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Thesis Abstract

Effects of Organic Amendments and Plants on the Chemistry of Acid Sulfate Soils under Aerobic and Anaerobic Conditions

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Acid sulfate soils with sulfuric horizons (sulfuric soils) can exert a range of negative impacts on the ecology and productivity of soils. The primary treatment for these soils is to raise the pH using lime. Although often effective, this treatment can be expensive and not well suited to large areas. In this research, the possible use of plant organic matter to ameliorate sulfuric soils or to prevent acid sulfate soils with sulfidic materials (sulfidic soils) from acidifying was investigated. The advantage of this approach is that organic matter is readily available, inexpensive and environmentally friendly, especially in Ramsar listed wetlands where lime cannot be used. The experimental treatments used ground leaves of *Phragmites*, lucerne hay, pea straw and wheat straw as sources of organic matter with varying nitrogen, which were either incorporated into or overlaid on the surface of the soils. After six months of incubation under either aerobic or anaerobic soil conditions, pH, Eh and sulfate content were measured. Incorporation of complex organic matter significantly increased the pH of both sulfuric and sulfidic soils. These changes were correlated with reductions in soil redox and sulfate content. The magnitude of the changes depended on the nitrogen content of the complex organic matter.

The relative importance of carbon and nitrogen in ameliorating acid sulfate soils was further investigated respectively using glucose, sodium acetate and molasses as simple carbon sources, and urea, nitrate and ammonium as simple nitrogen compounds. It was found that compounds containing inorganic nitrogen alone, without carbon, were ineffective, while urea significantly increased pH and reduced Eh, but did not affect the sulfate content of the soil. Glucose had no significant effect on sulfuric soils, either at low (catalytic) or high concentrations, while acetate significantly increased pH. Molasses (which may contain small amounts of nitrogen) caused moderate changes in pH, Eh and sulfate content. On sulfidic soils, acetate prevented oxidation but glucose strongly acidified the soil, most probably by fermentation to butyric acid.

The effects of live roots on sulfidic and sulfuric soil chemistry under either aerobic or anaerobic soil conditions were investigated using *Typha*, *Phragmites* and *Melaleuca*. *Typha* and *Melaleuca* are respectively common wetland and inland plants, whereas *Phragmites* grows under both wetland and inland soil conditions. The

study was extended to investigate the combined effects of incorporated ground *Phragmites* leaves as organic matter and *Phragmites* plants together. Generally, a great deal of variability was found in the changes in pH, redox and sulfate content, the overall effects being dependent on plant type, whether there was incorporated organic matter, the type of soil and the moisture conditions. However, in all cases the growth of the live plants resulted in greater acidity than in the unplanted control soils. In the case of *Typha* and *Phragmites,* which have aerenchymatous tissues, the acidification under anaerobic conditions was attributed to the transport of oxygen in these tissues into the soil. Under non-flooded conditions, the acidification was most likely due to increased oxygen penetration as a result of loosening of the soil by the plant roots.

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