# Agricultural uses of sewage sludge stabilized with fly ash and lime

## Report to Coal Ash Board for 2006

Presented by:

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## Report Abstract

Lime-stabilized sludge compounds were prepared from sludges taken from Beit Shemesh or Ashdod mixed with quicklime or CKD, using fly ash or clay as fillers. In all, the characteristics of six different preparations were examined. The preparations were combined with dune sand in ten different compositions; their nutritional features and effect on the chemical makeup of plants were tested in planter experiments in a hothouse, with corn as a test crop, and in comparison to planters with sludge from Beit Shemesh, or with fertilizer as control treatments. The ratio of the additives with sand in the mixtures corresponded with the content of organic matter in them (from 0.6 to 3.3 ton/liter), and the overall load of the stabilized sludge in the soil was from 6.5 to 26 ton/dunam. We used sand rather than soil in order to maximize the effect of the additives. The initial pH of the mixture was around 12.5, and it remained at this level for at least a week after the mixtures were prepared. The carbonization of the surplus hydroxyl, after being mixed with sand and moisture, lowered the pH level to 9, after 10 days, and at the end of the trial period (115 days after the mixture was prepared), the pH level was 8 or less (even at application loads equivalent to 36 tons/dunam).

The average mineralization level of the organic nitrogen in the lime-stabilized sludge was high, about 60 percent of the additive, in both types of sludge and with coal ash or clays as fillers. This indicates that the biological functioning of the soil was not damaged. Nevertheless, it would appear that the loss of nitrogen in the system decreased the availability of the nitrogen and restricted growth. The potassium yields in the sludge-soil mixtures provided normal growth only in lime-stabilized sludge treatments with clays as fillers. The behavior of the phosphorus in the system is interesting. The availability of the phosphorus did not represent a restricting factor in all the treatments, as can be inferred from the following factors: (A) The potential availability of the phosphorus in the soil (based on the extraction with bicarbonate) decreased by only about 10-40 percent over the approximately 115 days of incubation in the planters (despite the extensive changes in the pH, sometimes from 12.5 to <8), (B) The available phosphorus at the end of the process still represented about 20-30 percent of the total added phosphorus that remained in the soil. (C) The absorption of phosphorus in the plants was generally at a low level (up to 5 percent of the entire amount added to the soil). The phosphorus content in the sludge itself (far higher in the Ashdod sludge than in the Beit Shemesh sludge) and in the filler (higher in coal ash) affected the availability of the phosphorus.

All the mixtures met the Israeli standard for heavy metals. The coal ash slightly increased the concentration of nickel in the sludges, had no effect on the concentration of chrome, and considerably lowered the concentrations of cadmium, lead, zinc and copper. The addition to the soil of most of the monitored elements (mercury was not examined) with the different lime-stabilized sludges was hundredths of mg/kg of soil (cadmium), to just a few milligrams per kilogram (lead, copper, chrome and nickel) and 15 mg/kg (zinc), and was below the sensitivity threshold for measurement of most of the elements and treatments. The vital trace elements and heavy metals in the plants were barely influenced by the lime-stabilized sludge compared to the analogous treatments (chemical fertilizer or unstabilized sludge). The lead and cadmium concentrations were below or at the measurement threshold. The concentrations of the vital trace elements lead, copper and manganese were fairly uniform in all the treatments. The concentrations of zinc were fairly high, but in most of the various treatments, it was very high. The boron concentrations were higher in plants grown on additives that contained coal ash, but all the concentrations were low (up to about 40 mg/kg). The molybdenum and lithium concentrations in plants treated with lime-stabilized sludge (especially those that contained coal ash) were considerably higher in comparison to analogous plants and in comparison to reported concentrations, but these elements pose no danger to the environment or the food chain. The concentrations of some elements (chrome, cobalt, boron, strontium) were in the normal range.

Two field experiments (with wheat and irrigated crops) using lime-stabilized sludge on a coal ash base are currently being carried out, and a third experiment (potatoes, irrigated crops) is being planned for early January 2007.

To sum up, there appears to be no danger to the plant, soil, food chain or environment from the use of lime-stabilized sludge and clays or coal ash, and no significant change in the biological or nutritional features of the soil were noted.