Modification of cell-wall properties through silicon: effect on aluminium resistance of maize

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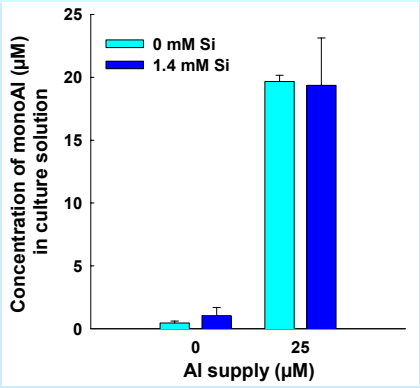
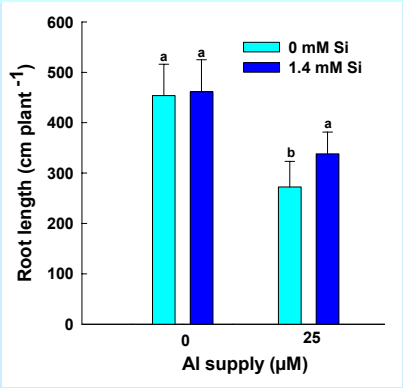
Introduction

Aluminium toxicity is one of the main factors limiting plant growth on acid soils. An ameliorative effect or no effect of Si on Al resistance has been reported. The alleviating mechanism was suggested to be based on two aspects: solution chemistry and an in-planta mechanisms (Cocker et al., 1998). The Si effect has not been studied in relation to the Al and Si distribution in the root apices of plants, the main and most sensitive sites of Al injury in maize (Sivaguru and Horst, 1998). Particular emphasis was layed on the root apoplast, since Al was expected to accumulate primarily in the apoplast.

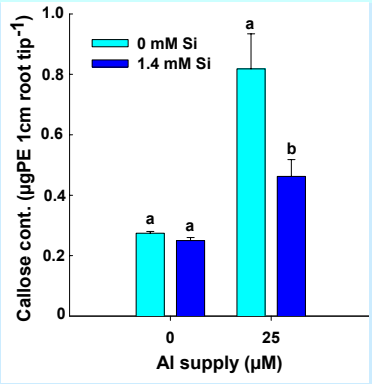
Results



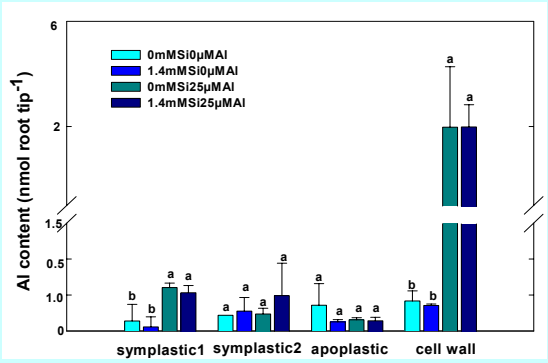
Si treatments did not influence the availability of phytotoxic Al in the culture solution.



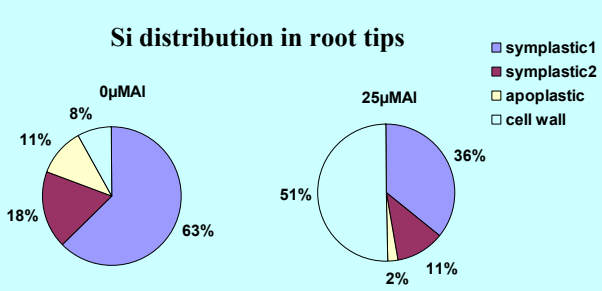
Si increased the total root length in plants treated with Al



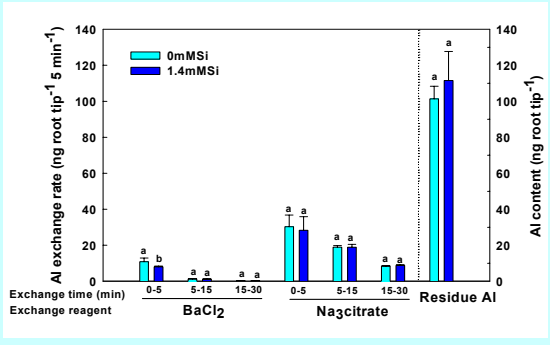
Si-treated plants produced less callose than untreated plants under Al toxic conditions.



85% of the Al in the root tip was located in the cell wall. Si did not affect Al distribution.



Al treatment enhanced Si accumulation in the cell wall.



The amount of the readily exchangeable Al from the apoplast is lower in Si-treated plants.

Conclusion

Based on root length and callose formation, silicon can ameliorate Al toxicity in maize in planta. The cell wall of root tips is likely to be the main compartment where the amelioration of Al toxicity by Si takes place. Silicon did not reduce Al uptake of the root tip, but modified Al binding to the cell wall of the root tips .

Material and methods

3 day old seedlings of an Al-sensitive maize cultivar, Lixis, were grown in culture solution containing 500 µM $CaCl_2$ and 8 µM H_3BO_3 with or without 1.4 mM H_4SiO_4 supply for 36 hours. Then plants were exposed to 0 and 25 Al for 12 hours (44 hours for root growth). At harvest, 1 cm root tips were excised for Al, Si, and callose analysis. The apoplastic and symplastic (after defreezing) sap of the root tips was collected by centrifugation. Exchangeable Al was extracted from the pellet on Millipore. The root length was measured using Win/Mac Rhizo 2002. Root Al content was determined by GFAAS after wet digestion. Monomeric Al concentrations of the culture solution were determined colorimetrically. Si content was determined colorimetrically after acid extraction.

Literature: 1. Sivaguru and Horst (1998) Plant Physiol. 116, 155-163 2. Cocker et al. (1998) Physiol. Plant. 104, 608-614