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Water balance of rice plots under three different water treatments: monitoring activity and experimental results

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In the agricultural seasons 2012 and 2013, a broad monitoring activity was carried out at the Rice Research Centre of Ente Nazionale Risi (CRR-ENR) located in Castello d'Agogna (PV, Italy) with the purpose of comparing the water balance components of paddy rice (Gladio cv.) under different water regimes and assessing the possibility of reducing the high water inputs related to the conventional practice of continuous submergence.
The experiments were laid out in six plots of about 20 m x 80 m each, with two replicates for each of the following water regimes: i) continuous flooding with wet-seeded rice (FLD), ii) continuous flooding from around the 3-leaf stage with dry-seeded rice (3L-FLD), and iii) surface irrigation every 7-10 days with dry-seeded rice (IRR). One out of the two replicates of each treatment was instrumented with: water inflow and outflow meters, set of piezometers, set of tensiometers and multi-sensor moisture probes. Moreover, an eddy covariance station was installed on the bund between the treatments FLD and IRR. Data were automatically recorded and sent by a wireless connection to a PC, so as to be remotely controlled thanks to the development of a Java interface. Furthermore, periodic measurements of crop biometric parameters (LAI, crop height and rooting depth) were performed in both 2012 and 2013 (11 and 14 campaigns respectively).
Cumulative water balance components from dry-seeding (3L-FLD and IRR), or flooding (FLD), to harvest were calculated for each plot by either measurements (i.e. rainfall, irrigation and surface drainage) or estimations (i.e. difference in the field water storage, evaporation from both the soil and the water surface and transpiration), whereas the sum of percolation and capillary rise (i.e. the 'net percolation') was obtained as the residual term of the water balance. Incidentally, indices of water application efficiency (evapotranspiration over net water input) and water productivity (grain production over net water input) were calculated for each treatment.
The outcomes show that the water application efficiencies of all treatments were higher in 2013 than in 2012 (by 23%, 25% and 4% for FLD, 3L-FLD, and IRR respectively). These results could be ascribed to the higher groundwater level observed in 2013 (about 10-15 cm closer to the soil surface), likely due to the conversion of the field beyond the monitored plots from soybean to flooded rice. Moreover, a small increase of the water application efficiency of 3L-FLD was found if compared to FLD (3% on average), while the water application efficiency of IRR was, on average, higher by 67% compared to FLD. The good performance of IRR is related to lower percolation rates and a relevant contribution of capillary rise due to the shallow groundwater table maintained by the continuous submergence of the surrounding paddy fields.
The performed experiment highlighted that significant improvement in the water use efficiency at the field scale can be achieved. However, a widespread adoption of water regimes different from continuous flooding should be carefully evaluated by a larger-scale approach since a consequent drop in the groundwater table depth could have repercussions on the potential gains themselves.