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Influence of N inhibitors on carbon losses/sequestration in Maize cropping

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As a result of globally strongly intensified N fertilization, agriculture is an important source not only for greenhouse gas (GHG) and especially gaseous N emissions but also N pollution through leaching. To increase nitrogen use efficiency and reduce gaseous N emissions and leaching, N inhibitors can be used. The use of N inhibitors, however, might directly affect crop growth and alter yield, which influences CO_2 exchange and might potentially change C sequestration. While the applicability of N inhibitors to reduce especially NH_3 and N_2O emissions is well recognized, to date, the influence of these inhibiters on CO_2 emissions and C sequestration is rather unclear.

We investigated the influence of urease (UI) and nitrification inhibitors (NI) when used with mineral fertilizer on GHG emissions and C sequestration for maize cropping in an on-farm, strip-field trial in NE Germany (Uckermark Region, “53°18'54.2"N, 13°40'15.2"E”). The on-farm field trial consists of four treatments, each implemented on a strip of 15m by 100m: non-fertilized (NF), fertilized (Urea Ammonium Sulfate (AS-HS)), with one (AS-HS + UI) and with two (AS-HS + UI + NI) inhibitors. On each treatment 5 PVC frames (0.5625 m^2) for manual closed chamber measurements of GHG emissions were installed. Out of these 5 repetitive plots, one frame per treatment was kept clear of maize crops to obtain soil respiration (Rs). N_2O (and CH_4) emissions were measured using opaque chambers, evacuated glass bottles for sampling and subsequent GC analyses (Shimadzu GC-14B with ECD and FID detectors), while CO_2 exchange (Reco, Rs (opaque chamber) and NEE (transparent chamber)) were determined on-site by connecting the chambers with an infrared gas analyzer (LI-850, LI-COR Biosciences, Lincoln, USA). Crop growth was monitored through weekly measurements of plant height, NDVI and RVI as well as biomass samples. To obtain heterotrophic respiration (Rh), complementary to in-situ measurements, laboratory incubation experiment was conducted, using a fully automated incubation system (Rillig et al. 2021) and soil samples collected at distinct periods of maize cropping period and under different temperatures, to determine soil respiration. C sequestration was determined through calculating the net ecosystem C balance (NECB = NEE + C_{import} - C_{export}) as well as through repeated soil inventories.

The use of N inhibitors did reduce GHG emissions through reducing N_2O emissions, but also reduced maize biomass production (dry matter (t/ha): 18.2, 24.1, 19.9 and 19.5 for NF, AS-HS, AS-HS + UI, and AS-HS + UI + NI respectively). Consequently, Reco and gross primary productivity

(GPP) were lower for the treatments with N inhibitors compared to the fertilized field without N inhibitors but higher than the non-fertilized treatment. No significant effect on NEE was found, while the C losses seemed to be slightly higher for the treatment without N inhibitor use.