Characterisation of maize cultivars in their adaptation to acid soils on the single plant level

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INTRODUCTION

In most acid soils, Al is the most growth and yield limiting factor. An economically and environmentally acceptable alternative to overcome this problem is to develop plants tolerant to subsoil acidity. Aluminium-induced callose formation has been proposed as a marker of Al sensitivity in maize. However, it often has been proved difficult to establish correlations between results obtained in complete nutrient solutions and soil studies.

MATERIAL & METHODS

Seeds were sown into paper beakers filled with peat substrate and sealed with a wax layer at the bottom. Roots penetrated the wax layer into plastic boxes (22 L) filled with nutrient solution of low ionic strength. Eight days after sowing, concentrations of 0 µM or 25 µM Al were added to the nutrient solution (pH = 4.3). After 12 h of Al treatment, callose formation was determined as described by Horst *et al.* (1997). Thereafter, seedlings without Al supply were transplanted (Fig.1) to a non-acid site, those treated with Al to an acid Al-toxic site in Colombia. At maturity, the grain yield, above-ground dry matter, plant and ear height were determined.

Maize seedlings in hydroponics

Transverse section of paper beaker

Transplanting

Transplanted maize on an acid soil at maturity

Fig.1: Transplanting method.

RESULTS

Individual plants could be successfully transplanted from nutrient solution into the field after sampling for Al-induced callose formation. Transplanting resulted in a lower plant height but did not consistently influence grain yield production (Fig. 2). Plant development was significantly reduced by soil acidity (Tab. 1). Aluminium-induced callose formation was not correlated to plant height at early stages but to overall plant development as expressed in relative grain yield and relative above-ground dry matter at maturity (Fig. 3; r = - 0.79*, r = 0.84**). The correlations found were even stronger than between root length assessed in nutrient solution and grain yield on acid soils reported for maize (Kasim *et al.*, 1990; Magnavaca and Bahia Filho, 1993).

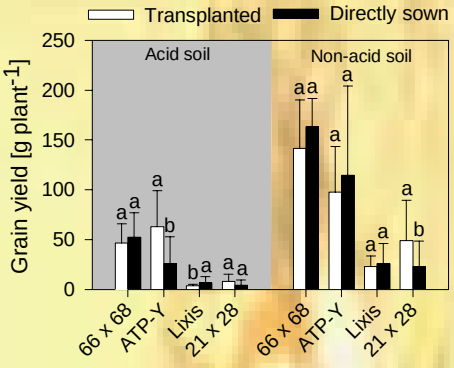

Fig. 2: Grain yield of maize cultivars trans- planted or sown to an acid and non-acid soil.

Tab. 1: Means of agronomic traits for 9 transplanted maize cultivars on an acid Al-toxic and non-acid soil.

Parameter	Non-acid soil	Acid soil
Plant height [cm]	188.4±38.2 a	110.7±30.1 b
50% silking [d]	61.8±4.8 a	72.2±8.7 b
ASI [d]	0±1.8 a	2.3±2.7 b
Ear height [cm]	100.3±30.4 a	40.2±20.4 b
Above-ground dry matter [g]	301.5±141.3 a	95.6±60.5 b
Grain yield [g]	110.3±71.5 a	39.8±30.3 b

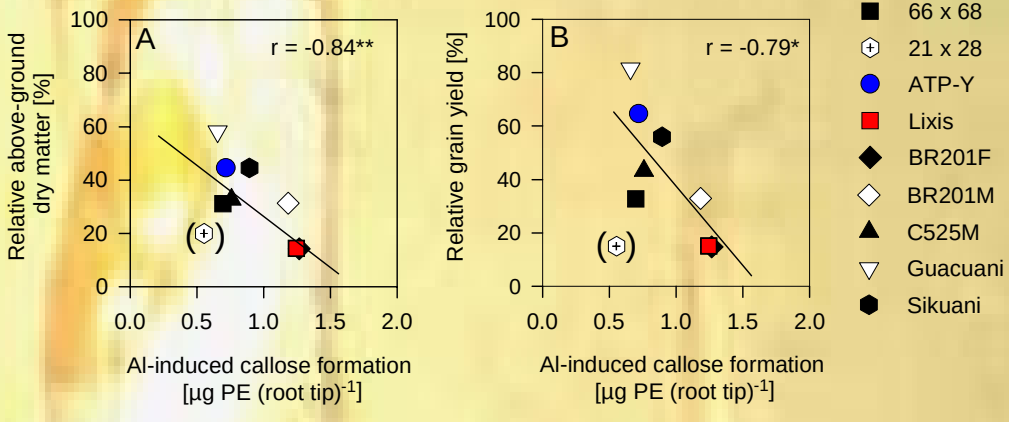

Fig. 3: Aluminium-induced callose formation related to (A) relative above-ground dry matter and (B) relative grain yield of transplanted maize cultivars. Cross 21x28 excluded from correla-tion analysis.

CONCLUSIONS

Considering the small effect of transplanting compared to soil acidity on plant performance, transplanting proved to be useful in validating screening methods in hydroponics targeting at the root.

Al-induced callose formation proved to be a sensitive indicator for adaptation of maize cultivars to an acid soil with Al toxicity as the most limiting factor.

The established methodology should be especially useful in studies of inheritance of Al resistance where seed supply is small and it is desirable to save individual plants after screening in nutrient solution for further observations and/or seed multiplication in the field.

Horst W J, Püschel A-K and Schmohl N 1997 Plant Soil 192, 23-30. - Kasim F, Haag W L and Wassom C E 1990 Ind. J. Crop Sci. 5, 53-65. - Magnavaca R and Bahia Filho A F C 1993 pp 209-220 Intsormil Publ. No 94-2, Univ. Nebraska, USA.

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