氏　　名	FARUK HOSSAIN KHAN
授与した学位	博　士
専攻分野の名称	学　術
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学位授与の要件	環境生命科学研究科　　農生命科学専攻 （学位規則第４条第１項該当）
学位論文の題目	Roles of reactive carbonyl species in salt-stressed rice （塩ストレス下のイネにおける活性カルボニル種の役割）
論文審査委員	教授　仁戸田照彦　　准教授　宗正晋太郎　　教授　中村宜督　　准教授　中村俊之

学位論文内容の要旨

This thesis has three chapters. **Chapter 1** describes the background and objectives of the research.

Chapter 2 represents the RCS scavengers, carnosine and pyridoxamine suppress the RCS accumulation. Salt stress inhibited germination of seeds and growth of roots and shoots of seedlings in salt-sensitive rice Nipponbare. Supplementation of RCS scavengers to the culture medium suppressed the germination and growth inhibition by salt stress. These results suggest that RCS is involved in the inhibition by salt stress. Salt stress-induced ROS accumulation in the rice variety Nipponbare and salt stress-induced ROS accumulation in the rice varieties. In this study, the RCS scavengers did not decrease ROS accumulation but decreased MDA levels and carbonyl protein levels in the stressed rice. These results strongly support the hypothesis that RCS is closely involved in the salt stress mechanism in rice seedlings. Taken together, the damage induced by salt stress can be attributed to RCS accumulation rather than ROS accumulation, and suppression of RCS accumulation is likely to improve salt tolerance in rice seeds and seedlings.

Chapter 3 represents the role of proline in RCS-mediated salt-stressed rice plants. we investigated the ROS, RCS production, MDA, protein carbonylation level and enzymatic activities on salt-stressed rice. Salt stress increased ROS, RCS, MDA, protein carbonylation content, and enzyme activities in rice plants in the absence of proline. Whereas exogenous proline improved the ROS, RCS production, MDA, protein carbonylation level, and antioxidant enzyme activity in rice plants (*Oryza sativa* L., cv Nipponbare) under salt-stressed rice plants. It is suggested that exogenous proline mitigates ROS, ultimately reducing the harmful effects of salt stress via increasing enzymatic activity. Proline significantly suppressed the increase in RCS, such as acrolein, HNE, (*E*)-2-Pentenal, HHE, methacrolein, acetone, acetaldehyde, propionaldehyde, crotonaldehyde, phenylaldehyde, and n-Pentenal. These carbonyls thus contributed only considerably to the NaCl-induced growth inhibition. Together these results demonstrate that in growing rice seedlings, several types of RCS were increased by salt stress, and they caused growth inhibition.

We also checked the role of proline in ROS and RCS-mediated salt-stressed rice plants. The application of exogenous proline has been studied as a stimulator for salt tolerance. Exogenous application of proline resulted in a decrease of H_2O_2, MDA, and protein carbonylation contents in the salt-stressed rice plants. The activities of superoxide dismutase (SOD), catalase (CAT), peroxidase (POX), ascorbate peroxidase (APX), dehydroascorbate reductase (DHAR), and glutathione reductase (GR) were increased by salinity. Supplementation of proline at 1 mM and 5 mM decreased CAT, POX, APX, and DHAR activity and GR activity under salinity conditions, whereas SOD activity slightly decreased. It is suggested that exogenous proline mitigates the detrimental effects of salt stress via decreasing of H_2O_2, MDA, protein carbonylation, and antioxidant enzymes. Taken together, the damage induced by salt stress can be attributed to ROS and RCS accumulation, and suppression of RCS accumulation is likely to improve salt tolerance in rice seeds and seedlings.

論文審査結果の要旨

塩ストレスは、イネを含めた多くの作物の成長を阻害する。その成長の阻害には、塩ストレスによる活性酸素種の蓄積が主な原因の一つとされてきた。また、その下流で生成する活性カルボニル種は、反応性が高く、塩ストレスの原因となる可能性がある。本研究では、イネを材料として、塩ストレス応答における活性カルボニル種の役割明らかにすることを目指した。

塩ストレスによる種子発芽と実生の成長の阻害は、活性酸素種を消去せず、活性カルボニル種のみを消去することによって軽減されることを明らかにした。また、塩ストレスによる種子発芽と実生の成長の阻害には、活性酸素種よりも活性カルボニル種が関与していることを明らかにした。さらに、活性カルボニル種の消去によって、種々の環境ストレスを軽減できる可能性が示唆された。

本研究内容は、学術的な価値のみならず、ストレスによって生成する活性カルボニル種に着目した植物（作物）生産制御のための技術の基礎となるものである。従って、本審査委員会は本論文が博士（学術）の学位論文に値すると判断した。