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Molecular Cloning And Characterization Of AltSB, A Major Aluminum Tolerance Gene In Sorghum

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Aluminum (Al) toxicity on acid soils represents a major constraint for crop production as ~ 50% of the potentially arable soils worldwide are acidic. Therefore, understanding the genetic and molecular mechanisms underlying plant Al tolerance has been a major focus for a number of laboratories around the world. Here, we report on the isolation and characterization of AltSB, a major Al tolerance gene in sorghum. Through high-resolution mapping, we identified AltSB as a single, partially dominant Al tolerance gene on sorghum chromosome 3. We subsequently verified that AltSB is responsible for Al tolerance in sorghum based on: 1) a strong correlation between Al-inducible AltSB expression and Al-inducible tolerance and root citrate exudation; 2) sequence predictions indicating it is a member of a gene family involved in the efflux of organic solutes; 3) protein localization to the plasma membrane; and 4) AltSB expression in transgenic Arabidopsis resulting in significant increases in Al tolerance and Al-activated root citrate efflux. Sequence analysis of the parental AltSB alleles and the promoter region from selected members of a sorghum diversity panel, combined with determination of AltSB expression, Al tolerance and root citrate exudation in members of the diversity panel indicates that differences in gene expression are a major determinant of differential tolerance in sorghum. Furthermore, a MITE-type transposable element in the AltSB promoter appears to be a highly polymorphic motif in the promoter region and may play a role in the differential Al-inducible expression.