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Preliminary results on yield and CO_2 fluxes when using alternate wetting and drying on different varieties of European rice

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In Europe, rice is grown (467 000 ha) under permanently flooded conditions (PF) using irrigation waters of major rivers. Climate change, which has led to a greater fluctuation in river flows, is a major challenge to rice production systems, which depend on large and consistent water supplies. This challenge will become more acute in the future, with more frequent extreme weather (e.g. drought) predicted under climate change and increased demands for rice. Alternate wetting and drying (AWD) is a system in where irrigation is applied to obtain 2-5 cm of field water depth, after which the soil is allowed to drain naturally to typically 15 cm below the surface before re-wetting once more. Preliminary studies suggest that AWD can reduce water use by up 30 %, with no net loss in yield but significantly reducing CH_4 emissions. However, uncertainties still remain as to the impacts of AWD on CO_2 exchange, N_2O fluxes, and plant acclimation responses to a fluctuating water regime. For example, CO_2 emissions could potentially increase in AWD due to higher rates of soil organic matter decomposition when the fields are drained. The work presented here evaluated the impacts of AWD on the productivity and yield of twelve varieties of European rice, whilst simultaneously measuring CO_2 exchange, N_2O fluxes, and plant biomass allocation patterns under different treatment regimes. Field experiments were conducted in the Piedmont region (northern Italy Po river plain) in a loamy soil during the growing season of 2015 in a 2-factor paired plot design, with water treatment (AWD, PF) and variety (12 European varieties) as factors (n=4 per variety per treatment). The varieties chosen were commercially important cultivars from across the rice growing regions of Europe (6 Italian, 3 French, 3 Spanish). Light and dark CO_2 fluxes were measured six times over the growing season, using an infra-red gas analyzer. Environmental variables (soil moisture, temperature, water table depth, water potential, PAR) were collected concomitantly. Above and belowground biomass were determined by destructively harvesting at the end of the growing season. Belowground biomass was estimated by manually extracting roots from 30 cm deep soil cores and aboveground biomass estimated by collecting and weighing the rachis, grain and straw on a 1 metre linear section from every variety of rice. Overall, there was no significant effect between AWD and PF systems on rough grain production (863 and 822 g DM m^{-2}) or straw yield (776 and 813 g DM m^{-2}) for PF and AWD, respectively. There was also no significant difference for net ecosystem exchange (NEE) (-10.83 $\pm$ 1.10 and -9.71 $\pm$ 1.17 mg C m^{-2} s^{-1}) or ecosystem respiration (R_e) (6.86 $\pm$ 0.63 and 6.26 $\pm$ 0.61 mg C m^{-2} s^{-1}), with the exception of one French variety (Gageron). This cultivar showed a significant increase in NEE under AWD (PF = -13.61 $\pm$ 2.89 and AWD = -17.63 $\pm$ 5.33 mg C m^{-2} s^{-1}). The results from this study highlight that this novel water management strategy for European rice can have multiple environmental benefits without sacrificing yield.