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Effect of Exposure Levels and Exposure Time on Subcellular Distribution of Cadmium in Indian Mustard (*Brassica juncea*)

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英文关键词：cadmium subcellular distribution exposure time exposure levels Inductively Coupled Plasma-Mass Spectrometry Scanning Transmission Electron Microscopy

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中文摘要：

超积累植物对重金属的区隔化作用能有效降低细胞质内金属离子的浓度，是对重金属重要的解毒机制之一，而细胞内各组织的区隔化作用大小并未取得一致性结论。本文研究了胁迫浓度和胁迫时间对超积累植物印度芥菜（*Brassica juncea*）细胞及亚细胞中镉分布的影响。印度芥菜幼苗分别用0.5、1.0、2.0、3.0、5.0 mg/L镉胁迫1、5、7、10、14天后收获，采用电感耦合等离子体质谱法测定印度芥菜根系和叶片亚细胞中镉的含量。结果表明：镉在细胞壁中的比例占50%~64%，细胞液占22%~38%，细胞器占7%~17%，镉在细胞壁中所占比例显著高于细胞液和细胞器，证明细胞壁区隔化在镉的解毒机制中具有重要的作用。随着胁迫时间和胁迫浓度的增加，根系和叶片中亚细胞各组织中镉含量持续增加，超过7天，镉含量显著升高，说明镉对植物的危害是一个缓慢过程。印度芥菜对镉胁迫浓度的最大耐受量为1.0 mg/L，超过此浓度，植物细胞的破坏症状加重；细胞超微结构研究也表明，镉胁迫浓度超过1.0 mg/L后，细胞结构发生了不同程度的损坏，出现质壁分离、液泡增大甚至空泡化、质膜粗糙等现象，进而影响到细胞的正常功能。因此，在考察重金属对植物的危害时，要充分考虑时间和浓度梯度两个参数的协同作用。

英 文 摘 要：

Segmentation effect of super accumulation of heavy metals in plants which can reduce the concentration of metal ions in the cytoplasm of a cell is one of the important mechanisms of heavy metal detoxification. However, the compartmentalization effect from different tissues of a cell does not get a consistent conclusion. In order to evaluate whether intracellular compartmentalization could explain Cd detoxification mechanisms, the work described in this paper was designed to study the effect of exposure time and levels on Cd distribution of Indian mustard (*Brassica juncea*) at the cell and sub-cell level. Root and leaf samples were exposed to 0.5, 1.0, 2.0, 3.0 and 5.0 mg/L and harvested after 1, 5, 7, 10 and 14 days exposure. Cells were separated into three fractions: cytoderm, soluble fraction and organelle containing fraction using differential centrifugation technique, then Cr from all three fractions was determined by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Results showed that Cr in cytoderm, cytoplasm and organelles accounted for 50%-64%, 22%-38% and 7%-17% of total cadmium, respectively. It can be clearly indicated that the proportion of Cr in cytoderm is significantly higher than that in cytoplasm and organelles, indicating that compartmentalization of cytoderm plays a prominent role in Cd detoxification. As the exposure concentration and time increases, the content of Cd in cell fraction increases significantly especially after 7 days, which demonstrates that the effect of Cd on plant development is a slow process. Moreover, the excess of Cr stress concentration (>1.0 mg/L) would lead to deteriorative damage on plant cells, which was visually identified by TEM research, demonstrating different degrees of damages-plasmolysis, vacuolization and plasmalemma roughness, thus affecting the normal function of cells. These results suggest exposure time and levels are important parameters that must be taken into consideration in the study of the toxicity of heavy metals in plants.

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