Role of Image Orthorectification on Crop Vegetative Indices

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Introduction & Overall Goal

- Crop phenotyping is a critical aspect of any breeding program, where crop responses to the environment are evaluated.
- Internet of things (IoT) based sensing system has potential to capture crop responses continuously in plant breeding and agricultural production field sites.
- However, given the angle of data collection using IoT-based sensor system, orthorectification of the captured images is needed prior to data interpretation.
- The overall goal of this research is to study the effect of image orthorectification on extracted crop vegetation indices (VIs, indicative of overall crop health status) acquired using IoT-based sensor system.

Methods

- Fourteen random wheat plots were selected for imaging using IoT-based sensor system at different angles—45°, 60°, and nadir (90°) at a height of 2.60 m.

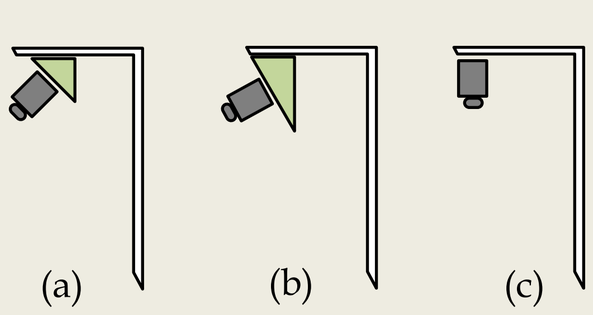

Fig. 1. Images taken at (a) 45°, (b) 60°, and (c) nadir [90°].

- White frame with reference panel (55 cm x 55 cm) was used to delineate the same vegetation area within each plot such that VIs can be computed for the same area at different angles.
- Perspective control correction algorithm in MATLAB was utilized to orthorectify RGB (red-green-blue) and NoIR (no infrared) images collected at the 45° and 60° angles.
- VIs such as normalized difference vegetation index (NDVI), blue-green index (BGI), and green leaf index (GLI) were computed from original and orthorectified images.

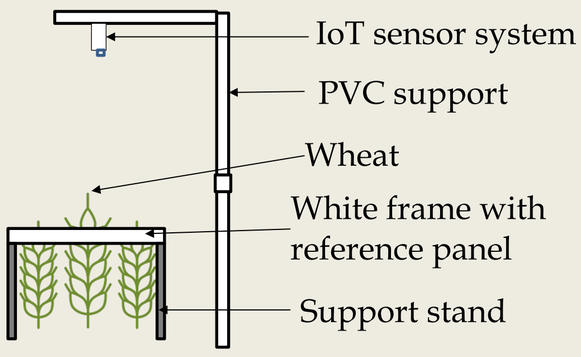

Fig. 2. Image of the data collection (top) and setup of this process for nadir (bottom).

Results and Discussion

- The correlation coefficients between NDVI, BGI, and GLI data extracted from pre- and post-orthorectified imagery were highly significant ($p < 0.01$).
- Only correlation coefficient between pre- and post-orthorectified NDVI data extracted from 60° images was significantly correlated with NDVI data extracted from 90° images.

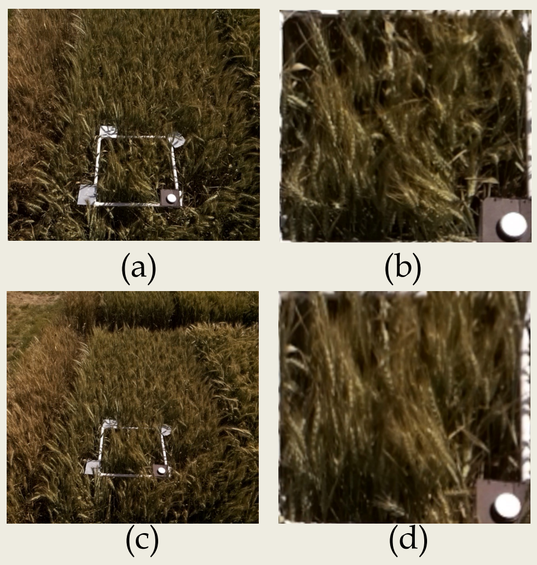

Fig. 3. The original image (a, c) and orthorectified images (b, d) acquired at 45° (a, b) and 60° (c, d) angles.

Table 1. Correlation coefficients between data extracted from pre- and post-orthorectified images with data from nadir (90°) images.

Image Source	NDVI	BGI	GLI
Original 45°	0.16	0.44	0.12
Rectified 45°	0.22	0.39	0.12
Original 60°	0.73	0.49	0.43
Rectified 60°	0.78	0.36	0.38

- Analysis of variance (ANOVA) test performed on the VI data extracted from the pre-rectified and post-rectified images, and the pseudo-reference (nadir) images signified no mean differences ($p > 0.05$).

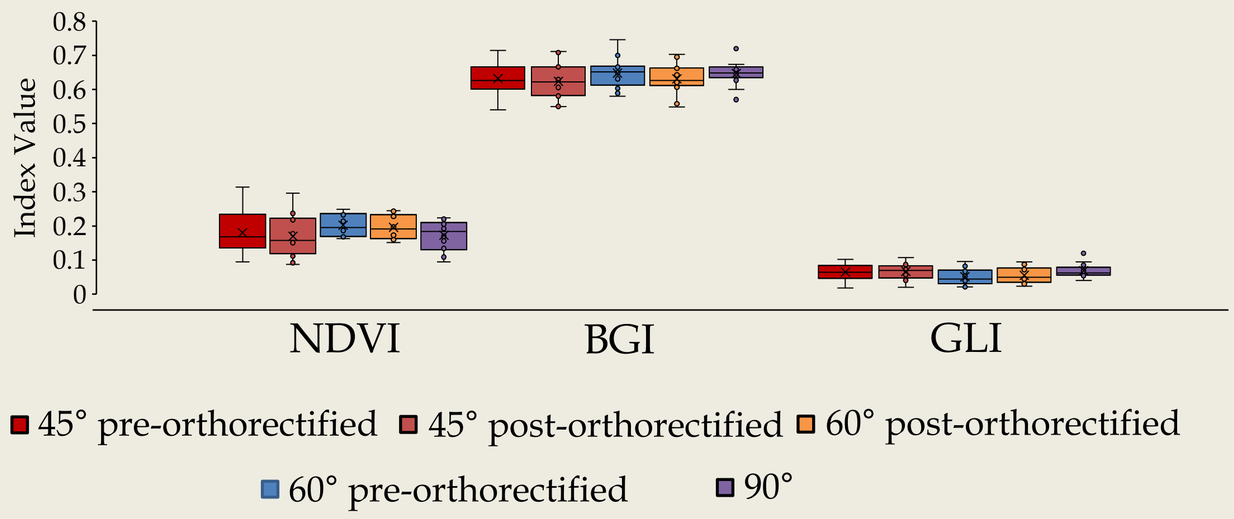

Fig. 4. Boxplots of mean VIs associated with pre- and post-orthorectified, and nadir angle images.

Conclusions

- The significant correlation between NDVI data from 60° images and NDVI data from 90° images suggests that there is an inherent link between the two types of images for NDVI.
- No significant difference in mean VIs was found between pre-rectified and post-rectified images in comparison with VIs extracted from the pseudo-reference image (acquired at nadir).

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