Cell-wall composition modulates aluminium toxicity

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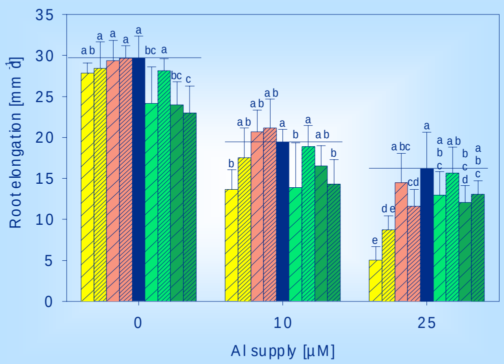
Introduction

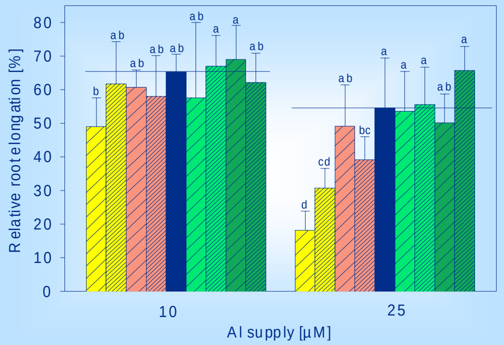
Aluminium primarily affects root growth by interfering with processes decisive for the regulation of growth in the root apex. The mechanism of Al-induced inhibition of root growth and the reasons for the spatial differences in Al sensitivity between apical root zones are still not well understood. Over the last years, evidence has been accumulated supporting the hypothesis that the root apoplast plays an important role in the expression of Al toxicity and Al resistance.

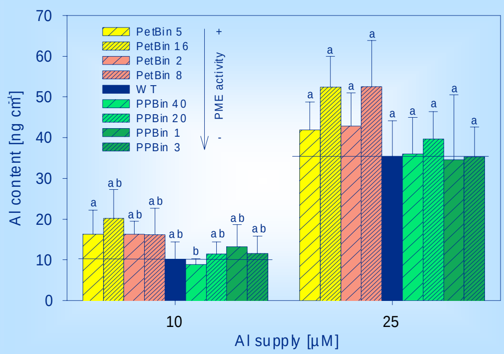
To investigate the role of the cell wall for the expression of Al toxicity we used plant species of different cell wall types and transgenic potato plants differing in the degree of expression of pectin methylesterase (PME).

Results

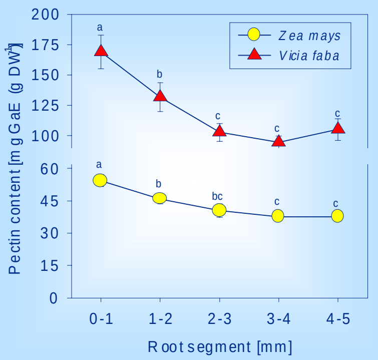
Relative root elongation was more inhibited and Al contents higher in lines overexpressing PME than in the wildtype and antisense lines. This indicates that lines overexpressing PME are more Al-sensitive than the WT while antisense inhibition had almost no effect on Al-sensitivity.

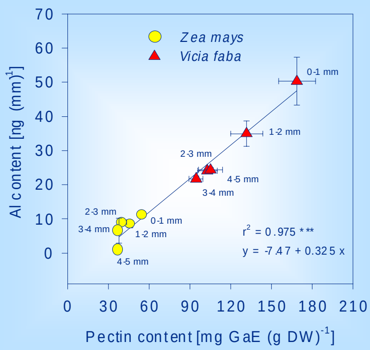


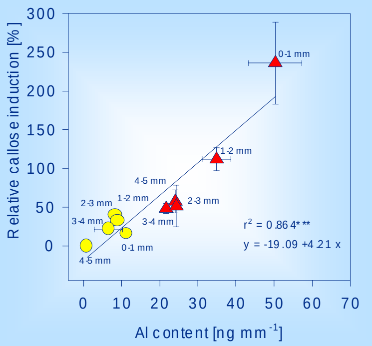




Root tips of *Zea mays* and *Vicia faba* show a tip to base gradient in pectin contents which is reflected in Al contents and Al-induced callose formation indicative of Al injury.

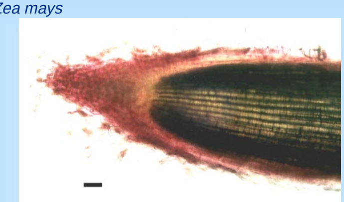




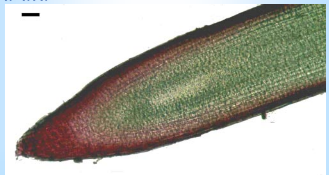


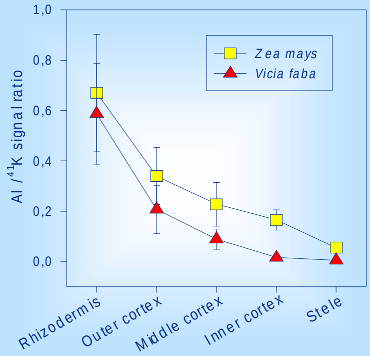
Pectin with low degree of esterification (red staining indicating negative charges of pectins) is more abundant in *Vicia faba* than in *Zea mays*. The radial distribution of Al in the root tip is steeper in *Vicia faba* indicating higher retention of Al in the outer cell layers where pectin with low degree in esterification is located.

Zea mays



Vicia faba





Conclusions

The root-tip content of pectin and its degree of methlation modify Al toxicity.

Material and Methods

Seeds of maize (*Zea mays* cv Helix) and broad bean (*Vicia faba* cv Herz Freya) were germinated between filter paper. For the experiments plants (10 d old) were incubated for 2 h in nutrient solution with 50 µM $AlCl_3$ or 10 µM digitonin. Aluminium and pectin contents of each 1 mm segment were determined. Radial distribution of Al was investigated *via* Laser Microprobe Mass Analysis (LAMMA). Potato plants (*Solanum tuberosum* cv. Desiree) and its transgenic lines overexpressing or antisense-inhibited in pectin methylesterase (PME) were provided by J. Fisahn (MPI Golm, Germany). Plants were treated in nutrient solution for 24 h at pH 4.3 ± Al. Coefficients of determination from regression analysis are given according to their level of significance as ***, ** or * for p< 0.001, 0.01 and 0.05, respectively.

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