate the capacity of agricultural soils to act as sinks or sources of P to runoff or leaching. The SPSC is based on a threshold molar ratio of extractable P/(Al+Fe), called the soil phosphorus saturation ratio (PSR), above which water-extractable P (a surrogate for soil porewater P) abruptly begins to increase. The objective of our study was to test the consistency of the threshold PSR value across a geographic diversity of soils within the Southern /Central/ Chesapeake Bay regions of the US. The threshold PSR for the range of soils (186 samples) is 0.1 (confidence interval: 0.05 to 0.15; $p<0.0001$) based on P, Al, and Fe as extracted by the Mehlich 3 soil test, indicating that a common threshold is applicable across the geographic range of this study. We further related SPSC to field water quality data (runoff/leaching data) and identified locations where the soil was a P source (PSR > 0.1; SPSC is negative). Results thus far suggest that the PSR/SPSC concept could be used as an environmental P monitor for non-calcareous soils of the Eastern and Central US.

Heavy metal concentrations in traditional and herbal tea: potential health risk to humans

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Abstract

Food consumption is an important route for human exposure to pollutants. Tea (*Camellia sinensis* L.) is a widely-consumed beverage and may accumulate toxic metals. Concentrations of heavy metals plus Al, including total concentrations and in 5-minutes infusions, were determined in 48 traditional and herbal teas from different countries to assess their potential health risk. The data showed that herbal tea exhibited significantly higher As (0.26 mg kg^{-1}), Cd (0.19 mg kg^{-1}) and Pb (2.4 mg kg^{-1}) compared to traditional teas. Black tea from India had the highest Cr at 31 mg kg^{-1}, while herbal tea from China had the lowest Cr at 0.39 mg kg^{-1}. Arsenic, Cd and Pb did not exceed the WHO limit for medicinal plants except one herbal tea with 1.1 mg kg^{-1} As and 26 mg kg^{-1} Pb. However, Cr in 47% herbal teas and 73% traditional teas exceeded the Canadian regulations Cr limit of 2 mg kg^{-1}. Total Al was the least in herbal tea (47–1745 mg kg^{-1}) and its infusion (0.09–3.95 mg L^{-1}) compared to traditional tea (50.3–2517 mg kg^{-1}) and in infusions (0.02–7.51 mg L^{-1}). During tea infusion, 0.9–22% and 4–49% of the Al was released into water from herbal and traditional teas. All black tea and 25-83% of the green and herbal tea samples exceeded the stipulated Al guideline in drinking water of 0.2 mg L^{-1}. However, low daily intakes of Al show that the consumption of drinking teas is not dangerous for humans. In addition, considering the hazard quotient, drinking teas posed no imminent health hazards to adults or children. However, since we did not consider Al from food and drink sources, health risks from tea for heavy drinkers cannot be ruled out.

Keywords: *Camellia sinensis*; heavy metal, aluminum; hazard quotient; infusion; herbal tea;

Abstract

Soil Health Assessment and Management Strategies

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Soil health is defined as the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals and humans. Healthy soil has good tilth, sufficient water retention capacity, adequate drainage, optimum nutrients, small population of plant pathogens, insect pests and weeds, large population of earthworm, microbes, fungi, resilient and free of contaminants. The list can go on and on, however, all these factors influence a soil's ability to function sustainably and to satisfy the needs of humans, support plants, and cycle elements, water, and energy between earth systems. While the Soil Health Institute recently released a list of 19 soil health measurements that would help accelerate agricultural transformation, our goal at the Soil, Water, and Nutrient Management Laboratory at the Everglades REC is to test a handful of methods listed that will help evaluate changes in soil quality. The potential for testing soil health indicators like organic matter content, pH, bulk density, aggregate stability and microbial activity as a function of land-management practices, such as no till, cover crops, crop rotation, mulching, and nutrient management can be useful to scientists, farmers and regulators. In Florida, planting flooded rice as a crop rotation practice on muck soils in the south, or the application of organic amendments on sandy soils are farming practices that has tremendous potential to improve soil health and warrants investigation. This poster highlights some of the methods being used to evaluate soil health indicators and potential outcomes of current research.

Phytoremediation of Pb-contaminated soil by *Pelargonium zonale* and associated growth response

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Lead contamination is a challenging issue as it is toxic, persistent and non-biodegradable, therefore accumulating in the environment. The removal of Pb for the ecological sustainability is important. Various cultivars of Pelargonium have been reported as Pb-hyperaccumulator but are susceptible to climatic conditions. The present study was conducted to evaluate the ability of locally-grown *Pelargonium zonale* for Pb phytoremediation. Soil was spiked with different level of Pb (250, 500, 750, 1000, 1250, and 1500 mg Pb kg^{-1}). The control was also set for comparison. One month old seedlings of *P. zonale* were transferred to the pots. After 8-wk of exposure, plants were harvested and growth parameters (fresh, dry biomass) was measured. For Pb analysis in the roots and shoots, plant samples were digested in HNO_3: $HClO_4$ mixture at 3:1 ratio and were analyzed through an atomic absorption spectrophotometer. The translocation factor (TF), and tolerance index (Ti) was determined. The pot experiment showed that the TF of *P. zonale* was > 1. Moreover. *P. zonale* survived at higher Pb levels and Ti was more than 60% at 1500 mg Pb kg^{-1} treatment. The accumulation of Pb in the aerial parts was > 1000 mg kg^{-1}. Decreasing trend was observed in *P. zonale* biomass with increasing Pb level. A significant difference ($P<0.05$) in the Pb uptake by aerial parts of *P. zonale* was observed. The maximum accumulation of Pb in the shoots and roots of *P. zonale* was 1545 and 137 mg kg^{-1} respectively in 1500 mg kg^{-1} Pb treatment. *P. zonale* accumulated 11.2-fold more Pb in the shoots than the roots. The results indicate that *P. zonale* has ability for the phytoremediation of Pb-contaminated soil.

Keyword: Phytoremediation, *Pelargonium zonale*, Lead, Translocation factor, Tolerance index

Tolerance, mobilizing ability and plant growth promoting characteristics of fungal strains in Pb-contaminated soil

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Ability of fungal strains to enhance phytoextraction of Pb-contaminated soil has been explored in this study. Five nonpathogenic fungal strains (*T. harzianum*, *P. simplicissimum*, *A. flavus*, *A. niger* and *Mucor spp*.) were tested for their ability to modify soil environment to increase Pb phytoextraction. Pb tolerance of the strains were examined at varying Pb concentrations up to 1000 mg L^{-1} on potato dextrose agar and broth. Soil incubation experiments were performed to evaluate fungi's ability to increase Pb mobility in soil. Further, plant growth promoting characteristics were monitored through assays including IAA, PS, GA_3, and siderophore. According to results the sequence of Pb tolerance in fungal strains observed was *T. harzianum* >*A. niger*> P. *simplicissimum* > *Mucor sp*. > *A. flavous*. Presence of fungal strains had positive effect on soil Pb mobility. At 2000 mg Pb kg^{-1}soil, Pb mobility was significantly (P> 0.05) increased from 48.1 to 62.9, 76.4 and 88.7 mg kg^{-1} in soil treated with *A. niger*, *A. flavous*, and *Mucor spp,* respectively, when compared to control. Soil pH and organic matter were also altered by fungal treatment. *A. niger* and *A. flavous* lowered the soil pH by -0.14 and -0.13 unit, respectively. The maximum increase in % OM recorded were 1.68 and 1.36% for *A.flavous* and *A.niger*, respectively at 500 mg kg^{-1} soil. PGPR assays confirmed the beneficial role of these fungi. Significantly high production of IAA, PS and siderophores was observed in *A. niger* (247, 58.8 and 60.9 µg/ml, respectively), and GA_3 production in *A. flavous* (42.5 µg/ml). Based on our results, in Pb-contaminated soil, *A. niger, A. flavous*, and *Mucor spp*. have potential to enhance phytoextraction of Pb by promoting Pb phytoavailability in soil and improving plant biomass production through plant growth promoting activities.

Keywords: Pb tolerance, Pb mobility, IAA, GA3, PS, sidrophore production, phytoextraction

Abbreviations: lead (Pb), indole acetic acid production (IAA), phosphorus solubilization (PS), gibberellic acid (GA_3); organic matter (OM)

Sustainable Irrigation System for Rural Farming Operations

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A solar-powered irrigation system was designed and implemented at the Bioenergy and Sustainable Technology Laboratory community gardens. The irrigation system was designed to harvest rainwater that would be dispersed through overhead sprinkler heads certified by Energy Star to promote water conservation. The irrigation schedule was set for the evening hours to minimize evaporative losses at a rate of 200 gallons/day unless daily rainfall was sufficient. The community gardens consisted of 1,800 square feet of seasonal vegetables planted in rows spaced 36 inches apart. The inter-row spacing varied from one to two feet, depending on the crop. The seasonal vegetables included potatoes, kale, squash, cucumbers, okra, peppers and eggplant. Transplants were planted from February 15th through March 15th and the harvest schedule extended from April 19th through September 4th. The crops were fertilized at a rate of 3 lbs N/1000 ft^2, based on recommendations following soil fertility analyses. The objective of the project was to develop a sustainable model for maximizing agronomic productivity for a diverse selection of nutritional vegetables with minimal water and power inputs, specifically for rural and/or low socio-economic communities. The agronomic harvest productivities for each crop were measured by pound of vegetable produced per plant and per acre. Agronomic productivities (lbs/plant) were highest for cucumbers (18), eggplant (10), and squash (5) and were lower for kale (1.8), okra (1.5), potatoes (1.0) and peppers (0.8). When expressed as lbs/acre, the crops descended in the same order and ranged from 260,839 lbs/acre for cucumbers to 12,232 lbs/acre for peppers.