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Effect of wheat varieties and growth regulators on soil greenhouse gas emissions

Elsbe von der Lancken[1], Victoria Nasser[2], Katharina Hey[1], Stefan Siebert[1], and Ana Meijide[1]
[1]Division of Agronomy, Department of Crop Science, University of Göttingen, Göttingen, Germany (elsbevonderlancken@web.de)
[2]Division of Plant Nutrition and Crop Physiology, Department of Crop Science, University of Göttingen, Göttingen, Germany (victoria.nasser@uni-goettingen.de)

The need to sustain global food demand while mitigating greenhouse gases (GHG) emissions is a challenge for agricultural production systems. Since the reduction of GHGs has never been a breeding target, it is still unclear to which extend different crop varieties will affect GHG emissions. The objective of this study was to evaluate the impact of N-fertilization and of the use of growth regulators applied to three historical and three modern varieties of winter wheat on the emissions of the three most important anthropogenic GHGs, i.e. carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Furthermore, we aimed at identifying which combination of cultivars and management practises could mitigate GHG emissions in agricultural systems without compromising the yield. GHG measurements were performed using the closed chamber method in a field experiment located in Göttingen (Germany) evaluating three historical and three modern winter wheat varieties, with or without growth regulators under two fertilization levels (120 and 240 kg nitrogen ha^{-1}). GHG measurements were carried out for 2 weeks following the third nitrogen fertilizer application (where one third of the total nitrogen was applied), together with studies on the evolution of mineral nitrogen and dissolved organic carbon in the soil. Modern varieties showed significantly higher CO_2 emissions (i.e. soil and plant respiration; +23 %) than historical varieties. The soils were found to be a sink for CH_4, but CH_4 fluxes were not affected by the different treatments. N_2O emissions were not significantly influenced by the variety age or by the growth regulators, and emissions increased with increasing fertilization level. The global warming potential (GWP) for the modern varieties was 7284.0 ± 266.9 kg $CO_{2\text{-eq}}$ ha^{-1}. Even though the GWP was lower for the historic varieties (5939.5 ± 238.2 kg $CO_{2\text{-eq}}$ ha^{-1}), their greenhouse gas intensity (GHGI), which relates GHG and crop yield, was larger (1.5 ± 0.3 g $CO_{2\text{-eq}}$ g^{-1} grain), compared to the GHGI of modern varieties (0.9 ± 0.0 g $CO_{2\text{-eq}}$ g^{-1} grain), due to the much lower grain yield in the historic varieties. Our results suggest that in order to mitigate GHG emissions without compromising the grain yield, the best management practise is to use modern high yielding varieties with growth regulators and a fertilization scheme according to the demand of the crop.