The Role of Mugineic Acid Family Phytosiderophores in the Uptake and Translocation of Zinc in Plants

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INTRODUCTION

Mugineic acid family phytosiderophores (MAs) are metal chelators that are produced in graminaceous plants in response to Fe deficiency, but current evidence regarding secretion of MAs during Zn deficiency is contradictory.

In this study, we used barley (tolerant to Zn deficiency) and rice (intolerant to Zn deficiency) for analysis of MA secretion from their roots. In addition to measurement of MA secretion, we investigated the expression pattern of genes involved in MA synthesis in each species. We also investigated the contribution of MAs for Zn uptake in plant using Positron Emitting Tracer Imaging System (PETIS). The PETIS enabled us to visualize the real-time movement of ^{62}Zn within the plants. Moreover, we measured endogenous deoxymugineic acid (DMA) in shoots.

METHODS

Barley and rice were grown hydroponically in nutrient solution. The amount of MA secretion and endogenous MAs were measured using High Performance Liquid Chromatography (HPLC) analysis.

Details of the PETIS experiment were described in Suzuki et al. (2006).

RESULTS AND DISCUSSION

The secretion of MAs was increased by Zn deficiency in barley with increasing expression of all genes involved in MA synthesis in roots (Fig. 2A). On the other hand, MA secretion was not increased by Zn deficiency in rice, it slightly decreased.

The PETIS experiment showed that DMA-Zn was the more important form to absorb Zn into roots compared to Zn^{2+} in barley, while Zn^{2+} was the more important form in rice. The difference may be due to the area where each species evolved.

Furthermore, endogenous DMA in shoots was increased by Zn deficiency in rice and barley, together with an increase of the expression of genes involved in DMA synthesis (Fig. 2). The PETIS experiment showed that DMA-Zn was translocated more rapidly compared to Zn^{2+} in Zn-deficient rice.

These data suggest that MAs play a role not only for the Zn uptake from soil but also for the translocation of Zn within graminaceous plants.

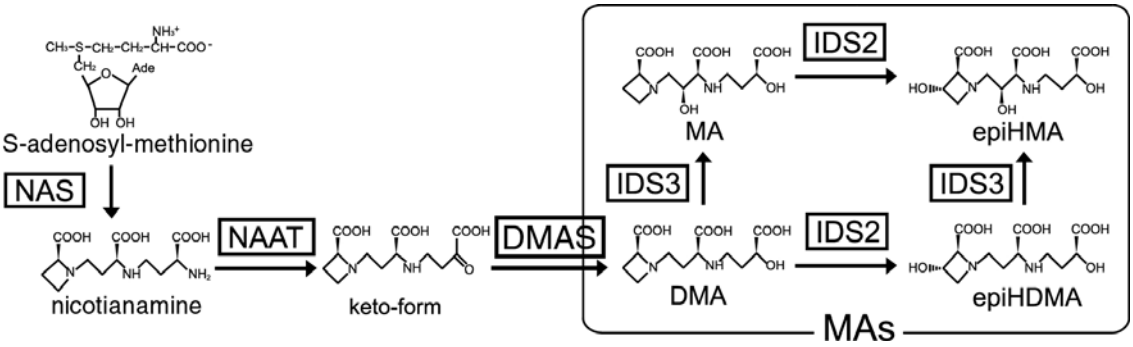

Fig. 1. The pathway of MA synthesis.

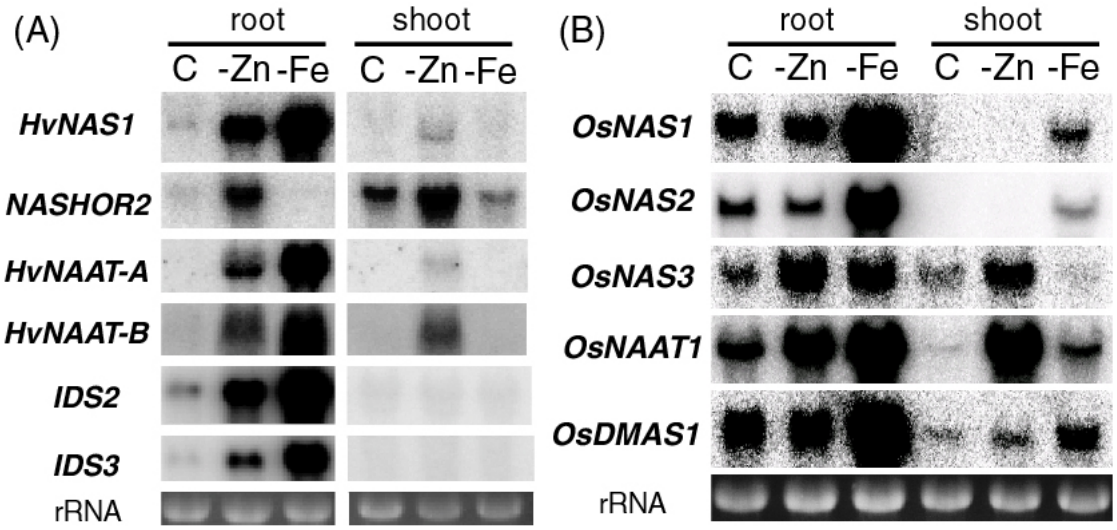

Fig. 2. The expression pattern of genes involved in MA synthesis in barley (A) and rice (B).

ACKNOWLEDGEMENTS

We thank to Takasaki Advanced Radiation Research Institute, Japan Atomic Energy Agency (Gunma, Japan) for PETIS experiment.

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