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Effect of fertilization on N_2O emissions from a marginal soil used for perennial grass bioenergy production

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Marginal lands constitute the primary land base available for development of bioenergy feedstocks in New York and the northeastern USA. Many of these soils are marginal because seasonal wetness prevents profitable row crop cultivation, but they are potentially suitable for perennial bioenergy feedstocks like switchgrass. Using these frequently wet soils for bioenergy production has multiple environmental and socio-economic benefits, yet little is known about how sustainable this practice is regarding greenhouse gas emissions – particularly in relation to the application of fertilizers. In a 2.2-ha field study near Ithaca, NY, USA, we are therefore monitoring greenhouse gas production from marginal silty clay loam soils cultivated with switchgrass.

Here, we present results of our 2013 monitoring campaign, in which we assessed the effect of surface-applied granular ammonium sulfate-fertilizer (0, 56 and 112 kg N/ha) on N_2O emissions along a natural catena from organic matter-rich wet lowland soil to drier midslope and upslope soils with higher rock fragment content. Sampling was done at $^1/_2$-week intervals around fertilization in June extending to 3-week intervals around harvest in September, giving a total of 15 sampling events. Emissions were sampled in a factorial design using four replicate static chambers per plot, and soil moisture, soil temperature and perched water table depth was assessed likewise.

As expected, N_2O emissions increased with N-fertilizer application. This effect of fertilization was much stronger than the effect of soil type or slope position. The greatest N_2O fluxes were observed a few days after fertilization; we will explore and present the effects of rainfall, air temperature, soil moisture and soil temperature as potential drivers of smaller peaks occurring post-fertilization. Since the non-fertilized plots had negligible N_2O emissions while still producing switchgrass at 6 Mg/ha, unfertilized switchgrass production is naturally most sustainable if regarded solely from an emissions standpoint. While biomass yields increased 1.5- to almost 2-fold with addition of 56 and 112 kg-N/ha, the data suggest that the increase in N_2O emission was much greater, indicating that the N_2O emission per unit yield may not decrease but rather increase with increasing fertilizer application. This information is valuable for quantifying environmental impact of bioenergy feedstock production from the most important land base available in the regions with marginal agricultural soils, and facilitates development of guidelines for sustainable farming practices.