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The efficacy of PAM fluorometry as a tool to quantify heat stress in wheat

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Fluorescence (spontaneous emission) is a highly sensitive probe for a multitude of molecular processes during the light-dependent steps of photosynthesis in numerous organisms. In living organisms, the fluorescence signal is dwarfed by reflection and scattering; however, the signal-to-noise ratio can be significantly enhanced by gating the fluorescence to sub-ms excitation pulses through a non-invasive technique known as pulse-amplitude-modulated (PAM) fluorometry. Wheat is an economically important crop that is susceptible to heat stress and consequent yield reduction at temperatures above 30℃. However, the changes to molecular processes that cause the decrease in yield have not been well reported. In this study, PAM fluorometry was used to investigate the effects of high temperatures on the energy transfer pathways during the light-dependent steps of photosynthesis. The quantum efficiency of energy conversion from light to chemical energy was not significantly altered at 30℃ but was reduced by 10.7% at 35℃. We show that the biological changes due to the heat shock response can be measured at a time resolution of 30 seconds. PAM fluorometry, and thus fluorescence, is able to provide information about the effects of heat stress on electron transport during light-dependent photosynthesis. This opens many possible directions of study, such as investigating the effects of different types of stress on photosynthesis or further modelling the photosynthetic energy-transfer pathways under heat stress.

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Primary author: Ms BURNETT, Sarah (University of Pretoria)

Co-authors: Prof. HAMMERBACHER, Almuth (University of Pretoria); Prof. KRÜGER, Tjaart (University of Pretoria)

Presenter: Ms BURNETT, Sarah (University of Pretoria)

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