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Biological Nitrification Inhibition (BNI) in Rice (*Oryza sativa* L.) for Contrasting Piedmont Llanos Soils of Colombia

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Abstract

Within the nitrogen cycle, nitrification is the oxidation of ammonium (NH_4^+) to nitrate (NO_3) and is mediated by microorganisms. Nitrate is an inorganic form of nitrogen (N), susceptible to being lost by leaching and denitrification resulting in the loss of N fertiliser (around 70 %). These losses of applied N fertiliser have negative socio-economic and environmental impacts. One strategy to prevent the loss of N in agricultural systems, is the inhibition of nitrification. Certain plants are able to release chemicals from their roots that inhibit nitrification in the rhizosphere, this process is called Biological Nitrification Inhibition (BNI). BNI function has been characterised in *Brachiaria humidicola* (Bh) tropical grass, and identified as the species with the greatest BNI activity. This study evaluated the residual BNI effect of Bh in a simulation of a Bh-upland rice rotation system for contrasting Piedmont Llanos soils from Santa Rosa, department of Meta, Colombia. In soils from Santa Rosa the BNI potential of different lowland and upland rice genotypes was explored, with comparisons made between varieties, breeding lines and commercial cultivars. The methodologies used were those developed for the determination of BNI in Bh and sorghum, including bioluminescence assay (bioassay) with the recombinant ammonia-oxidising bacteria (AOB) *Nitrosomonas europaea* strain, and the incubation of rhizosphere soil for the determination of nitrification rates. Yield differences were found among the rice lines with greater yields obtained from those that grew in the soil where Bh was previously planted. In terms of BNI activity (determined by bioassay) of root exudates, significant differences ($P \leq 0.05$) were identified between rice genotypes expressed as allylthiourea units per gram of dry root (ATU g^{-1}) in a range of 3.27 to 31.75. Moreover, soil nitrification rates expressed as mg NO_3-N kg^{-1} soil day^{-1} ranged from 3.06 to 7.63. For lowland rice genotypes there was a 50 % of relation (r^2=0.52) between the root exudates and nitrification rates. Altogether, these results indicate that some rice genotypes have the ability to reduce nitrification in soil. Additionally the Bh-rice rotation system should be further evaluated and implemented in the field to increase rice yields and N use efficiency.

Keywords: Agropastoral systems, bioluminescence assay, nitrification inhibition, nitrogen, rice yield

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