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Growth Response of Rice to Different Vapor Pressure Deficits and Diurnal Temperature Patterns

DUY HOANG VU¹, SABINE STÜRZ², FOLKARD ASCH²

¹*Vietnam National University of Agriculture (VNUA), Dept. of Cultivation Science, Vietnam*

²*University of Hohenheim, Inst. of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

Abstract

In arid and semi-arid environments, rice plants are challenged by large diurnal temperature amplitudes and high evaporative demands by the atmosphere. In rice grown under typical lowland conditions, the plant's meristem is below the water surface and therefore, water temperature can have a larger effect on plant growth than air temperature. The impact of either water temperature or vapour pressure deficit (VPD) on rice growth has been widely investigated; however, the interactive effect of day/night temperature patterns at root and meristem level under varying VPD has barely been studied so far. The aim of our greenhouse study was to determine growth responses of two rice varieties (IR64, Sahel108) to three water temperature regimes (constant temperature: 23°C; warm day/cold night: 28/18°C; cold day/warm night: 18/28°C) under two VPD levels (2.2 and 0.92 kPa). Individual plants were grown in temperature-controlled nutrient solution. Leaf elongation rate (LER) was measured for the 9–10th leaf of the main tiller for 48 hours. Under low VPD, LER was higher than under high VPD for both varieties. Interestingly, under high VPD, highest LER were found during the night and in the early morning (0–8 am), whereas under low VPD, LER was highest between 8am and 4pm. Under low VPD conditions, constant temperature led to a higher LER but only for IR64, whereas under high VPD, highest leaf growth was observed under cold day/warm night conditions for both varieties. Under low VPD, cold day/warm night conditions led to a greater total root length, a larger root surface area, a higher root/shoot ratio and more total dry matter in both varieties, while under high VPD this effect was only found for IR64, but not for Sahel 108. Our results suggested that VPD has a larger impact on diurnal leaf growth patterns than temperature. Since under high evaporative demand, rice leaves mainly grow during the night and in the early morning, night temperature can have a larger effect on plant growth than day temperature. Furthermore, cold day/warm night conditions largely increased root growth, with might enable rice plants to tolerate a high VPD during the day and therefore promote plant growth.

Keywords: Hydroponics, leaf elongation rate, lowland rice, VPD