MEDWATERICE

Towards a sustainable water use in Mediterranean rice-based agro-ecosystems

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FACT SHEET

ALTERNATE WETTING AND DRYING (AWD) IN RICE AGRO-ECOSYSTEMS

What is AWD?

The AWD (*Alternate Wetting and Drying*) is an irrigation technique that involves alternating dry periods with periods of flooding during the rice cropping cycle. Depending on how long the single dry period is prolonged between one flooding and another (and consequently, on how much the water content of the soil drops below the saturation), AWD is classified as ‘safe’ or ‘severe’.

AWD severity influences yield production and irrigation requirement. A 40-50% reduction in methane emissions when adopting AWD instead of wet seeding and traditional flooding is reported in the literature; however, AWD can negatively affects nitrous oxide emissions if dry periods and nitrogen fertilization are not properly managed.

Nowadays, a "safe" AWD, has become a recommended practice in many water-scarce irrigated rice areas. It is very widespread throughout Southeast Asia, China, India and Japan. It has also been successfully adopted in temperate areas, such as California and Arkansas (USA). Recently, the first steps towards the AWD practice have been moved in the Mediterranean basin in the context of the MEDWATERICE project: AWD was tested in Italy (AWD-safe), Portugal (AWD-safe) and Turkey (AWD-safe and intermediate).

How to implement AWD?

The AWD technique is based on the irrigation of rice fields with a continuous alternation of aerobic and anaerobic soil conditions: starting for a certain crop phenological stage, flooding is stopped until water level under the soil surface or soil water potential measured at a certain soil depth drop below a predetermined threshold, after which the paddy field is flooded again.

In order to implement a ‘safe’ or a ‘severe’ AWD, it is important to set the threshold in term of soil water status at which the dry period must be stopped. The soil water status is usually monitored inside the paddy through hydraulic tensiometers (Figure 1) or field water tubes (Figure 2).

The water tube is a practical way to implement AWD, since it can be self-made. It is a perforated plastic tube having a length of 30-40 cm and a diameter of 10−20 cm, which allows the measurement of the water level “hidden” below the ground surface. Water tube and/or water tensiometers should be installed in an accessible part of the field (i.e. near the bunds) to facilitate the monitoring of the ponded water depth or soil water potential; however, the installation site must be representative of the field conditions.

Figure 1 – Hydraulic tensiometer

Figure 2– Field water tube

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How the AWD was implemented in the countries of the Mediterranean basin (MEDWATERICE)

In Italy: AWD-safe was tested during two experimental years (2019 and 2020) in the Lomellina area. It was associated with the wet seeding of rice, and started at the beginning of tillering. Irrigation events were applied when the water level in the field water tubes reached -10 cm below the ground level and the soil matrix potential measured at -5 cm below the soil surface was about -30 hPa (Figure 3). When these thresholds were reached, paddies were re-flooded to an average water level of about 10 cm. AWD was applied until 3 weeks before the time of harvest.

Irrigation water use was monitored through flow meters installed in the experimental parcels. The average water saving was found to be about 20% compared to the wet seeding and traditional flooding (WFL) without penalizing rice production.

Figure 3 – Tensiometers and field water tubes installed in the Italian CS

In Portugal: AWD-safe was tested during two experimental years (2020 and 2021) in paddies of Lower Mondego and Lis Valleys, after a precise land levelling. It was associated with the wet seeding of rice, and started after the early ripening phase. Irrigation events were scheduled when the water level in field water tubes reached an average value of about -7 cm below the ground level, which corresponded to an irrigation frequency between 12 and 15 days. When the threshold was reached, paddies were re-flooded to an average water level of about 6 cm. To prevent yield damage, a continuous water depth of 3-5 cm was maintained during panicle initiation, flowering and early ripening, due to high sensitivity of rice to water stress during these phases. The last irrigation event took place about 20 days before the harvest.

Irrigation water use was monitored through flow meters installed in the experimental fields. The average water saving was found to be about 12% compared to WFL, without a significant reduction in rice yield.

In Turkey: Alternate wetting and drying (AWD) was tested in Bafra Valley during three agricultural seasons (2019, 2020 and 2021) adopting three severity degrees corresponding to three water tube threshold levels (-5 cm, -10 cm and -15 cm below the soil surface). The technique was implemented in association with a wet transplanting in the first year (WFL), and with a dry seeding in the other two (DFL), respectively. As in the Lomellina case, AWD started at the beginning of early tillering.

For the three treatments, when thresholds were reached paddies were reflooded to an average water level of about 10 cm. At around flowering, the water depth of all AWD treatments was maintained from 8 to 10 cm depth to reduce the risk of panicle sterility which could be due to a water-deficit stress. After completion of the flowering stage, AWD was applied again until 3 weeks before the time of harvest.

Together with the quantification of the irrigation water use through measuring devices, the closed gas chamber method was used to measure methane emission in the AWD-15 parcels during the last experimental year (Figure 4). AWD-5, AWD-10, and AWD-15 showed an average water saving of about 20%, 27%, and 32% compared to WFL/DFL, and an average decrease in grain yield of about 4%, 9%, and 12%. AWD-15 was shown to reduce total methane emission by about 32% compared to DFL.

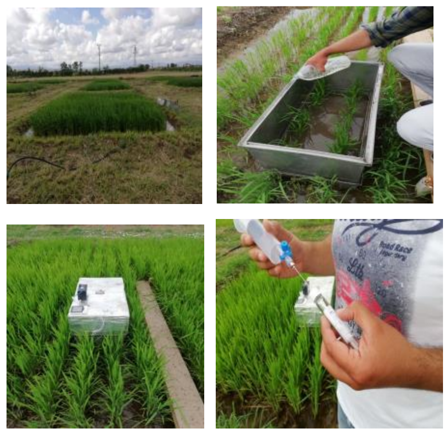

Figure 4 - Closed gas chamber used in the Turkish CS

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