Task 3 – Leaching and phytoavailability of trace elements in soils amended with coal-combustion fly ash and fly ash treated biosolids

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Evaluation of Agricultural Use of Fly Ash

Agricultural application needs to be evaluated with appropriate caution to understand the actual potential for beneficial and adverse effects from FA use and address potential perceptions of adverse impacts.

The research will consider amending FA to agricultural soils at high usage rates (5 times above suggested in proposed draft Israeli environmental regulations).

While the draft environmental regulations focus on boron, the potential impact of other constituents of potential concern (COPCs) will be considered.

Research Objectives

1. **Determine the uptake of constituents of potential concern (COPC) by certain crop plants and extent of leaching from soil application of (i) fly ash, (ii) fly ash-sewage sludge treated mixture, and (iii) sewage sludge.**
2. **Determine relationships between COPC availability for crop plant uptake and LEAF testing. The goal is to be able to use LEAF testing as a rapid surrogate for pot and field studies to determine the safety of use of fly ash-sewage sludge mixtures for agricultural soil applications. This may be accomplished either through direct empirical use of LEAF testing data and/or through chemical speciation modeling of soil-sludge/fly ash interactions.**

The main questions to be answered are the effects of FA on contaminants' availability, hence:

(i) what is the effect of soil type and intrinsic properties and processes on trace elements availabilities

(ii) does sludge reduce/increase them

(iii) does FA reduce/increase sludge-derived contaminants' availability.

Research outline

Research aim - to assess the leachability and phytoavailability of trace elements contained in fly ash (FA) and FA and lime-treated biosolids (N-Viro Soil, NVS).

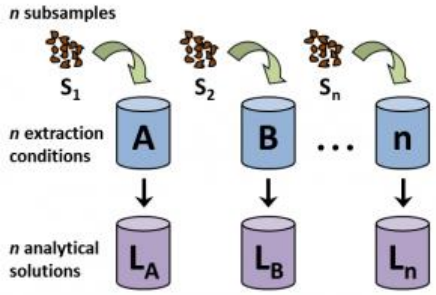
Agricultural methodology - pots packed with mixtures of these FA products with two Israeli soils that constitute a wide spectrum of chemical, mineralogical and physical properties (dune sand and a clayey soil). Pots will be either not planted or planted with the test plants lettuce as a leafy vegetable or fruiting peppers.

LEAF methodology - the experimental substances (soils, FA, NVS and their mixtures) will be characterized and evaluated by US-EPA Methods 1313 (liquid-solid partitioning as a function of eluate pH using a parallel batch extraction procedure), 1314 (liquid-solid partitioning as a function of liquid-to-solid ratio using an up-flow percolation column procedure).

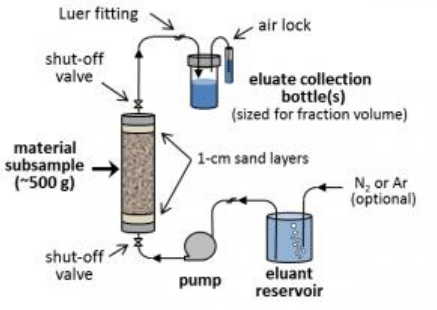
Data processing - The pots leaching data will be compared to the EPA leaching data to evaluate FA and NVS contribution to the leaching properties of the potting media. The out coming assessment will enable future applications to be examined in a much quicker and simpler manner.

Methodology

- Selection of reference samples: FA, Shafdan biosolids and N-Viro Soil (NVS; Shafdan biosolids stabilized with this FA and lime) and two reference soils: sand (Yavne dunes) and clay soils (Revadim). Homogenization of sufficient quantity to serve as on-going reference materials.
- All reference materials as well as FA & NVS mixtures with the soils will be tested using EPA Method 1313 and EPA Method 1314.



Method 1313 – pH-dependence



Method 1314 – Percolation Column

Worst case scenario
FA with high concentrations of contaminants also suitable for NVS production.

Plant uptake study – pot experiments

Plant uptake studies on the same FA/NVS/soil test cases. The outcomes from this study will provide the basis for specific testing recommendations consistent with the draft regulations and also provide information for acceptance or rejection of FA use.

Pots (2 L):

The NVS-soil mixing ratios according to total N content of NVS - to provide a loading rate equivalent to 500 and 2500 kg N ha^{-1}.

Loading rate	NVS	FA	RSS
"Normal"	500 kg N ha^{-1}	amount in NVS at 500 kg N ha^{-1}	amount in NVS at 500 kg N ha^{-1}
Five-times the normal load	2500 kg N ha^{-1}	amount in NVS at 2500 kg N ha^{-1}	amount in NVS at 2500 kg N ha^{-1}

Analyses of leachates and plants

Upon sampling of leachate: pH, EC, Cl, DOC and DIC, and mineral N forms (nitrate+nitrite, ammonium).

Further analyses including plants: P, Ca, Mg, Fe, K, SO_4, and trace elements.

USEPA 1313 & 1314

Additive	Substrate	Soils	Mix. rates	Treatments
NVS	*1*	2	2	5
FA	*1*	2	1	4
RSS	*1*	2	1	4
None	-	*2*	-	2
Total				15

Analysis from both methods will include:

- major and trace elements
- dissolved organic and inorganic carbon
- pH, ionic strength (conductivity), and redox

The specific trace elements to be analyzed will be screened based on the pH 2 extraction step from Method 1313 and a reduced analyte set will be developed.

All leaching and pot testing data will be managed in LeachXS.

Time schedule and work-plan

Reference materials

- The 5 reference materials have been collected and homogenized
- EPA 1313 method (pH dependence): June 2014 – August 2014
- EPA 1314 method (column test): August 2014 – December 2014

Plant uptake experiments: June 2014 – October 2014

Leaching characterization: Oct. 2014 – June 2015

- Components (soils) – Method 1314
- Mixtures for pot studies – Method 1313, 1314

- Modeling mixtures and column studies: Jan. – July 2015

- Data analysis and report preparation and completion: July 2015 – Feb 2016

THANKS FOR YOUR ATTENTION