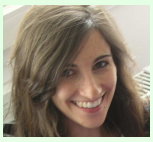
Rice Gene Traits involved in the adaptive capacity to AWD

Volpe V.[1], **Fiorilli V.**[1], **Bagnaresi P.**[2], **Bonfante P.**[1]

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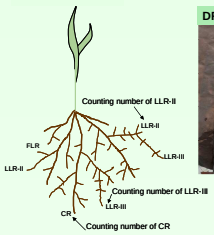
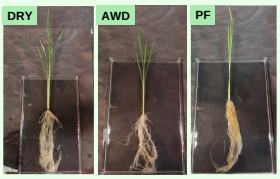
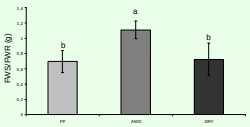
In the frame of the European project GreenRice, an **alternative wetting and drying method (AWD)** has been proposed: it is a system based on "intermittent irrigation" in which fields are allowed to dry out for a short period before being re-flooded again. It was estimated that water input can be reduced by 15-30% with no loss in yield and that CH4 emissions will be reduced by up to 48 % (Barker et al. 2010; Lampayan et al., 2015). Within this framework, and with the final aim to provide an expression atlas of rice genes that are modulated by different water regimes, we performed an RNA-seq analysis on large lateral roots (LLR) and fine lateral roots (FLR) of rice plants grown in **permanent flooding (PF)** condition. The data were compared with a previous data set, originated from rice plants grown in **dry condition (DRY)** (Fiorilli et al., 2015). In parallel, we assessed the morphological differences in root development of rice plants grown in three water regimes: PF, AWD and DRY.

Morphological analysis of plants grown under PF, AWD and DRY

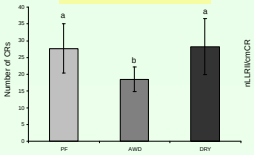




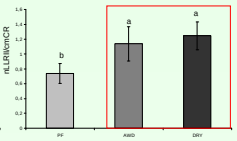
Plant Biomass



Number of CR



Root branching



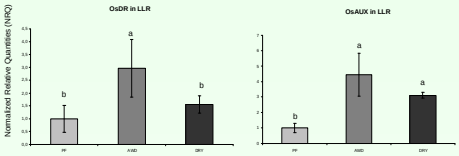
LLR-II: large lateral root secondary

LLR-III: large lateral root tertiary

Morphological results were confirmed by molecular data

OsDR (Deeper Root): it is involved in affecting the root system architecture through the control of root growth angle. Moreover it is effective for increasing rice yield under water limiting conditions

Marker genes for Root Development



Plants grown under AWD condition revealed:

- High shoot / root biomass ratio

- high root branching (LLR-II) compared to plants grown under DRY condition

- Higher number of LLR-III than PF

Transcriptomic response of rice plants grown under PF and DRY

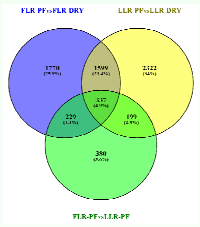
Global View

	FLR-PFvsFLR-DRY	LLR-PFvsLLR-DRY	FLR-PFvsLLR-PF
DEGtot	3935	4457	1145
DEG-up	2525	3350	560
DEG-down	1410	1107	585

We compared:
-same root types and different water regimes (PF vs DRY)
-same water regimes and different root types (LLR vs FLR)

Comparable number of up and down regulated genes

Venn diagrams of modulated genes (DEG)

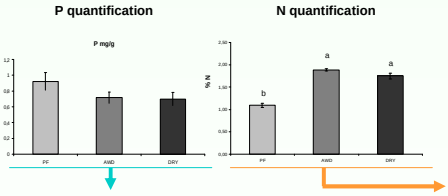


The PF treatment is the driving force that influences the gene expression in the comparison between FLR-PF vs LLR-PF

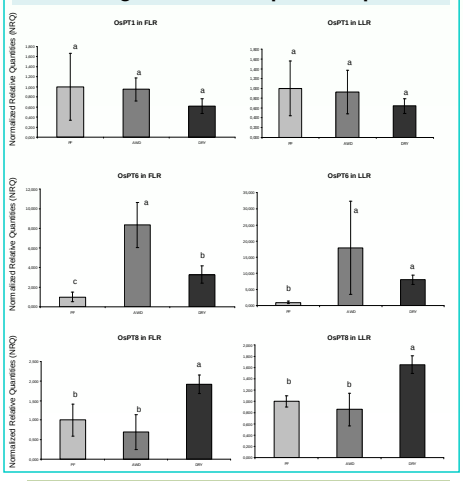
During the PF treatment the two roots types are characterized by similar transcriptomic profiles

Nutrients acquisition in rice plants grown under PF, AWD and DRY

Elements quantification

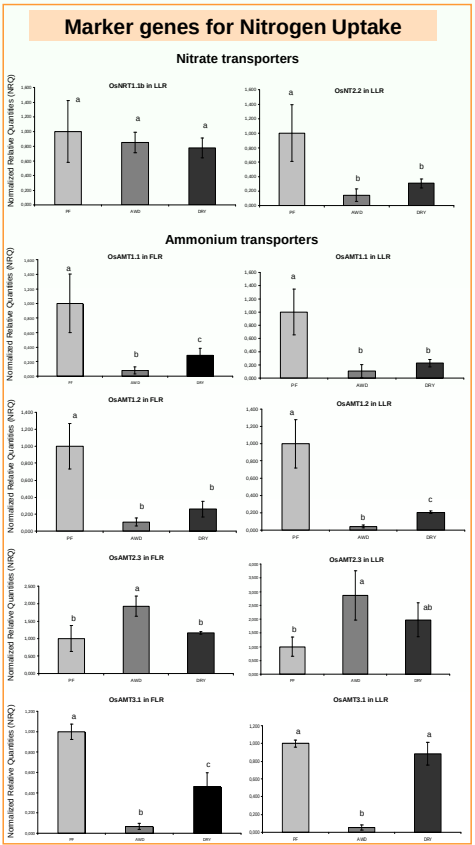


Marker genes for Phosphorus Uptake



During AWD treatment the transcript levels of OsPT6 resulted significantly up-regulated respect to PF and DRY condition. Is the OsPT6 a putative marker for AWD treatment?

Marker genes for Nitrogen Uptake



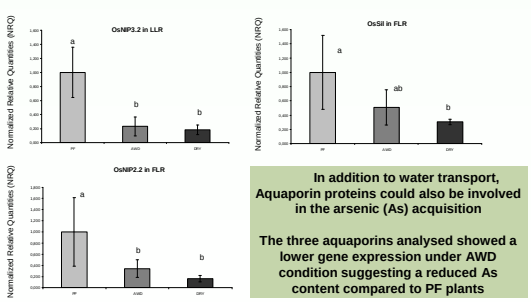
The gene expression of many Nitrogen transporters has been evaluated, but the only that is specifically induced in rice plants treated with AWD is the OsAMT2.3

In general most of nitrogen transporters are up-regulated under PF condition despite the lower N content:

-is this up-regulation induced by Nitrogen starvation?

- considering the higher root branching is the Nitrogen transport more efficient in AWD and DRY plants?

Aquaporins



In addition to water transport, Aquaporin proteins could also be involved in the arsenic (As) acquisition

The three aquaporins analysed showed a lower gene expression under AWD condition suggesting a reduced As content compared to PF plants

Take home message

Is the AWD system a convenient procedure?

Pros	Cons
-Increased branching	-
-Increased N content	-
-Potential reduction in As content	-

On the basis of these experiments, AWD seems to be a promising procedure