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论文

铝胁迫下大豆根尖细胞铝的微区分布与耐铝性分析

俞慧娜，刘鹏*，徐根娣，蔡妙珍

浙江师范大学植物学实验室，浙江金华321004

摘要：

以浙春3号为实验材料, 利用透射电镜(TEM: Transmission Electron Microscope)-X-射线能谱(EDS: Energy Dispersive X-ray), 调查铝胁迫下大豆根尖铝的微区分布及耐铝性。结果表明，Al^{3+}胁迫导致根尖细胞细胞壁不规则加厚, 线粒体数量增多, 核膜膨胀, 液泡中存在较多的电子致密沉淀物。90 mg L^{-1} Al^{3+}处理的根尖细胞内含物完全降解消失, 仅剩细胞壁。10 mg L^{-1} Al^{3+}处理的线粒体、细胞壁和液泡电子致密沉淀物中均检测到Al；随着Al^{3+}处理浓度的增大, 各细胞器中Al的质量和原子数百分比逐渐增大。线粒体在60 和90 mg $L^{-1}Al^{3+}$处理下, 液泡电子致密沉淀物在90 mg $L^{-1}Al^{3+}$处理下，均未被检测出Al。在60 mg $L^{-1}Al^{3+}$处理下唯一一次在细胞核中检测到Al。Al^{3+}抑制了根系生长, 根系细胞中细胞壁的Al^{3+}含量受影响最明显。P/Al在细胞壁和线粒体中的相对原子数随Al^{3+}浓度的增大而下降。研究结果表明X–射线能谱对铝在亚显微结构上的定位是一种快速、有效的方法。铝最先积累在细胞壁上, 随Al^{3+}处理浓度增大逐渐积累于部分细胞器和细胞核中, 且含量在细胞中的分布亦由外向里呈递减趋势。

关键词： 铝胁迫 大豆 根类细胞 透射电镜-X-射线能谱分析 根系生长

Distribution of Al^{3+} in Subcellular Structure of Root Tips Cells and Aluminum Tolerance in soybean

Key laboratory of Botany,Zhejiang Normal University,Jinhua321004,China

Key laboratory of Botany,Zhejiang Normal University,Jinhua321004,China

Abstract:

Aluminum(Al) toxicity is a major limiting factor for yield and quality in crop production in acid soil. Micromolar concentrations of Al^{3+} may inhibit root elongation and consequently influence water and nutrient uptake, resulting in poor plant growth. The microanalysis of the elements was conducted on Zhechun 3 by using Transmission Electron Microscope (TEM) and Energy Dispersive X-ray (EDS) to examine the distribution of Al^{3+} in root tips and Al resistance of soybean. We found that Al^{3+} stresses resulted in irregularly thickened cell wall, increased number of mitochondria, expanded nuclear membrane, and densified precipitates of vacuole. Under the highest Al^{3+} concentration, the mitochondria and other organelles disappeared but cell wall. We detected Al in cell wall, mitochondria and electron-dense precipitates of vacuole of root tip cell under the 10 mg $L^{-1}Al^{3+}$ stresses by EDS. With the increase of external Al^{3+} concentration treated, the weight and atomic percentage of Al in the organelles increased. The Al^{3+} was found in nuclei when the external Al^{3+} was over 60 mg L^{-1}. And there was no Al^{3+} in mitochondrion under 60 mg L^{-1} and 90 mg $L^{-1}Al^{3+}$ treatments and electron-dense precipitates of vacuole under the 90 mg L^{-1} Al^{3+} stresses. The 14 days Al^{3+} stresses significantly inhibited the growth of root system. The content of Al^{3+} in cell wall was most significantly impacted by the external Al^{3+} concentration. The atomic number of P / Al in cell wall and mitochondria decreased with increased Al^{3+} content. EDS can be used to determine the subcellular location of Al^{3+}. As the treatment concentrations of Al^{3+} increased, Al^{3+} primarily accumulated in the cell wall, gradually gathered in part of the organelles and nuclei. The Al^{3+} concentrations also decreased from out layer to insider in the cell.

Keywords: Al^{3+} stresses Soybean Root tip cell Transmission Electron Microscope-Energy Dispersive X-ray Analysis Root growth

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通讯作者: 刘鹏 E-mail:sky79@zjnu.cn

作者简介:

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