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Salinity Effects on Short-Term Carbon and Nitrogen Mineralisation and Soil Microbial Properties in a Paddy Rice Soil under Aerobic and Anaerobic Conditions

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Abstract

Bangladesh is affected by many of the challenges affecting future food production, such as a rising sea-water level leading to increased saltwater intrusion causing soil salinity. Moreover, the pronounced dry and rainy seasons lead to temporal accumulation of salts in the soils ultimately reducing plant growth. Addition of organic matter is expected to ease the effect of salinity on soil microorganisms therefore positively influencing nutrient cycling and soil fertility. However, it is not known to which extent this happens under anaerobic compared to aerobic conditions and if rice straw or manure is better suited. Therefore, the benefits of rice straw and manure addition to Bangladeshi paddy rice soils on microbial properties and nitrogen and carbon dynamics were evaluated in a short-term laboratory incubation experiment. Two different soils were incubated with rice straw, manure or a manure-rice straw mixture at 50 and 100 % water holding capacity for 27 days. Additionally, NaCl was added to half of the samples resulting in non-saline (1–1.5 dS m^{-1}) and saline (25–29 dS m^{-1}) conditions. Soil respiration was measured throughout the experiment. After termination, extractable C and N, inorganic N and microbial properties (microbial biomass, ergosterol, fungal, bacterial and archaeal DNA) were determined. Rice straw addition increased most microbial properties to a much greater extent than manure independent of moisture level. Salinity effects on microbial properties were strongly alleviated by rice straw and manure addition and therefore only detected in the non-amended soils. This is due to a higher availability of C for soil microorganisms after organic matter addition, which allows them to produce osmolytes, counteracting the osmotic effects of increased salinity. These results highlight the importance of organic matter addition in paddy rice soils to reduce negative effects of salinity on soil microbial communities, allowing them to maintain their main functions. Rice straw addition proved to be a valuable source of organic matter, which can counteract some of the negative effects of soil salinity. However, as rice straw is a valuable local source used also for other purposes, a combination of available organic sources might be a more economic viable option.

Keywords: Nutrient cycles, organic matter, residue management, salinisation, soil fertility

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