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Impact of Root Temperature Regime on Growth, Photosynthesis and Carbon Allocation in Rice Plants

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Abstract

Temperature is a key environmental factor affecting photosynthesis and crop growth, but most studies have focused on air temperature. Rice is mostly grown in flooded conditions in which the meristems are immersed in ponded water, so differences in night/day water temperatures are expected to have a large impact on growth.

Rice plants, cv IR64 were cultivated in a greenhouse in an hydroponic circulating system in which the root and meristem growth temperatures were inverted in order to distinguish the effect of night-time and day-time temperature on growth and carbon balance. Air temperatures were kept constant at 25°C ± 3 / 20°C ± 2 day / night, respectively. After 28 days under the inverted day/night root-meristem temperature regime, plants were measured and sampled for total and organ dry weight, photosynthesis rate in the three uppermost leaves on the main stem and carbohydrate and soluble proteins distribution.

Plants subjected to low day-/high night-time temperature (18°C/28°C) showed a larger total, leaf, root and stem dry weight than plants subjected to high-day/low-night (28°C/18°C) root-meristem temperature. However, leaf and stem biomass represented 30 % and 40 % of total plant dry weight, respectively in both treatments. Leaf area and photosynthetic rates were higher in the low-day/high-night temperature treatment but at the end of the light period, leaf carbohydrate concentration was larger in the high-day/low-night temperature treatment. The opposite was observed at the end of the dark period, which resulted in a higher fraction of accumulated carbon being mobilised during the dark period in the low-day/high-night temperature treatment. Leaf soluble protein concentration was higher in the high-day/low-night temperature treatment, particularly in leaf 1 (youngest) and leaf 3 (oldest), which led to a C/N ratio between 2.18 and 2.86 mmol CH_20 g protein^{-1} in all leaf ages and both treatments.

Our data indicate that inverting the root/meristem temperature regime (low day/high night) stimulates growth and leaf area development through the production of more tillers without major changes in biomass allocation. This could be partly explained by the faster rates of photosynthesis and the larger fraction of accumulated CH_20 which was remobilised during the night period.

Keywords: Carbohydrate mobilisation, carbon balance, rice, root temperature regime

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