Enhancing Root Growth in Georgia Red Clay Soils Through ALMT Gene Editing

Approximately 50% of the world's arable land is affected by aluminum toxicity, which reduces root growth and limits nutrient and water uptake, ultimately decreasing crop productivity. We aim to address this issue specifically in Georgia's red clay soils, exploring how we can enhance root development and crop performance at the genetic level. We focused on improving plant tolerance to aluminum stress by leveraging the Aluminum-Activated Malate Transporter (ALMT), a protein that releases malate from roots to chelate and neutralize Al^{3+} ions in acidic soil. Using CRISPR-Cas9 gene editing, we plan to enhance the expression of the plant's native ALMT gene to promote root growth, improve nutrient uptake, and reduce susceptibility to aluminum damage. We also investigated grafting techniques to strengthen root systems and support plant growth in nutrient-poor, acidic soils. We expect enhanced ALMT activity to increase root length and thickness, improve water and nutrient absorption, and provide greater resistance to aluminum toxicity. This offers a sustainable alternative to chemical soil treatments, allowing crops to thrive in Georgia's red clay soils. By creating stronger and longer roots, farmers can cultivate a wider variety of crops, expand usable farmland, lower production costs, and adopt more environmentally responsible agricultural practices.