International Workshop on
Environmental Aspects of Coal Ash Utilization
Tel Aviv, Israel
December 15th – 16th 2009

Agricultural Uses of Coal Fly Ash

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Abstract

Electricity generation is fuelled by coal in many countries. Burning coal leaves after combustion around 9% by weight of fly ash. Israel alone produces 1 million metric tons of fly-ash per year. This ash is composed of fine particles dominated by SiO_2 and CaO. Most ashes yield a high pH (~ 12) in suspension and contain significant concentrations of Cr, Se, Mo, B and other trace elements. The fly ash is pozolanic and serves as an additive in concrete and in cement and road construction. In the present study, fly ash was used as a soil amendment which improved the hydraulic and physical properties of sandy, loessial and sodic soils. The research exploited the cementing ability of the ash and its high calcium content to lower the dispersivity of loessial soils and the swelling capacity of sodium-rich soils. Rain simulation, wind tunnel runs, remote sensing (albedo measurements) and field experiments were conducted.

Up to 20% of coal fly-ash was added to the various soils and the effect of this addition on the soil's properties was determined. The addition of fly-ash to sands increased water retention by up to 8 fold and reduced the sand's susceptibility to wind erosion. While the untreated sand moved already at wind speed of 9 m/sec, the ash-treated sands withstood wind speeds of up to 26 m/sec. Ash addition improved water infiltration up to 2.5 fold in loessial soils by inhibiting the formation of crust. The albedo measurements confirmed the inhibitory effect of ash addition on crust formation. Weakening the crust, on the other, increased the susceptibility of the loess to wind erosion. Addition of fly-ash to sodium-rich soils reduced swelling to such a degree that the treated soil did not display any cracks, while the untreated soil cracked severely upon drying.

With the addition of fly ash, boron and a number of trace metals such as chromium lead and selenium, as well as a significant load of soluble salts are added to the soil. The availability of the added undesirable elements can be controlled by the rate of ash application, rate of water addition and the pH levels maintained. While in the rain simulation runs the leachates contained the aforementioned elements at concentrations above the maximum allowed levels, the crops grown in field plots with up to 20% fly ash did not display any negative effect on crop yield or quality and did not display any accumulation of the trace elements.