Tropentag, September 9-11, 2020, virtual conference

"Food and nutrition security and its resilience to global crises"

Leaf Gas Exchange of Lowland Rice in Response to Nitrogen Source and Vapor Pressure Deficit

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Abstract

In anaerobic lowland rice fields, ammonium (NH_4^+) is the dominant form of nitrogen (N) in the soil, whereas nitrate (NO_3) is the main form of N in aerobic fields. During drained periods in water-saving irrigation practices, nitrification is favoured and thus, plants take up a higher share of N as NO_3. Therefore, the progressive implementation of water-saving irrigation practices arouses increased interest in physiological responses of rice to different N sources. Since assimilation and translocation of the two N forms differ in their demand of photosynthates, leaf gas exchange may be subject to adjustments in response to N source. Two experiments were carried out to study gas exchange of four lowland rice varieties (IR64, BT7, KD18, Jasmine 85) in response to N source (sole $NH_4^+$and sole NO_3). Since assimilation rate (A) strongly depends on stomatal conductance (gs), which is highly sensitive to vapour pressure deficit (VPD), the experiments were conducted at varying VPD. Plants were grown in the greenhouse in standard Yoshida nutrient solution during pre-cultivation. At the plant age of 3 weeks, nutrient solution with sole NH_4^+ or NO_3 was provided for another 2 weeks. At the end of this period, leaf gas exchange was measured, and after, morphological parameters were determined and starch concentration in the leaves was analyzed. Both, after 2 weeks at low VPD and after transferring the plants from low to high VPD, rice varieties did not show significant differences in A and gs between the two N sources. However, after 2 weeks at high VPD, NO_3 nutrition led to higher A and gs in IR64 and BT7, whereas no significant difference was found in KD18 and Jasmine 85. Increased root/shoot ratio and specific leaf area of plants in NO_3 solution was observed after 2 weeks at high VPD. At the same time, starch concentration in the leaves was not altered, indicating an increased allocation of photosynthetic products to the roots. Therefore, we conclude that under long-term high evaporative demand, NO_3 nutrition can increase assimilation rates of rice via an increased stomatal conductance in some, but not all varieties.

Keywords: Ammonium, nitrate, photosynthesis, stomatal conductance, VPD

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