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DRAINMOD-simulated performance of controlled drainage across the U.S. Midwest

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ABSTRACT

Controlled drainage (CD) has recently been proposed as a best management practice for reducing nutrientexport from drained cropland in the U.S. Midwest to the Mississippi River and the Gulf of Mexico. Weconducted a 25-year simulation study using the hydrological model, DRAINMOD, and the carbon andnitrogen (N) model, DRAINMOD-NII, to evaluate the performance of CD at 48 locations across the U.S.Midwest. Hydrological and Nitrogen predictions of this simulation study were compared to RZWQM-DSSAT predictions by Thorp et al. (2008). Simulation results showed that CD reduced annual subsurfacedrainage by 86 mm (30%) and annual N drainage losses by 10.9 kg N /ha(32%), on average over the48 sites. DRAINMOD predicted highest reductions in drain flow at the south and southeast locations andlowest reductions at the northwest locations. The large reductions in drain flow in the south and southeastlocations resulted in a large increase in surface runoff, which could increase soil erosion and sedimenttransport to surface water. In the north and northwest locations, the smaller amount of water that did notpass through the drainage system because of CD was primarily lost as evapotranspiration. DRAINMOD-NII predictions of annual reductions in N drainage loss followed the same trend of annual reductionsin drainage flow. DRAINMOD-NII predictions show that reductions in N drainage loss under CD weremainly attributed to increase in denitrification. The declining trend in predicted annual denitrificationfrom the southern to the northern locations of the Midwest region is most likely attributed to the lowertemperature and less precipitation at the northern locations. RZWQM-DSSAT predicted reductions inannual drainage and N loss under CD conditions showed a similar trend to DRAINMOD/DRAINMOD-NII predictions. RZWQM-DSSAT, however, predicted substantially higher reductions in both drain flow(regional average of 151/ mm/yr, 53%) and N drainage losses (regional average of 18.9 kg N ha/yr,51%). The discrepancies between DRAINMOD/DRAINMOD-NII and RZWQM-DSSAT predictions of annualreductions in drain flow and N loss under CD conditions were caused by differences in model predictionsof individual components of the water and nitrogen balances under both free drainage and controlleddrainage scenarios. Overall, this simulation study showed that climate variation across the region has asubstantial impact on CD efficacy for reducing N drainage loss.