MAGNESIUM DEFICIENCY RESPONSES IN RICE

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ABSTRACT

Magnesium is one of the essential macro nutrient required for the photosynthesis and enzyme activities. To study the mechanism controlling Mg-homeostasis, symptoms caused by Mg-deficiency in a rice plant were characterized to describe how the rice plant responses and acclimates to the Mg-starved condition.

Two weeks old rice seedlings, in which the 4th leaf (L4) was the youngest leaf, were transplanted to either Mg-, Fe-, Ca-, K- or P-free nutrient solution to observe the element specific symptoms. After 8 days, plants with another 2 developed leaves (L5 and L6) were transferred to the full-nutrient solution for recovery test. In case of the Mg-deficiency, only L5 was found in senescent stage and could not recover. Other nutrient deficiencies did not induce senescence in L5, suggesting L5 was sensitive particularly to the Mg-deficiency.

At day 8 of the Mg-deficiency, two major symptoms, decrease of chlorophyll content and accumulation of starch, were found both in L5 and L6. The recovery of L6 after re-supply of Mg suggests that the decrease of chlorophyll and starch accumulation is not showing a critical condition for the senescence induced by Mg deficiency. On the other hand, $^{32}\text{P}O_4^{3-}$ transport activity, representing xylem flow, was drastically decreased in L5 at day 8. Considering that all nutrients including Mg are transported to leaf through xylem, it could be concluded that the inactivation of xylem flow induced critical and irreversible senescence of L5. In fact, $^{28}\text{Mg}^2+$ transport activity to L5 was drastically decreased and almost disappeared at day 8, while uptake and transport activity of $^{28}\text{Mg}^2+$ to the other parts were increased to 10-fold by the Mg-deficiency.

Since the decrease of xylem flow in L5 was slightly observed as early as at day 6, transcriptome analysis was carried out at day 6 for L4, L5 and L6 to find out the molecular changes at an early stage of the Mg-deficiency. In L4 and especially in L5, several ABA related genes including $A{B}{I}4$ ortholog and $O{s}NC{E}D{I}$, and ROS related genes, such as catalase and peroxidase, were upregulated. From these results, the response to Mg-deficiency was indicated to share the ABA signaling pathway, which could affect on the xylem flow through closing the stomata. Further experiment is needed to explain why the Mg-deficiency is related to the ABA signaling response, particularly in L5.

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