Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute) (490)

# Nutrient and water uptake of rice in response to day and night root zone temperature

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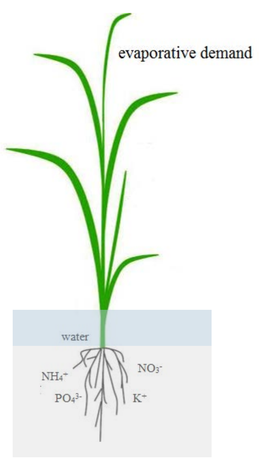
## Introduction

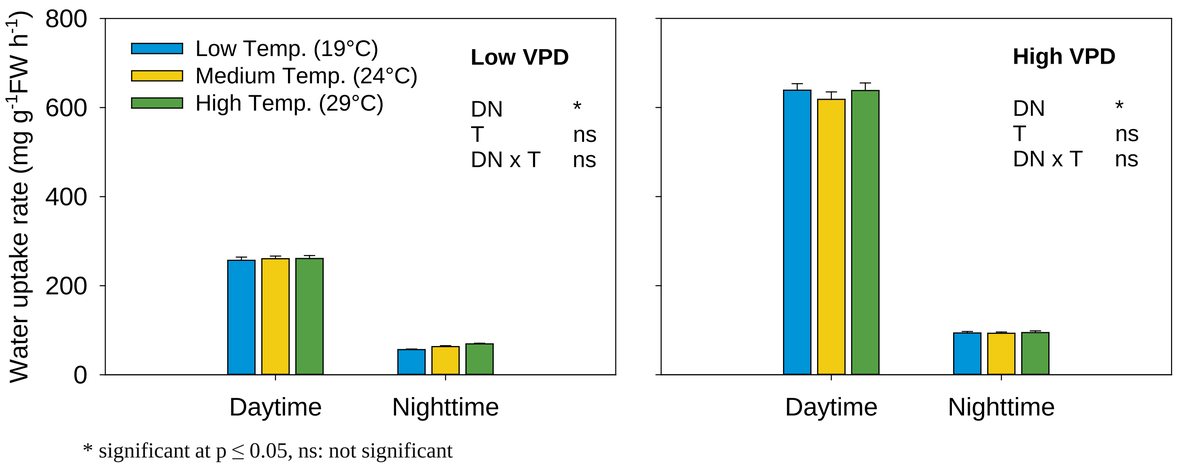
In flooded rice fields, the water layer can buffer peak temperatures, but with the progressive introduction of water-saving irrigation technologies, root zone temperature (RZT) will vary more widely. Shifts in RZT will probably affect the nutrient uptake of the plants and fertilizer management strategies might need to be adapted. Since nutrient and water uptake are linked under low transpirational demand, nutrient uptake at different RZT was investigated under different vapor pressure deficits (VPD).



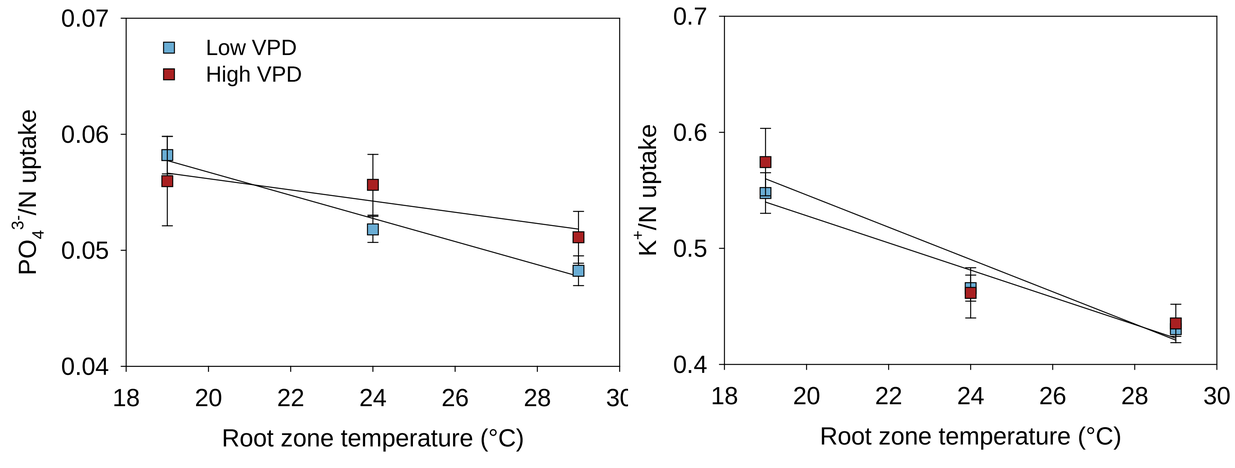

## Conclusion

- Higher RZT increases nutrient, but not water uptake.
- Transpirational demand has no effect on temperature response of nutrient uptake.
- With higher RZT, plant take up more N relative to $PO_4^{3-}$ and $K^+$ uptake, hence, fertilizer management might need to be adapted.
- Plants may benefit from higher RZT during the day via an increased N uptake and stimulated AA built-up in the leaves.

## Results and Discussion




* significant at $p \leq 0.05$, ns: not significant

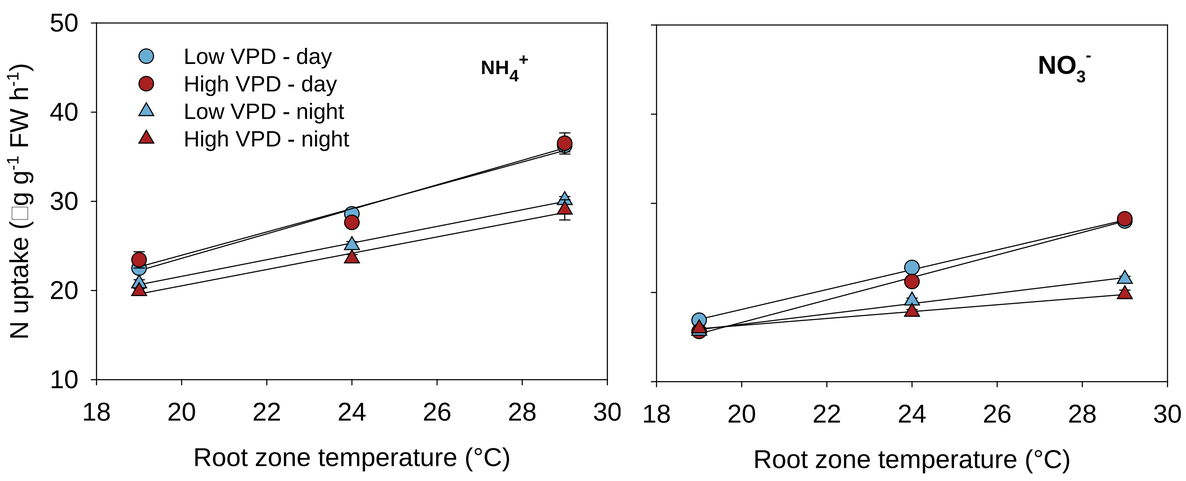



- Water uptake was not influenced by RZT, but differed between VPD levels, especially during the day.

➢ Water uptake was only driven by transpirational demand.

- The $K^+$/N uptake ratio decreased with higher RZT at both VPD levels, while the $PO_4^{3-}$/N uptake ratio significantly decreased at low VPD only.

➢ Since $NO_3^-$ and $NH_4^+$ uptake increased faster with RZT than $PO_4^{3-}$ and $K^+$, the ratio between the nutrients shifted with temperature.




| Amino acid concentration | Low VPD | | High VPD | |
|---|---|---|---|---|
| | N uptake | | N uptake | |
| | day | night | day | night |
| **Day** | 0.75** | -0.76** | 0.65** | -0.59** |
| **Night** | 0.72** | -0.72** | 0.73** | -0.72** |

** significant at $p \leq 0.01$

- At both VPD levels, $NH_4^+$ and $NO_3^-$ uptake rates significantly increased with RZT. During the day, the increase was larger than during the night.

➢ The linear increase of N uptake in the observed RZT range (19-29˚C) implies that the optimum RZT for N uptake is above 29˚C.

- AA concentrations were positively correlated with N uptake during the day, while they were negatively correlated during the night.

➢ N taken up during the day is directly metabolized into AA, while the fate of N taken up during the night remains unclear.

## Materials and Methods

Plants were grown in individual tubes containing 160 ml Yoshida nutrient solution. RZT was adjusted at three levels (19, 24, and 29˚C) during the day or the night with a mean daily temperature of 24˚C. Plants were placed in high VPD (0.8/0.3 kPa day/night) and low VPD (2.3/1.2 kPa day/night) chambers in three replications. Nutrient solution in the tubes was renewed every 12 hours at the beginning and the end of the day period. Fresh weight of the plants, nutrient content of the nutrient solution ($NH_4^+$, $NO_3^-$, $PO_4^{3-}$, $K^+$) and water uptake were measured for a period of seven days. Amino acid (AA) concentration in the youngest fully developed leaf was examined during the last day and last night of the experiment.