Gene Pyramiding for Boosted Plant Growth and Broad Abiotic Stress Tolerance (2024-016)

Combination of three specific genes to boost plant performance under adverse environmental conditions and enhance crop yield.

Market Overview

Climate change has widely impacted crop productivity due to frequent changes in various environmental factors, such as drought, salinity, heat, and disease. To address the need for hardier crops under changing climate conditions, researchers at Clemson University are exploring the feasibility of combining multiple favorable traits brought by individual genes to acquire superior plant performance through gene stacking. The researchers have proposed a novel biotechnology through combining three specific genes that boost plant performance under adverse environmental conditions and enhance crop yield. The technology was developed in perennial grass species and can be extended to food and other economically important crop species. This technology is part of the global genetically modified crops market, which was valued at $21.08 billion in 2022 and is expected to grow at a CAGR of 5.9% to $28.03 billion by 2027.

Technical Summary

The technology is comprised of three genes. These genes are known for their ability to improve plant performance and tolerate various abiotic stresses. Transgenic plants overexpressing these three genes performed significantly better than wild-type controls. Genetically modified plants expressing specific genes showed improved growth and resilience under both normal conditions and various environmental stresses. These plants demonstrated enhanced tolerance to drought, salinity, heat, and nutrient deficiencies (nitrogen and phosphate). The improvements were linked to changes in the plants' physiological and biochemical traits, as well as carefully regulated expression of genes involved in stress responses. The results suggest that these three genes function synergistically to regulate plant development and stress response, leading to superior overall performance in both normal and adverse environments.

Application
Plant breeding

Development Stage
TRL 2

Advantages
- Combines multiple favorable plant traits to create a plant with superior performance in handling biotic and abiotic stresses.
- Technology proven to lead to enhanced plant growth and tolerance to drought, salinity, heat stresses, and nutrient deficiencies.
- Potentially applies to other beneficial genes in various crop species (i.e. corn, rice, and soybean) for enhanced agricultural production.

About the Inventors

Dr. Hong Luo

Professor in the Department of Genetics and Biochemistry at Clemson University

Dr. Luo received his Ph.D. in Molecular Biology from the Catholic University of Louvain, Belgium. Before joining Clemson University, he was with HybriGene, Inc. as the Director of Research, working on gene transfer for trait modification in turfgrass and rice. His work leads to the development of the first genetically engineered, environmentally safe, male-sterile and herbicide-resistant turfgrass, and the development of a new method for hybrid crop production using site-specific DNA recombination systems. He is a Faculty Fellow, Clemson Spiro Institute for Entrepreneurial Leadership, and the recipient of the 2013 Clemson University Godley-Snell Agricultural Award for Excellence in Agricultural Research.

Dr. Qian Hu

Research Associate in the Department of Genetics and Biochemistry at Clemson University

Qian Hu is a Research Associate and lab manager in Dr. Hong Luo's lab. She is an expert in plant tissue culture, plant genetic transformation and has many years of experience working on genetic transformation of turfgrass, switchgrass, rice, soybean and cotton. She has co-authored many high-impact journal papers and is a co-inventor of five issued patents.

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