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Drone-based Multispectral Imaging for Precision Monitoring of Crop Growth Variables

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Introduction

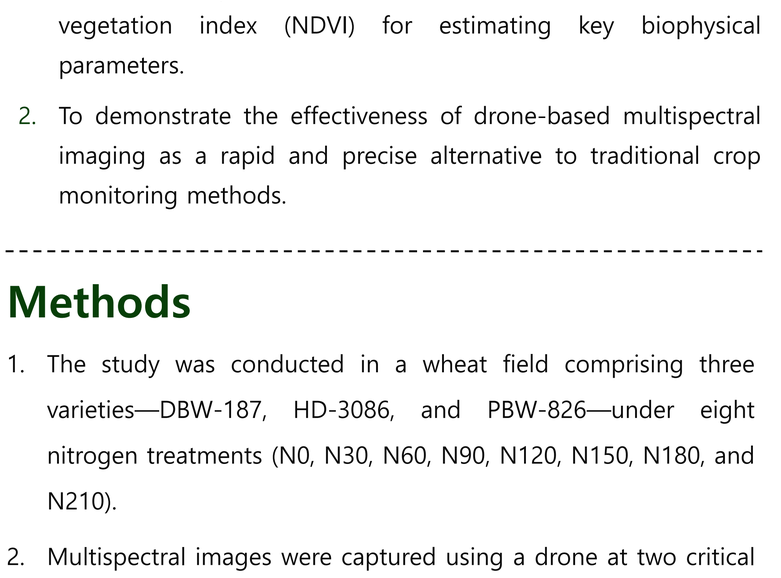
The advent of drone-assisted crop growth monitoring has significantly increased the demand for precision agriculture in recent years. Vegetation spectral indices derived from drone-based multispectral images have shown great promise as real-time monitoring tools, outperforming traditional methods and satellite remote sensing in terms of accuracy and efficiency. This study aimed to estimate leaf area index (LAI) and leaf nitrogen content (LNC) of wheat crops using drone-derived normalized difference vegetation index (NDVI) as a proxy.

Objectives

1. To assess the potential of drone-derived normalized difference vegetation index (NDVI) for estimating key biophysical parameters.
2. To demonstrate the effectiveness of drone-based multispectral imaging as a rapid and precise alternative to traditional crop monitoring methods.

Methods

1. The study was conducted in a wheat field comprising three varieties—DBW-187, HD-3086, and PBW-826—under eight nitrogen treatments (N0, N30, N60, N90, N120, N150, N180, and N210).
2. Multispectral images were captured using a drone at two critical growth stages: flowering (90 days after sowing, DAS) and grain-filling (108 DAS).
3. NDVI was calculated from the multispectral data, and its relationship with LAI and LNC was analyzed.
4. Multiple correlation analyses were conducted to determine the squared Pearson's correlation coefficients (R^2) between NDVI, LAI, and LNC for each variety at both growth stages.



Wheat field layout with 3 varieties - DBW-187, HD-3086, and PBW-826

Data Collection

LAI-2200C Plant Canopy Analyzer

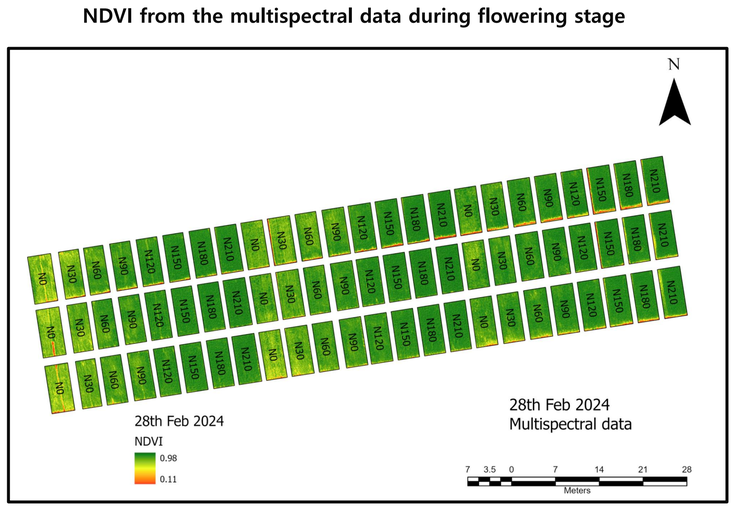
MicaSense Red Edge

GreenSeeker

CHNS Analyzer

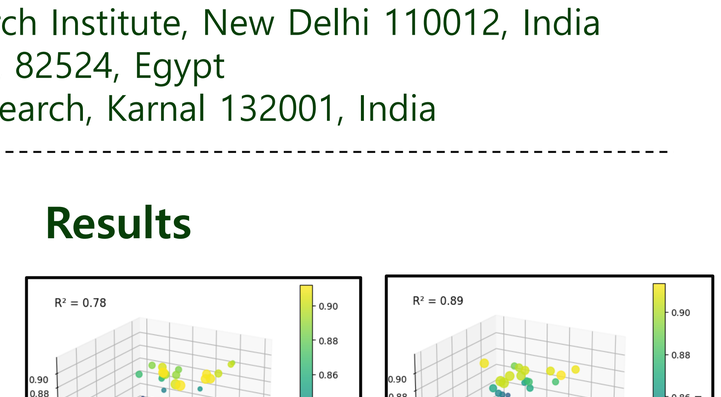
Data Analysis

NDVI from the multispectral data during flowering stage



NDVI from the multispectral data during grain filling stage

Results



1. The findings reveal a strong and positive correlation between NDVI, LAI, and LNC, with this relationship becoming stronger as the crop advances through its growth stages, particularly from flowering to grain-filling.
2. Drone-based remote sensing is an effective tool for assessing key crop biophysical parameters, offering a reliable, efficient, and less labor-intensive alternative to traditional crop monitoring methods.

Conclusion

- Drone-assisted remote sensing proved to be an efficient and accurate method for estimating key crop biophysical parameters, such as LAI and LNC, using NDVI derived from multispectral images, thereby reducing the need for labor-intensive traditional methods.
- The study highlights the potential of drone-based multispectral imaging for near real-time monitoring of LAI and LNC, offering a reliable and efficient tool to improve crop management practices and support precision agriculture.

Acknowledgment

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References

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