ETICHA, D., THÉ, C., WELCKER, C., NARRO, L., STAß, A., HORST, W.J. (2005): Aluminium-induced callose formation in root apices: inheritance and selection trait for adaptation of tropical maize to acid soils. Field Crops Res. (in press)

Abstract

Aluminium (Al) toxicity limits maize production on acid soils of the tropics. However, wide genetic variation exists in maize for Al resistance. The objective of this study was to assess the Al resistance of open pollinated tropical maize cultivars, from widely differing origin, and their diallel crosses based on callose formation as a physiological marker, and to study the inheritance and combining ability for Al resistance. Fifteen maize cultivars from four maize breeding programmes and their 105 crosses were grown under controlled environmental conditions in a growth chamber and treated without or with 25 μM Al at pH = 4.3. After 12 hours of Al treatment, callose contents of 1 cm root apices were determined. There was a significant genotypic variation in callose formation under Al stress. Furthermore, diallel analysis indicated a significant general combining ability (GCA) but not specific combining ability (SCA), indicating that Al resistance is mainly controlled by additive genes. In general, Al-resistant cultivars showed favourable GCA effects while the sensitive cultivars had unfavourable GCA effects clearly indicating the dominant role of Al-resistant cultivars in the development or improvement of Al-resistant maize varieties. Moreover, a relatively high heritability (h^2 = 0.7) was obtained for Al resistance in nutrient solution. Aluminium resistance as revealed by callose content in Al-treated root apices was positively correlated to the relative grain yield of the same crosses evaluated across 5 tropical environments. In addition, strong genetic correlation was observed as GCA of callose formation in nutrient solution closely correlated with GCA of yield on acid soils. These findings suggest that Al-induced callose formation is a powerful tool to enhance the breeding of maize cultivars with superior adaptation to acid and Al-toxic soils.