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Aluminum stress signaling in plants.

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Abstract

Aluminum (Al) toxicity is a major constraint for crop production in acidic soil worldwide. When the soil pH is lower than 5, Al(3+) is released to the soil and enters into root tip cell ceases root development of plant. In acid soil with high mineral content, Al is the major cause of phytotoxicity. The target of Al toxicity is the root tip, in which Al exposure causes inhibition of cell elongation and cell division, leading to root stunting accompanied by reduced water and nutrient uptake. A variety of genes have been identified that are induced or repressed upon Al exposure. At tissue level, the distal part of the transition zone is the most sensitive to Al. At cellular and molecular level, many cell components are implicated in the Al toxicity including DNA in nucleus, numerous cytoplastic compounds, mitochondria, the plasma membrane and the cell wall. Although it is difficult to distinguish the primary targets from the secondary effects so far, understanding of the target sites of the Al toxicity is helpful for elucidating the mechanisms by which Al exerts its deleterious effects on root growth. To develop high tolerance against Al stress is the major goal of plant sciences. This review examines our current understanding of the Al signaling with the physiological, genetic and molecular approaches to improve the crop performance under the Al toxicity. New discoveries will open up new avenues of molecular/physiological inquiry that should greatly advance our understanding of Al tolerance mechanisms. Additionally, these breakthroughs will provide new molecular resources for improving the crop Al tolerance via molecular-assisted breeding and biotechnology.

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