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"Resilience of agricultural systems against crises"

Impact of Irrigation System on Microclimatic Parameters and Gas Exchange in Lowland Rice

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Abstract

Interest in water-saving irrigation techniques in Senegal is rising from the aim to increase the domestic rice production. Rice-rice double-cropping and expansion of the rice growing area are the strategies for becoming self-sufficient on rice in the near future. Furthermore, high irrigation costs account for a relatively large share of production expenses due to increasing fuel and electricity prices. Nevertheless, yield stability under water-saving irrigation is not assured and the reasons remain widely unclear. In the absence of a ponded water layer, plants are exposed to higher temperature extremes at the growing point. In addition, reduced evaporation can lead to lower relative humidity in the canopy. Therefore, microclimate is considered to influence gas-exchange parameters.

Experiments were conducted between November 2008 and October 2010 in Ndiaye, located in the Senegal River delta, with typical Sahelian climatic conditions and thus three distinct seasons: a hot-dry-season from March to July, a short wet-season from August to October and a cold-dry-season from November to February. In bi-monthly staggered sowing dates, soil temperature, temperature at the growing point and inside the canopy as well as relative humidity inside the canopy was observed for five irrigated lowland rice varieties grown under flooded and non-flooded conditions year-around. Gas-exchange measurements for transpiration, assimilation and stomatal conductance were conducted on a regular basis.

The effect of higher temperature amplitude in the absence of a ponded water layer was more pronounced in the two dry-seasons than in the wet season. A negative effect of water-saving irrigation on soil temperature, temperature at the growing point and relative humidity and thus an increased vapour pressure deficit inside the canopy was observed under hot and dry conditions. Low soil temperature and high vapour pressure deficits were associated with a decrease in stomatal conductance and thus assimilation rate. Reduction of assimilation rate without standing water under high vapour pressure deficits was more distinct in varieties adapted to the wet tropics than in local varieties, whereas neither an impact of irrigation technique nor variety could be detected in the wet-season.

Keywords: Assimilation, Sahel, transpiration, water-saving irrigation

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