Non-destructive evaluation of selected indoor plants using multispectral imaging and NDVI under low light conditions

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Abstract

This study was conducted to quantitatively evaluate the resistance of houseplants to low light conditions using non-destructive multispectral imaging technology and the Normalized Difference Vegetation Index (NDVI) in a completely randomized design with 6 treatments and 5 replications. In this regard, after selecting six different houseplants and placing them in the same and controlled light conditions, multispectral images were recorded with a camera equipped with dedicated optical filters. After processing the images, NDVI values were calculated as numerical values for each plant. By analyzing statistical tests, it was determined that there was a significant difference between plants in terms of NDVI values. Among them, *Zamioculcas zamiifolia* and *clivia miniata* plants with the highest NDVI values showed the most resistance and *Dieffenbachia seguine* 'Variegata' showed the least tolerance to low light. In this study, the usefulness and efficiency of the multispectral imaging method and the NDVI index were introduced as a non-destructive, rapid, and reliable tool in monitoring and evaluating the resistance of houseplants to low light conditions. This method can be used as a scientific basis for selecting more resistant species in indoor green space design.

Introduction

In recent years, the need to use new technologies that can quantitatively measure plant evaluation without damaging the plant has been emphasized. Imaging and image processing methods are one of the effective methods in this field due to their non-destructive process and the possibility of widespread use (Peng et al., 2022) Spectral imaging, with processing capabilities beyond the human visible spectrum, is capable of revealing hidden physiological and structural information in plants (Song et al., 2025). With the help of this method and image processing such as Normalized Difference Vegetation Index (NDVI), it is possible to extract and analyze components related to vegetation cover. Due to its easy understanding and high operational efficiency, it allows researchers to monitor plants and assess the growth status of crops by measuring and quantifying the green cover of plants (based on the light reflectance of chlorophyll). In this regard, NDVI has been used as a non-destructive, fast, inexpensive, and yet powerful index that allows monitoring the health and vitality of vegetation using reflectance data (Wang et al., 2025). This study aimed to use multispectral imaging and NDVI to quantitatively assess and rank the low-light tolerance of a number of indoor plant.

Materials and methods

The experiment was conducted with 6 treatments and 5 replications based on a completely randomized design. The treatments consisted of six different indoor plant grown under identical conditions, which were randomly selected. Then, in order to create a standard light stress that is the same for all plants, they were all placed in complete darkness for 48 hours in a place where all environmental factors were the same. This condition activates the physiological responses of the plants to low light and allows the evaluation to be compared under more uniform conditions. All multispectral images were acquired using a full-spectrum Nikon D800 DSLR camera modified by permanent removal of the internal UV-IR blocking filter (hot mirror). This modification extended the spectral sensitivity of the 36.3-megapixel CMOS sensor (7360 × 4912 pixels) to approximately 350–1100 nm. The camera was equipped with a Nikon 50 mm f/1.8D lens and operated in fully manual mode with fixed focus, fixed exposure settings (aperture, shutter speed, and ISO), and a fixed custom white balance to ensure reproducibility across all spectral bands. Illumination was provided by two xenon flash units positioned symmetrically at approximately 45° to the subject surface. An X-Rite ColorChecker Classic chart was included in every scene as a spectrophotometric reference for reflectance calibration and cross-sample comparison. Images were captured in 14-bit Nikon RAW (NEF) format at the sensor's native resolution. Analysis of variance for traits was performed using Minitab software and graphs were drawn using Origin pro 2024 software.

Results and discussion

This study demonstrated that the NDVI index based on multispectral imaging is a non-destructive, rapid, reliable, and practical tool for assessing low-light tolerance in indoor plant. *Zamioculcas zamiifolia* and *Clivia miniata* were identified as the most resistant plants with the highest NDVI values, and *Dieffenbachia seguine* Variegata was identified as the most sensitive to low-light conditions. These findings may indicate that physiological and morphological responses to low light are common in different plants and that non-destructive indices such as NDVI can be reliably used to monitor these changes (Kesumawati et al., 2020). Although the capacity of multispectral imaging was demonstrated to be a reliable method, the interpretation of its results should be done with the specific characteristics of each plant and the accuracy of standardized measurement conditions. The overall and initial results of the application of the multispectral imaging method indicated the potential of this technology in identifying ornamental plants in controlled indoor environments.

References

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