Utilizing PCR and Induced Transformation to Reinsert Amplified Genes of Plant-Symbiotic Bacillus subtilis for Improved Growth, Antimicrobial Activity, and Abiotic Stress Resistance in Arabidopsis thaliana

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Due to population growth, demand for crop yields is rising, leading to greater use of environmentally harmful chemical fertilizers. Stressors (e.g., water, salinity stress) complicate this issue further by impairing plant growth. In a different aspect, plants serve as critical sources of phytochemicals, making enhanced plant antimicrobial activity essential for combating antibiotic resistance. This experiment evaluated the efficacy of genetically modified Bacillus subtilis, a plant-growth-promoting rhizobacteria, on the growth, antimicrobial activity, and stress tolerance of Arabidopsis thaliana (thale cress). The researcher separately modified three different genes in Bacillus: bdhA (promoting growth), srfAA (promoting antimicrobial production), and dhaS (promoting stress tolerance). To effectively modify Bacillus, a novel combination of PCR, CaCl2-induced transformation, and gene dosage theory was employed. Arabidopsis was tested in three groups, each corresponding to a modified strain. Two groups (for growth and stress tolerance) were evaluated for root and shoot area and height, while the third group (for antimicrobial activity) underwent Kirby-Bauer disc diffusion testing with ethanolic extracts. Modified bacteria-fed Arabidopsis demonstrated significantly greater height and growth than controls (ANOVA and linear regression model p-values demonstrate <0.01), indicating successful modification. For antimicrobial activity, no group showed zones of inhibition (including the penicillin discs), indicating experimental issues with the agar or plating process. Similarly, no increase in stress tolerance under the modified bacteria was observed, as all Arabidopsis in the modified drought group died during transfers, and salinity levels were excessive for survival.

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