Effects of heterogeneous Al and P supply on root growth and screening of maize cultivars differing in Al resistance

L. Collet* and W. J. Horst

Universität Hannover I.f.l

Institute of Plant Nutrition, University of Hannover, Herrenhäuser Str. 2, D-30419 Hannover, Germany

*Email: Lutz.Collet@t-online.de

INTRODUCTION

For velvet bean (*Mucuna pruriens*) grown in hydroponics with a split-root system, Hairiah *et al.* (1993) showed that *Mucuna* was Al-resistant when the whole root system was exposed to homogeneous Al supply. However, when Al was supplied to only one part of the root system roots avoided Al by preferential development of roots not in contact to Al, accompanied by marked inhibition of roots exposed to Al. This reaction was not observed at high P supply. Since screening for Al resistance using young seedlings is conducted in homogeneous nutrient solution (Horst *et al.* 1997) a possible Al-avoidance mechanism might lead to erroneous the classification of cultivars in Al resistance. The objective of this study was to determine, if an Al-avoidance reaction is expressed by maize seedlings when one part of the root system is exposed to Al.

MATERIAL & METHODS

Experiments were conducted with 9-day old seedlings of the maize cultivars Lixis (Al-sensitive) and BR201 M (Al-resistant), precultured at a P concentration of 1 µM, in order to reduce P reserves in the kernel. At the start of the experiment two P concentrations (1 µM, 25 µM) and two Al concentrations (0 µM, 10 µM) were applied using a split root system (Fig. 1). After 4 days, root elongation, root dry weight and callose formation in root tips were measured.

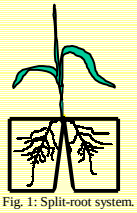

Fig. 1: Split-root system.

RESULTS

Al application decreased root elongation irrespective of P supply (Fig. 2). The Al-sensitive cv. Lixis was more affected than Al-resistant cv. BR201M. Root elongation was enhanced at low P supply compared to high P supply. Independent of P levels, a compen-satory root elongation for either cv. or an Al-avoidance reaction in root elongation for the Al-resistant cv. could not be found.

Callose formation, a marker for Al injury was enhanced up to 12-fold in Al-exposed root apices in the Al-sensitive cv. and 3-fold in the Al-resistant cv. (Fig. 3). Callose formation at the Al-exposed side of the Al-resistant cultivar BR201M did not reveal enhanced Al injury when part of the root system was not exposed to Al.

A significant effect was observed in root dry matter (Fig. 4) which was enhanced on the Al-free side for the Al-sensitive cv. Lixis, especially at high P supply, indicating compensatory growth. No such reaction was found for Al-resistant cv.BR201M.

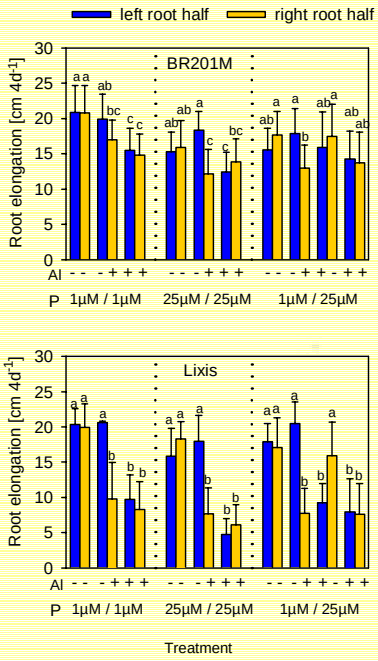

Fig. 2: Influence of a varying Al and P supply on root elongation of an Al-resistant (BR201M) and Al-sensitive (Lixis) maize cultivar.

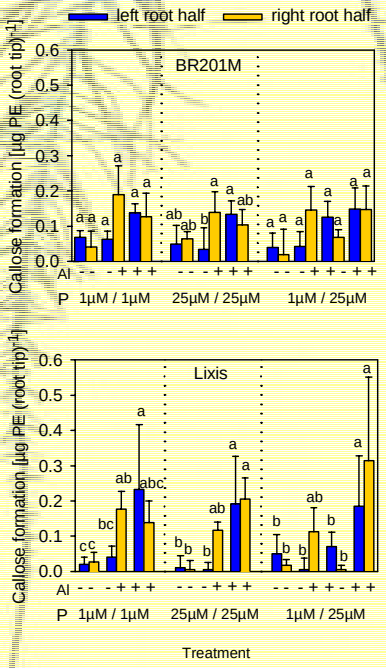

Fig. 3: Influence of a varying Al and P supply callose formation of an Al-resistant (BR201M) and Al-sensitive (Lixis) maize cultivar.

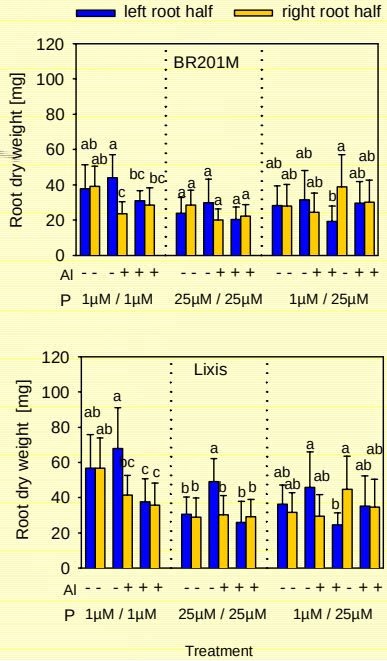

Fig. 4: Influence of a varying Al and P supply on root dry matter of an Al-resistant (BR201M) and Al-sensitive (Lixis) maize cultivar.

CONCLUSIONS

- No Al avoidance mechanism was found in young maize seedlings to medium-term Al treatment. Screening for adaptation to acid Al-toxic soils appears not to be limited using homogeneous Al supply to the entire root system.
- Compensatory root growth was expressed on the basis of root dry matter production when roots were subjected to inhomogeneous Al supply especially in the Al-sensitive cultivar. This may explain why some Al-sensitive cultivars grow better than expected on acid soils inhomogeneous Al supply.

LITERATURE

Hairiah, K., Van Noordwijk, M., Stulen, I., Meijboom, F. W., and Kuiper, P. J. C. (1993): Phosphate nutrition effects on aluminium avoidance of *Mucuna pruriens* var. *utilis*. *Environ. Exp. Bot.* **33**, 75-83.

Horst, W. J., Püschel, A.-K., and Schmohl, N. (1997): Induction of callose formation is a sensitive marker for genotypic aluminium sensitivity in maize. *Plant and Soil* **192**, 23-30.

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