Green House Gases

Title	**Zinc fertilizers influence greenhouse gas emissions and nitrifying and denitrifying communities in a non-irrigated arable cropland**
Author Name	Monica Montoya, Antonio Castellano-Hinojosa, Antonio Vallejo, Jose Manuel Alvarez, Eulogio J.Bedmar, Jaime Recio & Guillermo Guardia
Journal Name	Geoderma
Year	2018
Volume and Issue	325
Pages	208-217
Abstracts	Fertilization with micronutrients (e.g., zinc, Zn) is essential in order to overcome the global nutritional problems associated with human micronutrient deficiencies. However, little is known about the effect of micronutrient fertilizers and their interaction with nitrogen (N) on greenhouse gas (GHG) emissions and soil microbial processes involved in nitrous oxide (N2O) fluxes. In this context, a one-year field experiment was carried out using a winter wheat (Triticum aestivum L.) crop in Central Spain. Winter wheat was treated with different Zn sources (Zn-sulphate, Zn-lignosulphonate, Zn with a mixture of synthetic chelating compounds DTPA-HEDTA-EDTA and Zn-humic/fulvic acids) and N rates (0, 120 and 180 kg N ha−1). Zn sources were applied at 10 kg Zn ha−1 for Zn-sulphate and 0.36 kg Zn ha−1 for the rest of treatments. Nitrous oxide, methane (CH4) and respiration fluxes were measured (two-three times per week during the first month after each fertilization and thereafter with decreasing frequency), as were the total abundances of soil Bacteria and Archaea, ammonia-oxidizing Bacteria and Archaea, and denitrifying bacteria. The DTPA-HEDTA-EDTA reduced cumulative N2O losses by 21.4% and respiration fluxes by 24.4% from those of the no Zn application. The chelating of metal co-factors (mainly copper, Cu) of the enzymes involved in the nitrification and denitrification steps was the probable mechanism for the reduction of N2O emissions as bacterial amoA, nirK, nirS and norB gene abundances, as well as the extractable Cu content, decreased in this treatment. Unexpectedly, the DTPA-HEDTA-EDTA increased the copy number of nosZ by 31.2% over that of the no Zn application. The Zn applied together with the humic/fulvic acids mixture caused significant increases of total bacterial abundance and nitrifier and denitrifier communities, particularly the norB gene, thereby leading to the highest N2O emissions. The optimum N rate was 120 kg N ha−1 since it resulted in the lowest yield-scaled N2O losses and N surplus. The application of synthetic Zn chelates can be recommended as a win-win mitigation and adaptation strategy aimed at reducing yield-scaled GHG emissions and at the enhancement of Zn biofortification.
Keywords	Global warming potential; Nitrification inhibitors; Nitrogen cycling; Calcareous soil; Fertilizer rate; Micronutrient chelate

Title	**Effects of biochar amendment on net greenhouse gas emissions and soil fertility in a double rice cropping system: A 4-year field experiment**
Author Name	Cong Wang, Jieyun Liu, Jianlin Shen, Dan Chen, Yong Li, Bingshen Jiang & Jinshui Wu
Journal Name	Agriculture, Ecosystems & Environment
Year	2018
Volume and Issue	262
Pages	83-96
Abstracts	A 4-year field experiment was conducted to investigate the effects of biochar amendment on the net greenhouse gas emission (NGHGE), greenhouse gas intensity (GHGI), soil fertility and crop yield in a typical double rice cropping system in the central subtropics of China, from April 2012 to April 2016. Three biochar treatments were studied in this experiment, with application rates of 0, 24 and 48 t ha−1 (named CK, LB and HB, respectively) using straw-derived biochar applied once at the beginning of the experiment. In each treatment, the fluxes of methane (CH4), nitrous oxide (N2O) and soil heterotrophic respiration (Rh) were measured using a static chamber/gas chromatography method. Major soil fertility properties were also determined throughout the experimental period. Biochar amendment was found to persistently decrease annual total CH4 emissions by 20 to 51% in the four years, but increased the annual total N2O emissions and Rh by 150 to 190% and 2 to 19% in the first year and the following three years, respectively. On a 4-year average, biochar addition significantly reduced annual NGHGE and GHGI by 156 to 264% and 159 to 278%, respectively ($p < 0.05$), with much higher reduction in the first year than those in the following three years (916 to 1911% vs 24 to 51%) due to soil carbon sequestration from biochar addition in the first year. The reduction of NGHGE and GHGI was mainly caused by the decrease of CH4 emissions (71 to 74% contribution), and the increase of soil carbon sequestration (25 to 29% contribution) in biochar treatments. Biochar amendment also significantly and persistently increased soil pH, total organic carbon (TOC), total nitrogen (TSN), and total phosphorus (TSP) by 6 to 14%, 33 to 61%, 11 to 15%, and 9 to 12%, respectively ($p < 0.05$), in the four years. Significant increases ($p < 0.05$) of microbial biomass carbon and nitrogen contents were found only in the first year after biochar amendment. Soil pH was also increased significantly ($p < 0.05$) with biochar amendment, but showed a declining trend in the four years. Annual grain yields for the biochar treatments were enhanced by 1 to 13%, with an average of 4 to 7% in the four years, compared to CK ($p = 0.07–0.26$). Compared to the LB treatment, the HB treatment significantly decreased average NGHGE and GHGI, and significantly increased average soil pH value and TOC content, but there was no significantly difference in average TSN, TSP, and yield between LB and HB treatments ($p < 0.05$). The gross margin analysis by considering the profit from rice grain, gain for NGHGE, and cost for biochar indicated that the economical profit for the LB treatment might be higher than that for the CK and HB treatments. Our results suggest that addition of biochar at 24 t ha−1 can be regarded as a consistently effective and economic measure for greenhouse gas emission mitigation, and soil fertility improvement, in the double rice cropping system.
Keywords	Paddy field; Biochar; CH_4; CO_2; Greenhouse gas emission; Soil fertility

Title	**The effective mitigation of greenhouse gas emissions from rice paddies without compromising yield by early-season drainage**
Author Name	Islam SF, van Groenigen, Jensen, Sander BO, de Neergaard A
Journal Name	Science of The Total Environment
Volume and Issue	612
Year	2018
Pages	1329-1339
Abstracts	Global rice production systems face two opposing challenges: the need to increase production to accommodate the world's growing population while simultaneously reducing greenhouse gas (GHG) emissions. Adaptations to drainage regimes are one of the most promising options for methane mitigation in rice production. Whereas several studies have focused on mid-season drainage (MD) to mitigate GHG emissions, early-season drainage (ED) varying in timing and duration has not been extensively studied. However, such ED periods could potentially be very effective since initial available C levels (and thereby the potential for methanogenesis) can be very high in paddy systems with rice straw incorporation. This study tested the effectiveness of seven drainage regimes varying in their timing and duration (combinations of ED and MD) to mitigate CH4 and N2O emissions in a 101-day growth chamber experiment. Emissions were considerably reduced by early-season drainage compared to both conventional continuous flooding (CF) and the MD drainage regime. The results suggest that ED + MD drainage may have the potential to reduce CH4 emissions and yield-scaled GWP by 85–90% compared to CF and by 75–77% compared to MD only. A combination of (short or long) ED drainage and one MD drainage episode was found to be the most effective in mitigating CH4 emissions without negatively affecting yield. In particular, compared with CF, the long early-season drainage treatments LE + SM and LE + LM significantly ($p < 0.01$) decreased yield-scaled GWP by 85% and 87% respectively. This was associated with carbon being stabilised early in the season, thereby reducing available C for methanogenesis. Overall N2O emissions were small and not significantly affected by ED. It is concluded that ED + MD drainage might be an effective low-tech option for small-scale farmers to reduce GHG emissions and save water while maintaining yield.
Keywords	Methane; Nitrous oxide; Drainage timing and duration; Redox potential; Rice straw management; Global warming potential

Title	**Greenhouse gas emissions from the energy crop oilseed rape (Brassica napus); the role of photosynthetically active radiation in diurnal N_2O flux variation**
Author Name	Ben J. Keane, Phil Ineson, Harry W. Vallack, Emanuel Blei, Mark Bentley, Steve Howarth, Niall P. McNamara, Rebecca L. Rowe, Mat Williams & Sylvia Toet
Journal Name	Global Change Biology Bioenergy
Year	2017
Volume and Issue	10
Pages	306–319
Abstracts	Oilseed rape (OSR, Brassica napus L.) is an important feedstock for biodiesel; hence, carbon dioxide (CO2), methane (CH4) and particularly fertilizer-derived nitrous oxide (N2O) emissions during cultivation must be quantified to assess putative greenhouse gas (GHG) savings, thus creating an urgent and increasing need for such data. Substrates of nitrification [ammonium (NH4)] and denitrification [nitrate (NO3)], the predominant N2O production pathways, were supplied separately and in combination to OSR in a UK field trial aiming to: (i) produce an accurate GHG budget of fertilizer application; (ii) characterize short- to medium-term variation in GHG fluxes; (iii) establish the processes driving N2O emission. Three treatments were applied twice, 1 week apart: ammonium nitrate fertilizer (NH4NO3, 69 kg-N ha−1) mimicking the farm management, ammonium chloride (NH4Cl, 34.4 kg-N ha−1) and sodium nitrate (NaNO3, 34.6 kg-N ha−1). We deployed SkyLine2D for the very first time, a novel automated chamber system to measure CO2, CH4 and N2O fluxes at unprecedented high temporal and spatial resolution from OSR. During 3 weeks following the fertilizer application, CH4 fluxes were negligible, but all treatments were a net sink for CO2 (ca. 100 g CO2 m−2). Cumulative N2O emissions (ca. 120 g CO2-eq m−2) from NH4NO3 were significantly greater ($P < 0.04$) than from NaNO3 (ca. 80 g CO2-eq m−2), but did not differ from NH4Cl (ca. 100 g CO2-eq m−2) and reduced the carbon sink of photosynthesis so that OSR was a net GHG source in the fertilizer treatment. Diurnal variation in N2O emissions, peaking in the afternoon, was more strongly associated with photosynthetically active radiation (PAR) than temperature. This suggests that the supply of carbon (C) from photosynthate may have been the key driver of the observed diurnal pattern in N2O emission and thus should be considered in future process-based models of GHG emissions.
Keywords	automatic chamber; biodiesel; carbon dioxide; denitrification; greenhouse gas; methane; nitrification; nitrogen; nitrous oxide; oilseed rape

Title	**Nitrogen fertilization and conservation tillage: a review on growth, yield, and greenhouse gas emissions in cotton**
Author Name	Shah AN, Iqbal J, Tanveer M, Yang G, Hassan W, Fahad S, Yousaf M & Wu Y
Journal Name	Environmental Science and Pollution Research
Year	2017
Volume and Issue	24, 3
Pages	2261–2272
Abstracts	Cotton is planted worldwide as a “cash crop” providing us fiber, edible oil, and animal feed as well. In this review, we presented a contemporary synthesis of the existing data regarding the importance of nitrogen application and tillage system on cotton growth and greenhouse gas (GHG) emission. Cotton growth and development are greatly influenced by nitrogen (N); therefore, proper N application is important in this context. Tillage system also influences cottonseed yield. Conservation tillage shows more promising results as compared to the conventional tillage in the context of cotton growth and GHG emission. Moreover, the research and knowledge gap relating to nitrogen application, tillage and cotton growth and yield, and GHG emission was also highlighted in order to guide the further studies in the future. Although limited data were available regarding N application, tillage and their interactive effects on cotton performance, and GHG emission, we also tried to highlight some key factors which influence them significantly.
Keywords	Cotton Greenhouse gases; Nitrogen management; Tillage; Sustainable agriculture