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Nitrogen Use Efficiency of California Almond Orchards Using Advanced Farming Practices

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Mobilization of reactive nitrogen species (NH3, NH4+, NO_x, N2O, NO_2- and NO_3-) is perceived as one of the foremost challenges for modern agricultural production systems. Yet information to address the question of how advanced nitrogen (N) management alters reactive N mobilization is lacking. During 2009 to 2012 we monitored spatially constrained N2O emissions and potential leachable NO_3-, along with yield-N content to examine their contribution to nitrogen use efficiency (NUE, fruit-N exported/fertilizer-N applied) for a modern, high yielding almond production system. This modern production system schedules irrigation to match evapotranspiration (ETc) estimated from the Penman-Montieth calculation of a reference evapotranspiration (ETo) times a seasonal crop coefficient (Kc) which was verified using eddy covariance and surface renewal latent heat flux estimates. Split N-fertilizer applications were targeted to tree-N demand and root proliferation. These production systems demand upwards of 300 kg N ha-1. NUE was found to be nearly 80% at an N application level allowing for economic sustainability of the system (308 kg N ha-1). When mobilization of N2O and NO_3- were included in the NUE assessment, these systems were still highly sustainable in terms of N applied. We also monitored production and consumption of the greenhouse gases of carbon dioxide (CO_2) and methane (CH4). These systems had relatively low levels of N2O emissions with emissions of N2O as a fraction of N-fertilizer applied being consistently less than IPCC Tier 1 emissions factors, and lower than the average estimated for most continental US farming systems. The system also demonstrated a capacity for net CH4 oxidation over the course of a season that occurred mainly in the driveways between tree rows that are kept dry over the course of the season in this arid environment. Our study indicated that tight management of water resources and targeted applications of N-fertilizer resulted in net positive greenhouse gas consumption overall.