別紙４

学 位 論 文 の 要 旨

論文題目　Molecular Physiological Study on the Underlying Mechanisms of Riboflavin Pretreatment to Alleviate Salinity Stress in Rice
リボフラビン前処理によるイネの塩ストレス緩和メカニズムの分子生理学的解析

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Salinity stress is a major abiotic stress that leads to economic loss in the agricultural sector. With the challenge of an increasing global population and the limitation of food production, several researches have been conducted to alleviate and solve this problem. Nowadays, pretreatment has gained more attention due to its efficiency and simple methodology, as well as its lower time consumption in comparison with plant breeding. RIB is a vital component required for fundamental metabolism, a precursor of the coenzymes, and is known for biotic and abiotic stress alleviation. However, the information on RIB pretreatment in rice seedlings to confer salinity stress remains limited. Thus, the present study aimed to evaluate the underlying mechanisms of RIB pretreatment in the salt-sensitive variety, IR29, under both hydroponic and soil-based conditions. Physiological and biochemical responses in IR29 were investigated by measuring plant biomass, Na^+/K^+ ratio, accumulation of ROS detoxification compounds, element and chlorophyll concentrations, and expression profiles of some genes encoding Na^+ transporter genes. Further, alterations in expressions of the genes related to RIB and proline biosynthesis-related genes, which could also contribute to salinity-alleviation mechanisms by RIB pretreatment, were investigated. The results demonstrated that RIB-pretreated seedlings were relatively salinity-alleviated compared to the non-pretreated seedlings, and this was evident in higher plant biomass, a lower Na^+/K^+ ratio in the leaf blades, and lower H_2O_2 and MDA concentrations as well as the ability to manage Na^+ uptake from roots by downregulating *OsHKT2;1* and Na^+ accumulation in the leaf blades by upregulating *OsHKT1;4*, *OsHKT1;5*, and *OsNHX1* expression. Notably, RIB-pretreated seedlings induced expression of the gene in the rate-liming step (*OsRIBA1*) of the RIB biosynthesis pathway under hydroponic conditions. Under soil-based conditions, RIB-pretreated seedlings upregulated expression of the genes related to the rate-limiting steps (*OsP5CS1* and *OsP5CS2*) in proline biosynthesis pathways. Whereas, RIB and proline were recognized as non-enzymatic antioxidants attributing to ROS detoxification. Overall, these studies extrapolated that the salinity-alleviation effects by RIB pretreatment relies on its ability to activate mechanisms of oxidative stress, ionic stress, and tissue tolerance.

The practical application of RIB pretreatment in agriculture holds the promise of increased food security, especially in regions where salinity stress has cast a shadow over traditional farming methods. By integrating this innovative approach into mainstream agricultural practices, this study may pave the way for a more resilient global food supply chain.