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Agricultural uses of sewage sludge stabilized with bottom ash and lime

Report to Coal Ash Board for 2006

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Report Abstract

Alkaline-stabilized biosolids (ASB) were prepared using sludges taken from the WWTP of Bet Shemesh and/or Ashdod by mixing them with quicklime or cement kiln dust (CKD), and by adding fly ash or clays as fillers. Altogether, six different compositions were tested. The preparations were mixed with dune sand to form ten different compositions, and the nutritional features and effect on the chemical makeup of plants were tested in a pot experiment with corn as a test crop, and in comparison to Bet Shemesh raw sludge or with fertilizer as control treatments. The additives mixing ration with the sand corresponded to application rates of 6 to 33 dry tons per hectare. We used sand rather than soil in order to maximize the effect of the additives. The initial pH of the ASBs was around 12.5, and it remained at this level for at least a week after their preparation. Following potting and moistening, the pH level in the posts decreased to 9 within approximately 10 days as a result of the carbonation of the hydroxyls. At the end of the trial (115 days after the mixtures were prepared), the pH level in the sand-ASB mixtures was 8 or less (even at higher application loads). Irrigation was with tap water without nitrogen (N) or phosphorus (P) addition. Potassium (K) was added to some extent.

Approximately 60% of the ASBs' organic N content in the potting medium underwent mineralization; similarly in both sludge types and with either coal ash or clays as fillers. This indicates that the heterotrophic activity of the soil was not damaged by the initial high pH. Nevertheless, N losses probably occurred by volatilization and leaching, and this loss may have restricted plant growth. Another factor that seemed to restrict plant growth was potassium availability. The content of K in the sludge-sand mixtures was sufficient for normal plant growth only in the ASBs with clays as fillers.

Phosphorus bio-availability in the potting media is especially interesting because it is often predicted that P phyto-availability is bound to be restrictive in ASB amended soils. Our findings showed that P phyto-availability did not seem to restrict plant growth in all

the treatments. This was inferred this from the following observations: (i) P potential phyto-availability in the potting media (based on its extractability in the Olsen reagent) decreased by merely 10-40% over the 115 days experimental duration; (ii) potential phyto-available P at the end of the experiment still represented about 20-30 percent of the total P in the potting medium; (iii) Plant P uptake was generally $\leq$5% of the overall amount of soil P. The phosphorus content in the sludge itself (Ashdod sludge >> Bet Shemesh sludge) and in the filler (coal ash > clays) affected its content and potential phyto-availability.

All the ASB preparations met the Israeli standard for heavy metal content. Using coal fly ash as filler slightly increased the concentration of nickel in the ASBs, it had no effect on the concentration of chrome, and it considerably lowered the concentrations of cadmium, lead, zinc and copper. The calculated total amount of metal that was added to the potting medium with the ASBs (mercury was not examined) was between hundredths of mg/kg soil (cadmium) to a few mg/kg (lead, copper, chrome and nickel) and up to 15 mg/kg (zinc). The concentrations of trace and heavy elements in the plants were barely influenced by the ASBs (as compared to the fertilized control), and the concentrations of lead and cadmium were below or at the measurement threshold in all the treatments. The boron concentrations were higher in plants grown on additives that contained coal fly ash, but all the concentrations were low (up to about 40 mg/kg).

The above experiment demonstrated no danger to the test plants or food chain from the application of ASBs (made with either clays or coal fly ash) in irrigated crops. Despite that it was a short-term pot experiment it also seems to rule out possible long-term adverse changes in the biological or the nutritional properties of soil by ASB application under similar conditions. This is inferred from the recovery of soil pH, from the high residual P phyto-availability, from the low content and phyto-availability of trace and heavy elements, and from the preservation of the soil heterotrophic activity. This repeats evidence from many other laboratory and field studies with ASBs.

Currently, three field experiments with ASB, which was made from the Bet-Shemes WWTP sludge and coal fly ash, are being carried out. Two are with wheat as test plant (not fertilized; rainfed with supplemental irrigation; sawing was in October – November of 2006), and the other is with potatoes (fully fertilized except for phosphorus; irrigated; sawing was in February 2007).

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