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NITROGEN DYNAMICS IN LOWLAND RICE CROPPING SYSTEMS IN INLAND VALLEYS OF NORTHERN GHANA

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Abstract

Smallholder rice farmers in northern Ghana with low use of external inputs and dependence on rainfed conditions are challenged with low soil nitrogen as a major production constraint. This problem is exacerbated by the competitive use of crop residue for other purposes. Efficiently managing native soil N has been hypothesized to alleviate N deficiency in rainfed cropping systems and to increase lowland rice production. A field study was conducted in an inland valley in the moist savanna zone of Ghana, characterized by changing soil aeration status from aerobic (dry season) to anaerobic (wet season) with resulting effects on native soil N dynamics. We hypothesize that soil N mineralization at the onset of the rainy season entails the accumulation of soil nitrate in the soil profile and its subsequent losses by leaching in the soil profile and along the toposequence into the adjacent lowland. There, nitrate is lost by microbial respiration (denitrification) upon water saturation. Technical options avoiding the build-up of nitrate or its immobilization in the biomass of microorganisms or growing crops are expected to reduce N losses and enhance the performance of lowland rice. The aims of the study were to determine the *in-situ* native soil nitrate-N dynamics in an inland valley, the net contribution of water and nitrate by sub-surface flow from the upland to the lowland, and the effects of crop and land management options during the dry-to-wet season transition period (DWT) on seasonal soil N_{min} dynamics and rice production attributes. Large amounts of nitrate were accumulated during DWT with a peak of 56 kg ha^{-1} in upland and 58 kg ha^{-1} in lowland soils, most of which disappeared at the onset of the wet season. We observed a net nitrate contribution of 32 kg ha^{-1} from the upland into the adjacent lowland. The technical options applied at the lowland differently affected the soil nitrate dynamics by reducing the nitrate peaks during DWT. Bare fallow accumulated a total of about 77 kg ha^{-1} which was prone to losses. Surface applied and incorporated rice straw from the preceding season reduced the peak to 70 kg ha^{-1}. The cultivation of maize and *Crotalaria juncea* as nitrate catching crops during DWT further reduced the soil nitrate accumulation to 62 kg ha^{-1} and 51 kg ha^{-1} respectively. Preliminary results showed that rice responded to both conserved soil N as well as added biologically-fixed N in the case of the *Crotalaria* treatment. We conclude that pre-rice legume appears to be the most promising option to manage native and biologically fixed N during DWT and to positively affect the performance of a subsequent crop of lowland rice in the inland valleys of northern Ghana.