Saudi Journal of Biological Sciences 29 (2022) 2506–2513

Contents lists available at ScienceDirect

Saudi Journal of Biological Sciences

journal homepage: www.sciencedirect.com

Original article

Utilizing spectral vegetation indices for yield assessment of tomato genotypes grown in arid conditions

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A R T I C L E I N F O

Article history:
Received 25 October 2021
Revised 15 November 2021
Accepted 12 December 2021
Available online 16 December 2021

Keywords:
Solanum lycopersicum L.
Spectral reflectance
Vegetation indices
Heat stress

A B S T R A C T

Tomato is among important vegetable crops cultivated in different climates; however, heat stress can greatly affect fruit quality and overall yield. Crop reflectance measurements based on ground reflectance sensor data are reliable indicators of crop tolerance to abiotic stresses. Here, we report on using non-destructive spectral vegetation indices to monitor yield traits of 10 tomato genotypes transplanted on three different dates (Aug. 2, Sept. 3 and Oct. 1) during 2019 growing season in the Riyadh region. The ten genotypes comprised six commercial cultivars–(Pearson Improved, Strain B, Valentine, Marmande VF, Super Strain B, and Pearson early) ––and four local Saudi cultivars (Al-Ahsa, Al-Qatif, Hail and Najran). Spectral reflectance data were utilized using a FieldSpec 3 spectroradiometer in the range of 350–2500 nm to calculate nine vegetation indices (VIs): Normalized Water Band Index (NWBI), Difference Water Index (NDWI), Photochemical Reflectance Index (PRI), Normalized Difference Vegetation Index (NDVI), Green Normalized Difference Vegetation Index (GNDVI), Red Edge Normalized Difference Vegetation Index, Soil Adjusted Vegetation Index (SAVI), Red Edge Normalized Difference Vegetation Index (RENDVI), Renormalized Difference Vegetation Index (RDVI), and Normalized Difference Nitrogen Index (NDNI). VIs and yield parameters (total fruit yield, harvest index) revealed that second transplanting date was optimal for all the genotypes. Valentine showed the best growth performance followed by Najran, Hail, Super Strain B and finally Pearson early. For all the three transplanting dates, Valentine recorded the highest total fruit yield. Additionally, some genotypes had no significant differences in the VIs values or the total fruit yield between the second and third transplanting dates. This study indicated that yield parameters could be linked to rapid, non-destructive hyperspectral reflectance data to predict tomato production under heat stress.

1. Introduction

Heat waves and fluctuations in rainfall brought about by climate change are responsible for several types of abiotic stresses that are causing crop losses of about 50% (Atkinson and Urwin, 2012, Costa and Farrant, 2019). Therefore, evaluating and selecting crops with a high stress tolerance is a top priority (Newton et al., 2011; Abdelrahman et al., 2015; Mukhtar et al., 2020). Growth and development mainly depend on the interactions among genotypes, environment, and management, which can lead to significant variations in crop yield (Potgieter et al., 2021). Thus, to meet a steadily increasing food demand, an increase in productivity through the selection of good varieties and better managed agricultural practices is required. Heat stress negatively affect crop development, especially under open field conditions; hence, a reduction in yield is expected unless suitable strategies are implemented (Ayenan et al., 2019; Mukhtar et al., 2020). Berova et al., (2008) reported that the best way to increase plant tolerance for high temperature is to apply appropriate agricultural techniques and select good varieties.

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.sjbs.2021.12.030
1319-562X/