Geophysical Research Abstracts
Vol. 20, EGU2018-6146, 2018
EGU General Assembly 2018
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Water use and soil water dynamics under drip and continuously flooded irrigated rice

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Rice crop traditionally requires a great amount of water, but in many parts of the world water for agriculture is becoming scarce and expensive. Continuous flooding irrigation (CFI) is the most common irrigation system used by rice producers but other different production systems such as dry direct seeding, alternate wetting and drying, saturated soil culture and aerobic rice are being adopted to reduce irrigation water needs. For this purpouse, drip irrigation (DI) allows a high degree of control in water application, maintaining the soil at a targeted water content and, therefore, it could potentially save more water than any other irrigation system.

Usually, rice grows in deltaic regions where soil and water salinity can be an issue. Under these conditions, a reduction of the water used by irrigation, needs to be carefully managed, as a change in the water and salt dynamics in the soil can increase the risk of soil and groundwater salinization.

The objectives of this study were: (1) to compare soil water distribution under continuous flooded (CFI) and drip irrigated (DI) paddy fields obtained from field data and simulations with the model HYDRUS-1D, (2) to estimate water percolation and salinity of the shallow groundwater, (3) to compare water productivity in CFI and DI rice.

Field studies were conducted at Pals (Girona, Spain) during 2017 growing season in two different fields of approximately 1 ha with an Aquic Xerofluvents soil. Both fields were laser leveled at 0% slope before planting. In the DI field, driplines were spaced 0.75m and emitters 0.40m and emitter flow-rate was 1.05 L/h. During the growing season, the irrigation target was to maintain soil surface near to saturation minimizing runoff. The irrigation target in the CFI field was based on maintaining a water level of 5cm over the soil surface, except two weeks before harvesting, when irrigation was cut-off. Flooded water depth was regularly recorded at several locations in the field. Daily climate data were obtained from a meteorological station located at the drip irrigated field. Irrigation water in each field was measured using flow-meters. Soil water content (SWC) was continuously measured at three soil depths and, in the DI field, at different positions relative to the position of the emitters. Groundwater level and its electrical conductivity (EC) were also regularly measured. Phenological stages, leaf area index during the growing season and grain yield were determined.

HYDRUS-1D software was used to simulate soil water dynamics in both experimental fields since measured SWC confirmed the unidimensional component of water movement.

Simulated SWC showed good agreement with the observed ones. Drained water below 1m soil depth accounted 123 and 901mm for DI and CFI respectively. The EC of the drained water was higher in the DI field. DI reduced the amount of water needed for irrigation, but yield was slighly reduced. Consequently, the resulting water productivity, defined as the grain yield divided by irrigation plus precipitation, was greater for DI.