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Chemical analysis in a silicon uptake-deficient mutant lsi1 of rice

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A rice mutant lsi1 accumulates less silicon in the shoots than a wild type rice (cv. Oochikara). The mutant lsi1 and the wild type were planted in seedling cases, lignin contents in leaf and stem tissues were determined with Klason method. Lignin contents in leaves and stems of lsi1 were higher than those of the wild type. Lignin contents in leaves and stems of lsi1 planted in silicon addition soil (Si+) were lower than those in control soil (Si-). These results suggested that silicon accumulation in rice might have a negative influence on the deposition of lignin and formation of the secondary cell walls, and thus it affected mechanical strength of rice.

INTRODUCTION

Rice (Oriza sativa L.) is the most effective silicon accumulating plant. Silicon absorbed in rice tissues contributes to enhance their strength, hardness, and resistance to disease and insects. The rice mutant lsi1 (low silicon rice 1) was isolated from sodium azide-treated seeds of a wild type rice (cv. Oochikara). This mutant accumulates less silicon in the shoots than the wild type. The gene (Lsi 1) was predicted to encode a membrane protein which controls silicon transport in rice. Molecular and physiological studies of the mutant lsi1 have contributed to clarify the silicon accumulation system and the biotic resistance role such as pests and disease. Mechanical strength of rice is an important trait that affects grain yield and quality. The trait is associated with the contents of lignin, cellulose, hemicellulose, and silicon. However, it is unknown that correlation of quantity and quality between lignin and silicon in rice tissues. In this study, we compared lignin contents between the rice mutant lsi1 and the wild type to understand the mechanism controlling the mechanical strength.

RESULTS AND DISCUSSIONS

The wild type and lsi1 were planted in 6.1 kg of soil with 400 g of silica gel (Si+) and without silica gel (Si-: control soil) in seedling case. The leafs and stems were ground into powder by a Wiley mill. The powder (40-80 mesh) was extracted with a mixture of ethanol-benzene (1:2, v/v) for 6 h in Soxhlet extractors. The defatted powder was treated with pepsin to remove proteins. The amounts of lignin in the leaves and stems of the wild type and lsi1 were determined by Klason method. The ash was determined with a muffle furnace at 600C. In control soil (Si-), the lignin contents in leaves and stems of the mutant lsi1 were 17.6% and 19.4%, respectively, whereas those of the wild type were 14.2% and 16.6%, respectively. The lignin contents in leaves and stems of lsi1 were higher than those of the wild type. In silicon addition soil (Si+), the lignin contents in leaves and stems of lsi1, and those of the wild type were 14.7%, 18.0%, 12.1% and 14.4%, respectively. The lignin contents in lsi1 and the wild type planted in the silicon addition soil (Si+) were lower than those in the control soil (Si-). The amount of ash in the leaves and stems of both the wild type and lsi1 were determined. In the control soil (Si-), the ash contents in leaves and stems of the wild type were 11.5% and 5.68%, respectively. The mutant lsi1 contained little amount of silica in leaves and stems compared with the wild type ($<$ 2.0%). In the silicon addition soil (Si+), the ash content in leaves and stems of the wild type were about 2 fold higher than those in the control soil (Si-). While the ash contents of lsi1 were also increased than those in the control soil (Si-), the content in leaves and stems were ca 5% in silicon addition soil (Si+). Nakata et al. reported that silicon accumulation in the wild-type leaves cultivated with silicon amendment (Si+) was enhanced over three-fold compared with that the control. These results suggested that silicon accumulation in rice might have a negative influence on the deposition of lignin and formation of the secondary cell walls, and thus it affected mechanical strength of rice.

Keywords: lignin, silicon, lsi1