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Response of *Arabidopsis thaliana* to Flooding with Physical Flow

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Abstract: Flooding causes severe yield losses worldwide, making it urgent to enhance crop tolerance to this stress. Since natural flooding often involves physical flow, we hypothesized that the effects of submergence on plants could change when combined with physical flow. In this study, we analyzed the growth and transcriptome of *Arabidopsis thaliana* exposed to submergence or flooding with physical flow. Plants exposed to flooding with physical flow had smaller rosette diameters, especially at faster flow rates. Transcriptome analysis revealed that "defense response" transcripts were highly up-regulated in response to flooding with physical flow. In addition, up-regulation of transcripts encoding ROS-producing enzymes, SA synthesis, JA synthesis, and ethylene signaling was more pronounced under flooding with physical flow when compared to submergence. Although H_2O_2 accumulation changed in response to submergence or flooding with physical flow, it did not lead to lipid peroxidation, suggesting a role for ROS as signaling molecules under these conditions. Multiple regression analysis indicated possible links between rosette diameter under flooding with physical flow and the expression of *Rboh*s and SA synthesis transcripts. These findings suggest that pathogen defense responses, regulated by SA and ROS signaling, play crucial roles in plant responses to flooding with physical flow.

Keywords: flooding; jasmonic acid (JA); pathogen defense; physical flow; respiratory burst oxidase homologue (RBOH); salicylic acid (SA); submergence

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1. Introduction

Flooding can cause severe yield losses worldwide, resulting in devastating economic and sociological impacts [1]. Recent climate changes, such as rising sea levels and shifting rainfall patterns, can exacerbate the negative impact of flooding on crop yields [2,3]. Global warming increases air temperature, enabling the atmosphere to hold more moisture and leading to more intense rainfall [4]. Given these factors, the effects of flooding on plants and crops are likely to worsen due to global climate change. It is therefore urgent to establish strategies to enhance the tolerance of crops to flooding.

One of the most serious problems for plants caused by flooding is the disruption of gas diffusion between cells, leading to the inhibition of mitochondrial respiration and related metabolic processes [5]. Morphological and developmental alterations in plants