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Proposal for Evaluating Plant Stress via Steady State Fluorescence

Summerer S.[a], Petrozza A.[a], Briglia N.[b], Nuzzo V.[b], Cellini F.[a]

a) Plant Phenotyping Platform Phen-Italy, ALSIA Metapontum Agrobios, 75012, Metaponto, Italy
b) Dipartimento delle Culture Europee e del Mediterraneo: Architettura, Ambiente, Patrimoni Culturali. 75100 Matera, Italy

Abstract

Chlorophyll fluorescence analysis is a powerful tool to estimate photosystem II (PSII) performance under standard or biotic or abiotic stress condition. An important limiting factor in measuring these chlorophyll fluorescence parameters in a high throughput phenomics system is the availability of a flashing light source, used to block the photosynthetic apparatus, that is large and homogeneous enough for whole plants. Until recently such systems were limited to smaller plants such as Arabidopsis. Instead larger phenomic systems were, and often still are, built with imaging chambers that measured chlorophyll fluorescence under steady state conditions. Under these conditions only a single fluorescence value for each image pixel is measured and the quantum efficiencies cannot be calculated. In this study we investigate the use of hue component of the HSI (hue, saturation, intensity) colour space, which is analogous to the light spectrum, from plant chlorophyll fluorescence light as a parameter to measure plant stress and compared it to those parameters derived from traditional chlorophyll fluorescence kinetics. Tomato plants were treated to heat or drought stress and subsequently chlorophyll fluorescence kinetic measurements were taken as well as images at steady state fluorescence. By analysing the chlorophyll fluorescence hue channel we were able to detect differences from control plants in both the heat shocked and drought induced plants while the standard photosystem II yield measurement was only capable of measuring differences in the heat shocked plants. These results appear to suggest that the analysis of chlorophyll fluorescence light in the hue channel is capable of identifying perturbations due to abiotic stress in tomato plants. Currently we are continuing to investigate whether this method is applicable as a general method for more plant species and abiotic stresses.

Materials and Methods

- **Plant materials and field trials**
- Tomato plants, *Solanum lycopersicum* cv. Ikram (by Syngenta) were grown in vases, at 30 days after transfer to vases the plants were subjected to four types of abiotic stress witch were as follows: 1) drought stress (no irrigation for 7 days), 2) salt stress (irrigated with 170mM NaCl, 3 applications in 7 days) 3) cold stress (10 h at 5° C), and 4) heat stress (10 h at 40° C). Stress conditions were imposed before each measurements…
- **Chlorophyll Fluorescence Measurements**

Fast fluorescence parameters were measured with the Fluor Pen (Photo System Instruments), three measurements for each plant, one each at an apical, medial, and basal leaf. The plants were subsequently imaged with the Scanalyzer 3D (LemnaTec GmbH) with a standard fluorescence chamber. These measurements were conducted first at night (dark adapted) and the next day (light adapted).

Results

Figure 1. Chlorophyll fluorescence images of dark and light adapted Tomato plants with false colour images of Hue and Intensity channels from HUV colour space.

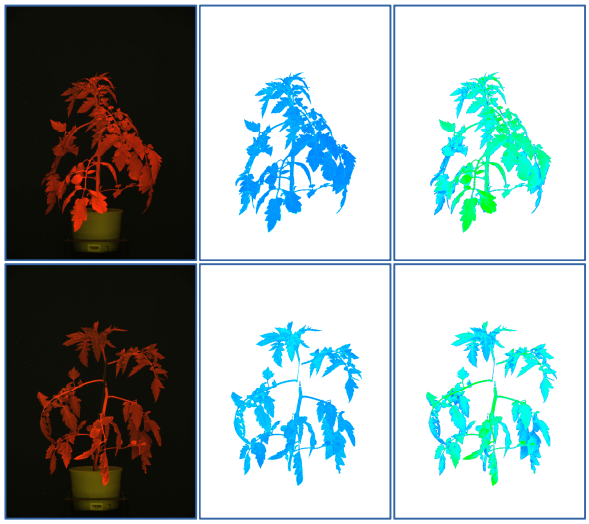


Figure 2. Distribution of image pixel values for Hue and Intensity channel of the HSV colour space.

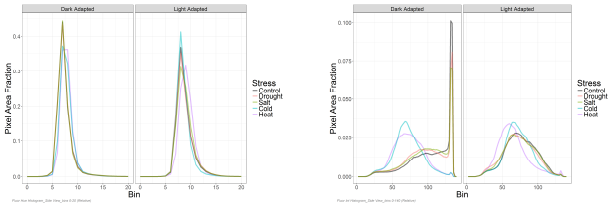
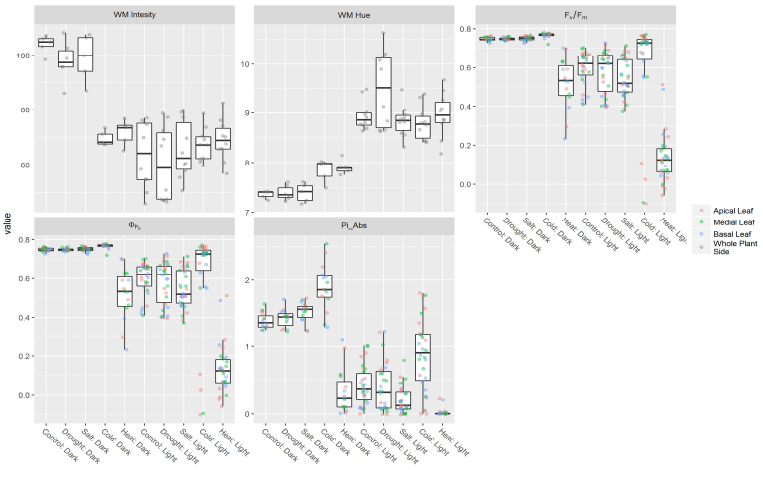


Figure 3. Measured and calculated chlorophyll fluorescence values .



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