The effect of aluminium on apoplastic and cytoplasmic proteins in root tips of maize

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Introduction

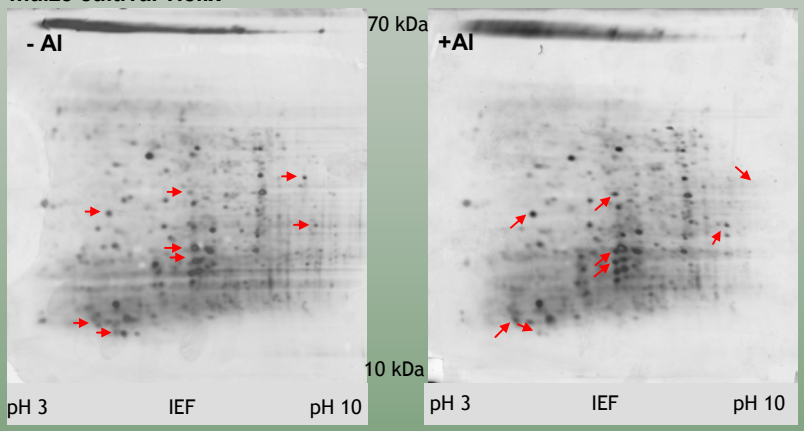
Aluminium is the one of the major factors limiting plant growth and crop yield on acid soils. The first symptoms of Al toxicity are the inhibition of root elongation and the induction of callose synthesis. The Al sensitive root zone is the DTZ (distal transition zone) the zone 2 to 3 mm from the root tip. The most likely target of Al is the apoplast, were it is supposed to exert its toxic effect through interaction with the negativ charges of the cell wall and plasma membrane. This interaction then leads to physiological changes in the cells. There is evidence that a disturbance of cytplasmic Ca^{2+} homeostasis is a primary mechanism of Al toxicity.

Materials and Methods

A fractionated extraction of proteins was performed from the root tips (1cm) of maize. The fractions of cytoplasmic and cell wall bound proteins were separated through 2D-IEF/SDS PAGE. Proteins differing in their expression after short term Al treatment (4 h) were identified through MALDI-TOF/MS.

Results

2D-IEF/SDS PAGE separation of proteins of the root tip of the Al sensitive maize cultivar Helix



Proteins that show a changed expression after 4 h Al treatment

Proteins with increased expression
Calreticulin
Protein kinase C inhibitor
Endo-1,3-1,4-β-D-glucanase precursor
α-1,4-glucan-protein synthase
Alcohol dehydrogenase
Proteins with decreased expression
Monocot -glucosidase
Heat shock protein cognate 70
ATP-synthase β-subunit
Sucrose synthase

Proteins with increased expression
Malat dehydrogenase
Putative malate dehydrogenase
Heat shock protein 70 kDa

In the Al tolerant maize cultivar ATP-Y several proteins show a changed expression after 4 h Al treatment

Conclusions

Results from the tolerant cultivar, which is known to excrete citrate as its major tolerance mechanism, show an increase in malate dehydrogenase. This could increase the concentration of a precursor of citrate.

The sensitive cultivar, which does not excrete organic acids, experiences Al toxicity. Zhang and Rengel (1999) showed that an increase in cytosolic Ca^{2+} is one effect of Al. This effect can possibly be ameliorated through an increased expression of Calreticulin, a Ca binding protein, and an inhibitor of protein kinase C, a protein, which is activated by Ca.

Literatur: Zhang and Rengel, Aust. J. Plant Physiol. 1999,26,401-409