Aluminium-induced exudation of citrate from the root tip of *Zea mays* (L.): Are differential impacts of Al on citrate metabolism involved in genotypical differences?

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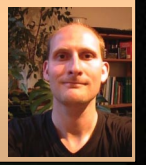

INTRODUCTION

The exudation of organic acid anions has frequently been shown to mediate aluminium (Al) resistance in various crop species. In a number of experiments a positive correlation between the exudation rate from root tips and Al resistance has been demonstrated. While the organic acid-anion release is mediated through anion channels, rather little is known about the role of the carboxylic acid metabolism in Al resistance. Hence, in this study we examined the possible role of the citrate metabolism in Al resistance of maize cultivars particularly considering differences between apical root zones.

MATERIALS & METHODS

Seeds of the maize (*Zea mays* L.) cultivars ATP-Y (Al-resistant) and Lixis (Al-sensitive) were germinated in filter-paper rolls moistened with tap water for 3 days in a growth chamber under controlled environmental conditions (16 / 8 h day / night cycle, 30 / 26 °C, 70 % air humidity, 300 µmol m^{-2} s^{-1} photon flux density). Excised apical 1-mm segments were incubated for 3 h in incubation solution containing 50 µM $AlCl_3$, pooling segments from 52 roots as one replicate. Organic acid anions exuded into the medium were detected by HPLC. Citrate contents were analysed in apical 1-mm root segments after incubation of intact root apices for 2 h in an agarose gel (0.6 % [w/v]) containing nutrient solution ± 90 µM monomeric Al (pH 4,3). Specific activities of citrate synthase (CS), NAD-malate dehydrogenase (MDH), Phosphoenolpyruvate carboxylase (PEPC) and aconitase (ACO) were analysed in apical 1-mm segments, pooling the specific segments of 17 roots as one replicate.

RESULTS

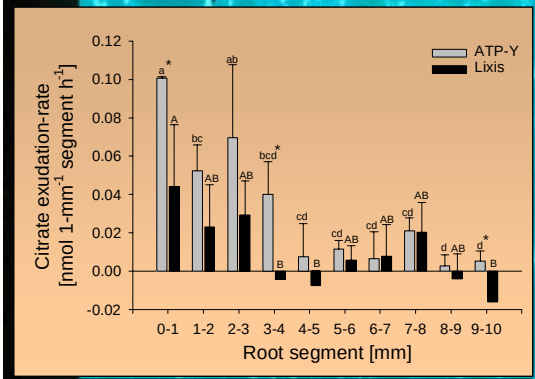

Fig. 1: Aluminium-induced exudation of citrate was mediated exclusively through the apical 4 mm of the primary root.

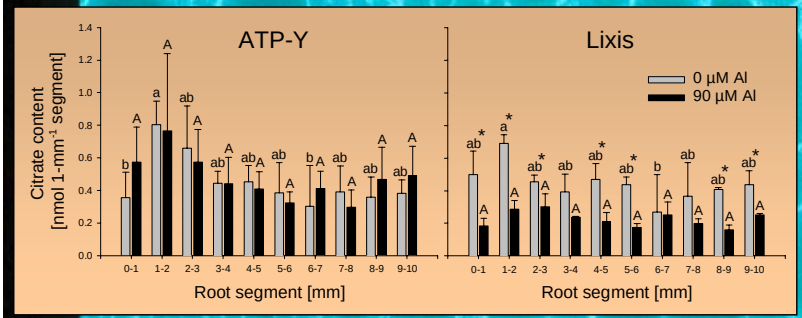

Fig. 2: Aluminium led to a significant decrease in the root apical citrate contents in the Al-sensitive cultivar Lixis, whereas the citrate contents in the Al-resistant cultivar ATP-Y were not affected.

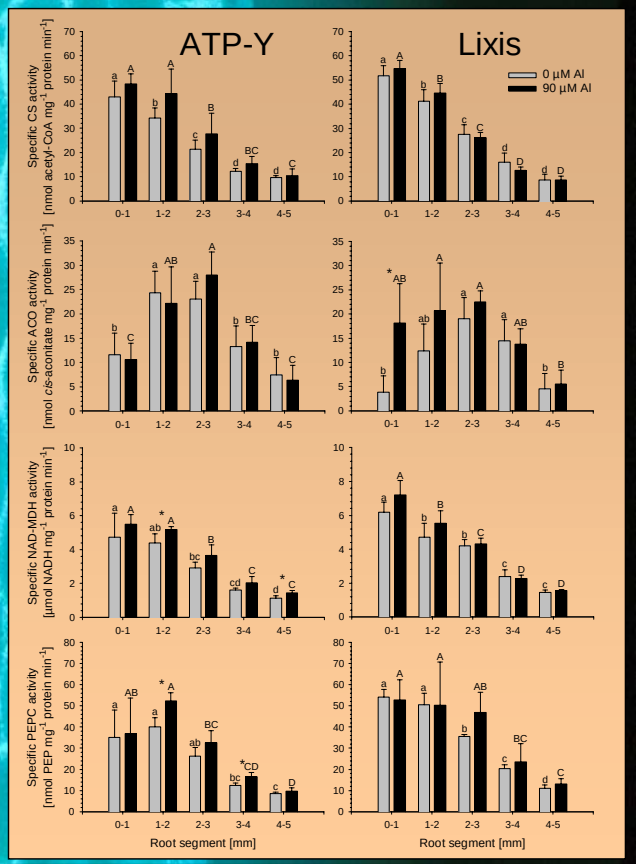

Fig. 3: The specific activities of enzymes of the carboxylic acid metabolism in the root apex were affected by Al differently in the 2 maize cultivars.

CONCLUSIONS

The results presented here clearly demonstrate the confinement of the Al-induced citrate release to the apical 4 mm of the maize root apex. They furthermore suggest that differential maintenance of citrate metabolism upon Al exposure contributes to genotypical differences in the citrate exudation-mediated Al resistance in *Zea mays* (L.).

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