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Dynamic Effects of Silicon in Rice Plants under Various Stress Conditions

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[Introduction]

In spite of silicon (Si) is second most abundant element in soil, various plant species showed significantly different Si uptake on their body. For this reason, many scientists believed that Si could induce physiological reponses in restricted plant species such as rice, barley, and wheat before identifying Si transport gene. In 2007, Japanese research team reported Si transport genes (Lsi1 and Lsi2) in rice plant. These two genes are located in rice root (exodermis and endodermis) and are involved in Si influx and efflux. Since identification of Si transport gene, we can figure it out how Si can transport from soil to plant. Moreover, recently developed Si mutant plant can facilitate evaluation of Si effect on hormones regulation, scavenge of reactive oxygen species (ROS) and reactive nitrogen species (RNS). In this study, we focused on how Si can mitigate various abiotic stress condition such as mechanical wounding, salinity and heavy metal stress.

[Materials and Methods]

Various concentration of Si (sodium metasilicate Na_2SiO_3) applied to hydroponically growing rice plant for short terms (6 h, 12 h and 24 h). After that, we harvested plant samples for analyzing element uptake, plant hormones, antioxidant activity and concern genes responses. All physiological, biochemical and genetic data were collected from fresh rice samples.

[Results and Discussions]

Silicon application induced inhibition of Ca uptake in leaf of rice plants as compared to non-Si treated plant. In particular, third leaf of rice plant revealed that increasing Si concentration induced a decrease of Ca uptake. Moreover, Si application can induce significant increase bio-active GA_1 level in comparison with non-Si treated rice plants. Based a forementioned results, we applied Si to rice plant growing under abiotic stress conditions (mechanical wounding, salinity and heavy metal). Decreased endogenous ethylene production and jasmonic acid (JA) contents were observed in comparison with non-Si treated rice plants. During salinity stress condition, Si treated rice plants showed more increased abscisic acid (ABA) contents in comparison with non-Si treated rice plant. Silicon application to rice plant growing at heavy metal stress conditions (Cd and Cu) also mitigated heavy metal induced stress conditions by regulating metal transport genes (HMA2 and HMA3) located in rice roots.

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