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Estimating nitrogen losses in furrow irrigated soil amended by compost using HYDRUS-2D model

Shahid Iqbal (1), Andrey Guber (2), Haroon Zaman Khan (1), and Ehsan ullah (1)

(1) Department of Agronomy, University of Agriculture, Faisalabad, Pakistan, (2) Department of Crop, Soil and Microbial Sciences, Michigan State University, USA

Furrow irrigation commonly results in high nitrogen (N) losses from soil profile via deep infiltration. Estimation of such losses and their reduction is not a trivial task because furrow irrigation creates highly nonuniform distribution of soil water that leads to preferential water and N fluxes in soil profile. Direct measurements of such fluxes are impractical. The objective of this study was to assess applicability of HYDRUS-2D model for estimating nitrogen balance in manure amended soil under furrow irrigation. Field experiments were conducted in a sandy loam soil amended by poultry manure compost (PMC) and pressmud compost (PrMC) fertilizers. The PMC and PrMC contained 2.5% and 0.9% N and were applied at 5 rates: 2, 4, 6, 8 and 10 ton/ha. Plots were irrigated starting from 26th day from planting using furrows with 1x1 ridge to furrow aspect ratio. Irrigation depths were 7.5 cm and time interval between irrigations varied from 8 to 15 days. Results of the field experiments showed that approximately the same corn yield was obtained with considerably higher N application rates using PMC than using PrMC as a fertilizer. HYDRUS-2D model was implemented to evaluate N fluxes in soil amended by PMC and PrMC fertilizers. Nitrogen exchange between two pools of organic N (compost and soil) and two pools of mineral N (soil NH4-N and soil NO_3-N) was modeled using mineralization and nitrification reactions. Sources of mineral N losses from soil profile included denitrification, root N uptake and leaching with deep infiltration of water. HYDRUS-2D simulations showed that the observed increases in N root water uptake and corn yields associated with compost application could not be explained by the amount of N added to soil profile with the compost. Predicted N uptake by roots significantly underestimated the field data. Good agreement between simulated and field-estimated values of N root uptake was achieved when the rate of organic N mineralization was increased proportionally to the compost application rates separately for PMC and PC fertilizers. HYDRUS-2D simulations also revealed high N losses from root zone caused by high water permeability of the studied soil that created preferential vertical water and N fluxes in close proximity to furrows. To reduce N losses from corn root zone the ridge to furrow aspect ratio was changed to 2 to 1. For the same application rates and irrigation scenario N losses from the root zone were significantly smaller in HYDRUS simulated with 2x1 aspect ratio compared to 1x1 ratio. Overall, HYDRUS-2D appeared to be a power tool for modeling nitrogen transport and assessment of N losses in furrow irrigated soils.