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Synergizing Artificial Intelligence and BioInoculants for Climate-Smart Farming

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ABSTRACT

Climate change has a profound impact on agriculture, influencing crop production through direct, indirect, and socioeconomic effects. It causes abiotic stresses such as drought, salinity, extreme temperatures, and flooding, alongside biotic stresses from pests, pathogens, and weeds. These stressors disrupt vital physiological processes, including photosynthesis, water uptake, and nutrient absorption, ultimately reducing crop yield and compromising global food security. Developing countries, in particular, face significant agricultural challenges due to erratic weather patterns, increasing temperatures, and elevated CO2 levels. Addressing these challenges requires innovative approaches, such as low input agriculture and the application of plant growth promoting bio-inoculants (PGPB), which can enhance nutrient availability, particularly phosphorus, and improve soil health while reducing chemical fertilizer dependence. To mitigate the effects of climate induced stresses, the integration of advanced imaging technologies with artificial intelligence (AI) has emerged as a transformative solution. Machine vision, leveraging high resolution imaging and spectroscopy, provides non-invasive, real-time monitoring of plant health. Coupled with AI techniques like machine learning, image segmentation, and feature extraction, these tools enable accurate and automated detection of stress signals, offering insights into plant responses under diverse conditions. This project aims to explore the efficacy of bioinoculants in enhancing plant growth under abiotic and biotic stress conditions, with a focus on salinity stress. The integration of AI with biological solutions offers a promising pathway to address the dual challenges of climate resilience and sustainable agricultural productivity.

Keywords: Global food security, Abiotic stresses, Plant growth promoting bio-inoculants (PGPB), Artificial intelligence (AI), Machine Vision