

Determination of basil morphological parameters by multispectral analyses

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Introduction

Basil (*Ocimum basilicum* L.) is one of the most important medicinal and aromatic plants worldwide. It is used as an ornamental plant and herb in many cuisines. Also, it has numerous potent activities due to the present metabolites. It is present in traditional medicine and has also been used as commercial fragrances, flavours and to improve the food products shelf life (Purushothaman et al., 2018).

Various plant phenotyping platforms which combine modern imaging techniques with automatic data analysis have been developed in order to assess plant performance under different environmental conditions (Rahaman et al., 2015). Non-destructive plant imaging techniques, such as chlorophyll fluorescence and multispectral imaging, are based on reflectance of different wavelengths from the plant leaves to be used for calculation of different Spectral Vegetation Indices as indicators of plant chemical composition and physiological status (Li et al., 2014).

The aim of this experiment was to quantify morphological traits in basil using 3D multispectral scanner and to investigate the potential of multispectral imaging systems for high-throughput yield phenotyping in basil.

Materials and methods

Plants of *O. basilicum* 'Genovese' were grown in greenhouse ($T_{\text{mean}}=22.5$) during their whole vegetation period. Multispectral LED lamps were placed 100 cm above plant level and a 16 h photoperiod was set from 5:00 am up to 9:00 pm. Plants were scanned four times (1st when they were planted in 3L pots and every week until they reach flowering stage) using PlantEye F500 multispectral 3D scanner (Phenospex, Heerlen, The Netherlands). Plant spectral reflectance in Red (620 - 645 nm), Green (530 - 540 nm), Blue (460 - 485 nm), Near-Infrared (820 - 850 nm) and the 3D Laser (940 nm) was scanned in 3D. Based on plant scans different vegetation indices and morphological parameters

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were automatically calculated using HortControl software (Phenospex, Heerlen, The Netherlands).

Calculated morphological parameters included: digital biomass (cm^3), plant height (mm), total leaf area (mm^2), projected leaf area (mm^2), leaf inclination ($\text{mm}^2 \text{mm}^{-2}$), leaf area index ($\text{mm}^2 \text{mm}^{-2}$), leaf angle ($^\circ$) and light penetration depth (mm).

The Pearson's correlation coefficients were calculated using the SAS system for Windows (SAS, 2011).

Results and discussion

All measured morphological traits showed increasing values during four scanning times, except leaf angle. Average leaf angle decreased for 7.9%, from 39.7° determined at first scan to 36.5° which was determined at last scan.

When comparing all measured morphological traits, greatest increase was detected in digital biomass which increased for 331% for four weeks, from 170.4 cm^3 to 734.6 cm^3 . Increase in digital biomass was more related to increase in leaf biomass (as indicated traits related to leaf area) than to increase in plant height. During for weeks (four scans) total leaf area increased for 183.2% (from 9602 mm^2 to 27199 mm^2), projected leaf area increased for 159.3% (from 5846 mm^2 to 15160 mm^2), and leaf area index increased for 182% (from $0.1 \text{ mm}^2 \text{mm}^{-2}$ to $0.28 \text{ mm}^2 \text{mm}^{-2}$), whereas plant height increased for 51.9% (from 176.9 mm to 268.9 mm).

Regardless of considerable incensement in leaf area and digital biomass, data show increased light penetration depth for 29.7% (from 101 mm to 131 mm). These results may seem confusing. However, the fact that light penetration depth increased is probably related to increased plant height, which thus increase depth to which light are penetrating canopy.

Significant correlation ($P < 0.001$) between digital biomass and shoot fresh weight ($r = 0.90$) as well between digital biomass and shoot dry weight ($r = 0.72$) indicated a high precision and usefulness of 3D multispectral scanning in measuring morphological traits in basil.

Conclusion

Concerning the measured basil morphological parameters all of them showed increasing values during four scanning times, except leaf angle. Moreover, used multispectral analyses are non-destructive and fast techniques with minimum error and human interference which potential usage covers disciplines from stress quantification to yield prediction, and thus are a highly recommended methods for plants phenotyping.

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