（第３号様式）(Form No. 3)

学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation Physiological and Biochemical Mechanisms of Polyamines-Induced Abiotic Stress Tolerance in Mung Bean (*Vigna radiata* L.): Study on Osmoregulation, Ion Homeostasis, Metal Detoxification, Antioxidant Defense and Glyoxalase Systems
（ヤエナリにおいてポリアミンにより誘導される非生物的ストレス耐性の生理・生化学的メカニズム：浸透圧調節、イオン恒常、金属解毒、抗酸化防御およびグリオキサラーゼ系に関する研究）

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The physiological roles of PAs (putrescine, Put; spermidine, Spd; and spermine, Spm) were investigated for their ability to confer abiotic stress tolerance in mung bean seedlings (*Vigna radiata* L. cv. BARI Mung-2). Salinity, drought, high temperature, low temperature, metal (cadmium and aluminium) toxicity stresses disrupted antioxidant defense system which caused oxidative damage as indicated by increased lipid peroxidation, H_2O_2 content, $O_2^{\bullet -}$ generation rate, and lipoxygenase activity. Salinity-induced methylglyoxal toxicity was also clearly evident. Salt (200 mM NaCl, 48 h) resulted in Na toxicity, decreased K, Ca, Mg, and Zn contents in roots and shoots. Exogenous PAs (putrescine, spermidine, and spermine) application reduced cellular Na content and maintained nutrient homeostasis and modulated endogenous PAs levels in salt affected mung bean seedlings. Supplementation of salt affected seedlings with exogenous PAs enhanced the contents of glutathione (GSH) and ascorbate (AsA), increased activities of antioxidant enzymes (dehydroascorbate reductase, DHAR; glutathione reductase, GR; catalase, CAT and glutathione peroxidase, GPX) and glyoxalase enzyme (glyoxalase II), which reduced salt-induced oxidative stress and methylglyoxal (MG) toxicity, respectively. Spermine (Spm, 0.2 mM) application enhanced mung bean (*Vigna radiata* L. cv. BARI Mung-2) seedlings tolerance to high temperature (HT, 40°C) and drought [induced by 5% polyethyleneglycol (PEG)]. Spermine

pretreatment maintained the AsA and GSH level high, upregulated the activities of superoxide dismutase (SOD), CAT, GPX, DHAR and GR which was vital for imparting ROS-induced oxidative stess tolerance under HT and/or drought stress. The cytotoxic compound MG was overproduced due to HT and/or drought but exogenous Spm pretreatment reduced MG toxicity enhancing the glyoxalase system. Spermine pretreatment modulated endogenous PAs levels. Osmoregulation and restoration of plant water status was other major contribution of Spm under HT and/or drought stress. Different doses of Cd (containing 1mM and 1.5 mM $CdCl_2$) significantly increased toxicity symptoms in mung bean seedlings. Exogenous Spm (0.25 mM) reduced Cd content in shoot and root, and decreased the subsequent toxic effects. Cross-protection roles of putrescine (Put, 0.2 mM) and nitric oxide (sodium nitroprusside; SNP, 1 mM) in conferring Cd ($CdCl_2$, 1.5 mM) tolerance in mung bean. Putrescine or nitric oxide application reduced root and shoot Cd content. Put and/or SNP reduced Cd uptake, increasd phytochelatin content, reduced oxidative damage enhancing non-enzymatic antioxidants (AsA and GSH) and activities of enzymes (SOD, CAT, GR, glutathione *S*-transferase (GST), and glutathione peroxidase, GPX). Exogenous Put and/or SNP modulated endogenous polyamine, PAs (putrescine, Put; spermidine, Spd; spermine, Spm), and NO; improved glyoxalase system in detoxifying MG Moreover their combined application decreased the Cd content more and rendered better growth. Exogenous Spd (0.3 mM) played roles in alleviating Al ($AlCl_3$, 0.5 mM, 48 h and 72 h) toxicity stress. Exogenous Spd increased AsA and GSH content, ratio of ascorbate and dehydroascorbate (AsA/DHA), ratio of glutathione and glutathione dissulfide (GSH/GSSG), activity of APX (ascorbate peroxidase), DHA, GR and CAT which reduced reactive oxygen species production and oxidative stress under Al stress. Spd-induced improvement of GSH pool and Gly II activity alleviated injurious effects of MG. Polyamine played crucial roles in improving antioxidant and glyoxalse system to alleviate reactive oxygen species and MG-induced oxidative stress under different abiotic stress conditions. The overall tolerance

was reflected in improved tissue water and chl content, and better seedling growth in PAs supplemented mung bean plants under different abiotic stresses.