Monitoring *Solanum lycopersicum* var. Elpida salinity stress using multispectral imaging

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Introduction

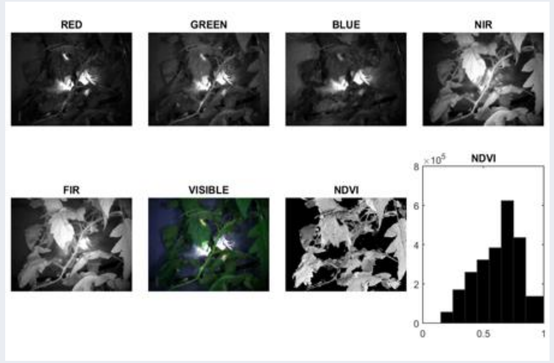
Under salinity stress, plant physiology and yield characteristics deteriorate, showing, among others, symptoms similar to those of water stress. Tomato (*Solanum lycopersicum*) is moderately sensitive to salinity stress and suffers yield losses of over 15% at irrigation water electrical conductivity (ECw) of 3 dS m^{-1} (Malash et al., 2008) and over 25% at ECw of 3.5 dS m^{-1} (Daliakopoulos et al., 2019). Especially in the case of NaCl, the two main threats imposed by salinity are induced by osmotic stress and ionic toxicity associated with excessive Na^+ and Cl^- uptake, leading to Ca^{2+} and K^+ deficiency and other nutrient imbalances (Sonneveld, 1988). As salinity can often buildup in soils and substrates, it can have a creeping effect not readily measurable in irrigation water ECw, therefore it is essential that plant physiology symptoms are spotted early to take corrective action.

Material and Methods

Here we investigate the capability of multispectral imaging, to detect early symptoms of salinity stress on *S. lycopersicum* plants (var. Elpida) due to NaCl accumulation in the nutrient solution of a soilless cultivation system. In this context, we established a control (0.5 mM) and five salinity treatments of 5.0, 10.0, 15.0, 20.0 mM NaCl, with three tomato plants (replications) per treatment, resulting in a total number of 18 *S. lycopersicum* plants. During the experiment, multispectral images (bands 460, 540, 630, 850, and 980 nm) were obtained at three stages of plant development (30, 60, and 90 days after transplant) using a MUSES9-MS sensor.

Results & Conclusions

For each multispectral image, four spectral indices (NDVI, OSAVI, LWSI and GOSAVI) were calculated. Although, the statistical analysis of the results reveal low sensitivity to the increasing salinity at early sampling stage (60 DAT), during the third sampling stage (120 DAT) all spectral indicators demonstrate significant sensitivity from 10.0 up to 20.0 mM NaCl. Accordingly, two physiological indicators were determined using a portable OS-30p fluorometer (Opti-Sciences, USA) and a SPAD-502 meter (Minolta, Japan), respectively, and the results demonstrated that maximum quantum yield fluorescence (Fv/Fm) and relative SPAD chlorophyll content were significantly reduced in the salinity treatments of 15 and 20 mM compared to 0.5, 5.0 and 15 mM NaCl treatment (120 DAT).



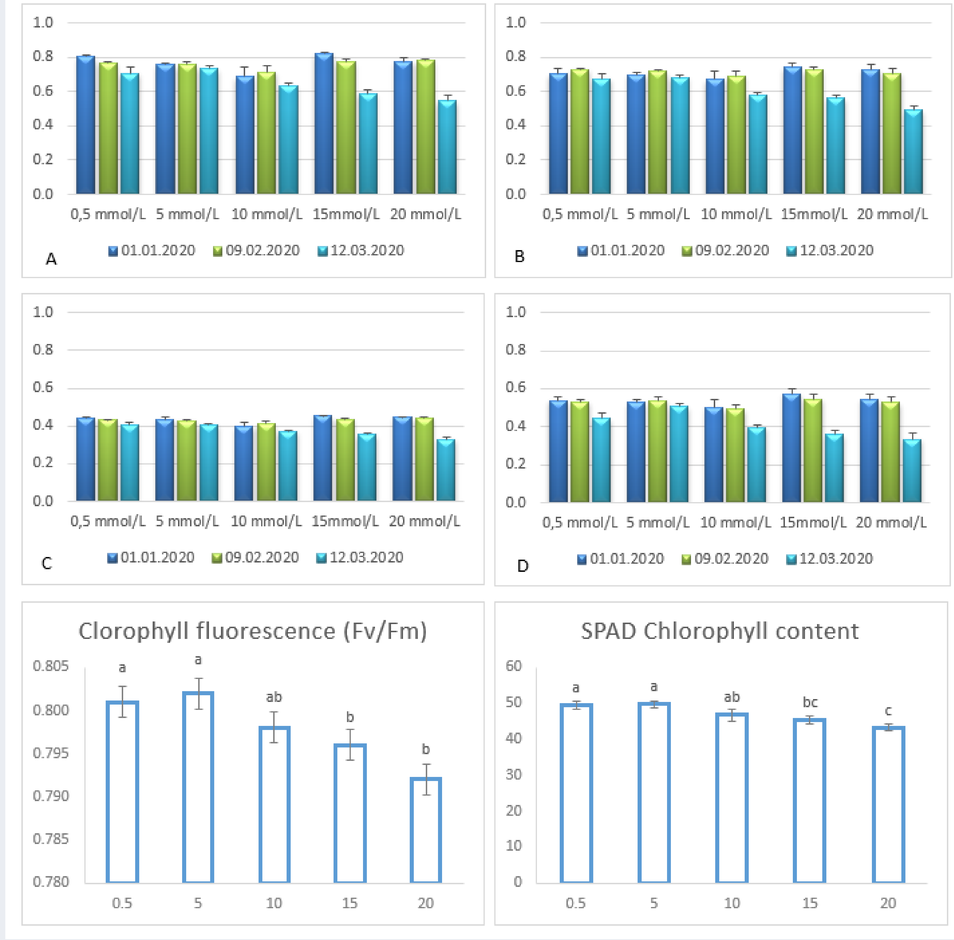


Image analysis for the NDVI (A), OSAVI (B), LWSI (C), GOSAVI (D) index, 30 (01.2022), 60 (02.2022) and 90 DAT (03.2022), and SPAD relative chlorophyll content and Chlorophyll florescence (Fv/Fm) at 90 DAT across treatments. Vertical bars denote standard errors of means, point colours denote treatments.

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