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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Effect of L-glutamic acid on enhancing abiotic stress tolerance through modulation of antioxidant defense system in lentil (*Lens culinaris* Medik.)

(レンズマメにおける抗酸化防御系の調整を介した非生物ストレス耐性強化に及ぼす L-グルタミン酸の効果)

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Now-a-days climatic change predicted to be a great challenge for plant production. Due to anthropogenic and natural resources, abiotic stresses such as salinity and heavy metal toxicity reduces crop production greatly. On the other hand, food demand is increasing day by day due to increase of population. To meet the demand for food of these increasing population, we need to produce more food. To sustain crop production under this stressful condition, chemical biology approach can be used as a way. In this approach, chemicals are used in plants to increase tolerance against multiple stress through stimulating the inherent tolerance mechanism in plants. Here, I conducted three experiments to figure out the potentiality of an eco-friendly chemical, L-glutamic acid in mitigating salinity stress and heavy metal toxicities in lentil seedlings.

In the first study, I treated the lentil seedlings with 110 mM salinity stress with or without 10 mM L-Glu. Results showed that, recovery from salinity stress reduced fresh weight (FW), dry weight (DW), photosynthetic pigments (chlorophylls and carotenoids) and disturbed water balance of lentil seedlings. I have also observed that salinity stress increased oxidative stress marker and disrupted antioxidant defense pathway by decreasing ascorbate (AsA) content and catalase (CAT) and ascorbate peroxidase (APX) activity, and increased Na^+ accumulation which in turn severe K^+ loss from roots of lentil. However, exogenous pretreatment of L-Glu improved phenotypic appearance by increasing plant growth and photosynthetic pigment and maintaining

water balance. Furthermore, L-Glu-Pretreatment reduced oxidative damage by modulating antioxidant defense pathway and maintained ion homeostasis by reducing uptake of Na^+ and loss of K^+.

In the second study, I conducted this experiment to determine the potential of L-Glu pretreatment in alleviating Cd-induced toxicity in lentil (*Lens culinaris* Medik.). Lentil seedlings were exposed to two doses of Cd (1 and 2 mM $CdCl_2$) with or without 10 mM L-Glu pretreatment. The results suggested that a high dose of Cd negatively affected the FW, DW, and photosynthetic pigments. Furthermore, Cd stress induced severe oxidative damage, a reduction in CAT activity and AsA content, and accumulation of Cd in both the roots and shoots. Addition of L-Glu protected the photosynthetic pigments of the lentil seedlings and thus improved the growth of the seedlings. In addition, L-Glu pretreatment enhanced the AsA content; increased the activity of enzymes such as CAT, APX, monodehydroascorbate reductase (MDHAR), and glutathione peroxidase (GPX); and reduced Cd uptake and translocation, which in turn alleviated the oxidative damage in the Cd-stressed seedlings. L-Glu regulating the uptake of Cd and reducing the oxidative stress caused by Cd toxicity indicated the potential role of this molecule. Our results suggest that pretreatment with L-Glu reduces Cd toxicity in lentil seedlings by inhibiting Cd accumulation and by reducing oxidative damage.

In the third study, I investigated how L-Glu protected lentil seedlings from oxidative stress produced by toxic level of physiologically excessive amount of Cu and allowed to survive under Cu toxicity. The results revealed that, inhibition of growth and reduction of biomass occurred in lentil seedlings associated with higher Cu accumulation and translocation from the root to shoot to leaves, when subjected to Cu. Exposure to toxic Cu also depleted photosynthetic pigments, imbalanced water content and other essential nutrients, increased oxidative stress and reduced enzymatic and non-enzymatic antioxidants. However, pretreatment of L-Glu improved phenotypic appearance of lentil seedlings, which was distinctly appeared by producing higher biomass of lentil, maintaining water balance and increasing photosynthetic pigments when exposed to toxic Cu. L-Glu also protected the seedlings from Cu-induced oxidative stress by reducing the oxidative stress marker, specifically by the efficient action of enzymatic and non-enzymatic antioxidants specially AsA, CAT, MDHAR and GPX and maintaining redox balance. Furthermore, L-Glu kept maintaining the homeostasis of Cu and other nutrient in the roots, shoots, and leaves of lentil. Collectively, our results provide evidence of the mechanism of L-Glu-mediated protective role in lentil against Cu toxicity, thus proposed as a potential chemical for controlling Cu toxicity not only in lentil but also other plants.