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Improvements in acid soil tolerance of Brazilian barley will require new allelic combinations

Euclydes Minella

Embrapa Wheat; Euclydes.Minella@embrapa.br

Co-authors: J.R. Ferreira, J.F. Pereira, P.R. Ryan, E. Delhaize, and C.A. Delatorre

ABSTRACT

More than 50% of the agricultural soils in Brazil have toxic levels of aluminum (Al3+). The Al3+ can limit root growth negatively interfering with water and nutrient uptake. Many plant species have evolved mechanisms to cope with the Al3+ stress and, among them, is the efflux of organic acids by the root tip. In Brazilian barley, a single major gene appears to control the Al3+ tolerance and, for this reason, the opportunity to introgress additional Al3+ tolerance genes derived from natural germplasm is limited. Here, we investigated the Al3+ tolerance in a collection of 51 Brazilian barley genotypes comparing the trait to seven foreign cultivars, six wild barley and one transgenic line overexpressing the wheat TaALMT1 gene. Moreover, we evaluated the polymorphism of two molecular markers linked to the HvAACT1 gene. Both TaALMT1 and HvAACT1 encode transporters responsible for the efflux of malate and citrate by the root apices that are thought to confer tolerance by chelating Al3+. In hydroponics, only six genotypes showed greater root growth than Antarctica 01, the Brazilian genotype used as a tolerant control. However, in the short-term soil experiment, that number was reduced to the two conventional cultivars Dayton and Murasakimochi. The transgenic line showed the greatest root growth in soil and performed better than any of the conventional genotypes. In hydroponics, the genotype Golden Promise, recognized as Al3+ sensitive, was similar to Antarctica 01 suggesting a low level of tolerance among the Brazilian materials. In the short-term soil experiment, a marker based on a 21-bp indel was associated with the root growth while only the two conventional cultivars showing the greatest performance had the 1 kb insertion in the promoter region of the HvAACT1 gene. This insertion is correlated with greater gene expression and citrate efflux and is probably the reason why these two cultivars had the greatest tolerance. In order to further improve the Al3+ tolerance of Brazilian barley, we suggest the introgression of the HvAACT1 allele containing the 1 kb insertion in the promoter as well as the TaALMT1 transgene.

SECTION:
Abiotic stresses