Quantifying Relative Canopy Temperature, Fraction of Radiation Intercepted, and Greenness Intensity of Crops from an Aerial Platform

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VASSAR COLLEGE A.D. 1861

INTRODUCTION

The introduction of reliable, inexpensive unmanned aerial systems (UASs) into US agriculture is anticipated to fundamentally change the way that farmers and agricultural scientists collect information about their crops. With correct sensors in place, information regarding crop nutrition, crop stress, disease, and soil moisture can be collected remotely.

Using remote-sensing, scientists have the potential of collecting data on large numbers of plots at the same time from aerial platforms and using that information to improve management and selection protocols in breeding programs. One impediment for utilizing this information includes a lack of appropriate tools to quantify remote-sensing data for individual research plots. The objective of this research was to develop software that could quickly and easily quantify remotely-sensed measurements from images of research plots taken from an aerial platform.

OBJECTIVES

- Develop easy-to-use software to quantify canopy greenness, infrared temperatures, and canopy coverage (i.e., fraction of radiation intercepted) from digital images taken from an aerial platform.
- Compare software performance with standards methods

Figure 1: Large kites (windy days) or a large tethered balloon (calm days) were used to lift camera systems ~75 m above experiments.

MATERIALS AND METHODS

Custom software –

- Custom software (Badhorse) developed as a Java application for the analysis of canopy coverage, Dark Green Color Index (DGCI, Rorie et al., 2011), and infrared temperature from aerial images (Purcell and Purcell, 2016)

Greenness –

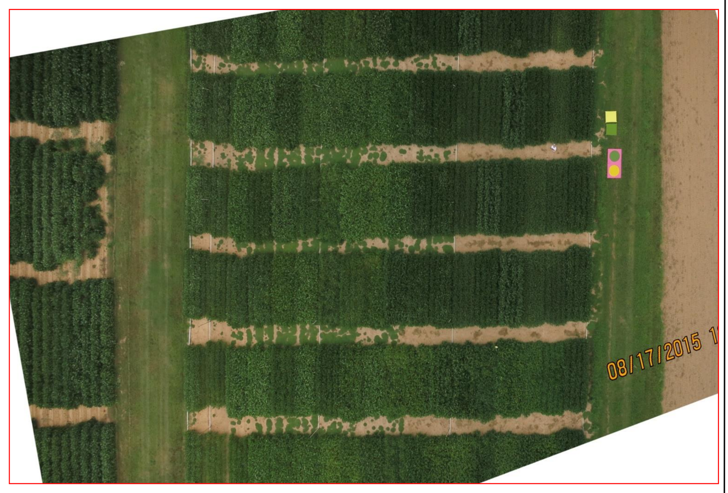
- Soybean maturity groups (MGs) 2-5 plots
- During seedfill, weekly color aerial images
- Green and yellow color standards included in each image
- DGCI compared using GIMP (www.gimp.com) and Badhorse

Canopy coverage –

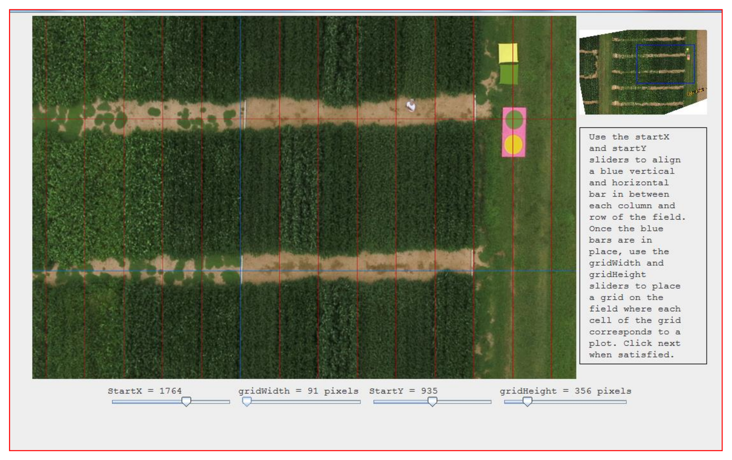
- Target populations of 10, 20, and 40 plants m^{-2}
- Color images made from ground and air
- Fraction of green pixels per plot measured with SigmaScan Pro 5 (ground) and using Badhorse (aerial)

PROCEDURE

Picture aligned horizontally in GIMP



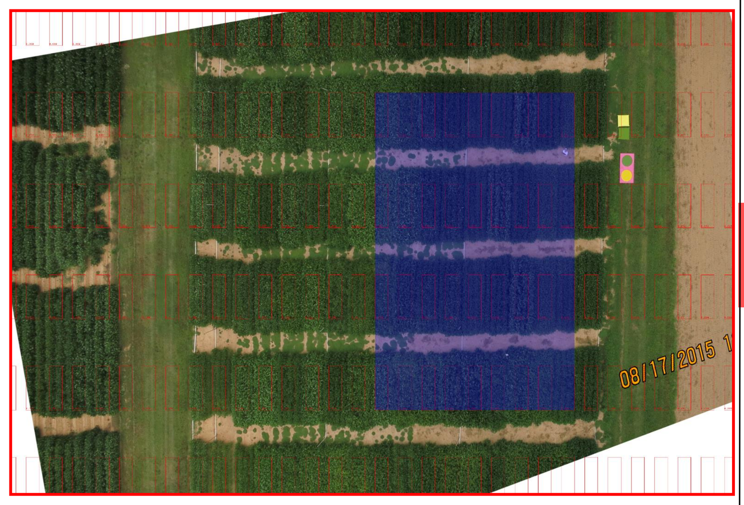
Custom software (Badhorse) used to delineate individual plots



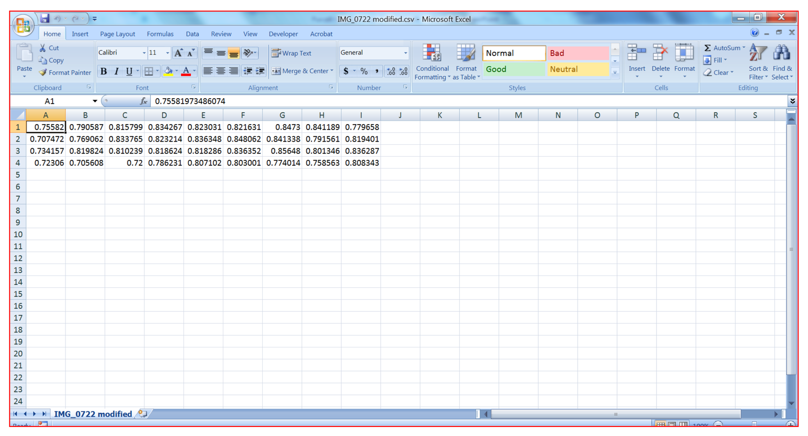
Border areas of plots removed

For DGCI analysis, color standards selected

Select plots for data analysis



Results are saved in a spreadsheet



Analysis for canopy coverage and IR are similar except:

- For IR, sliders eliminate heat signature from soil
- For canopy coverage, sliders identify green pixels based on hue, saturation, and brightness

RESULTS

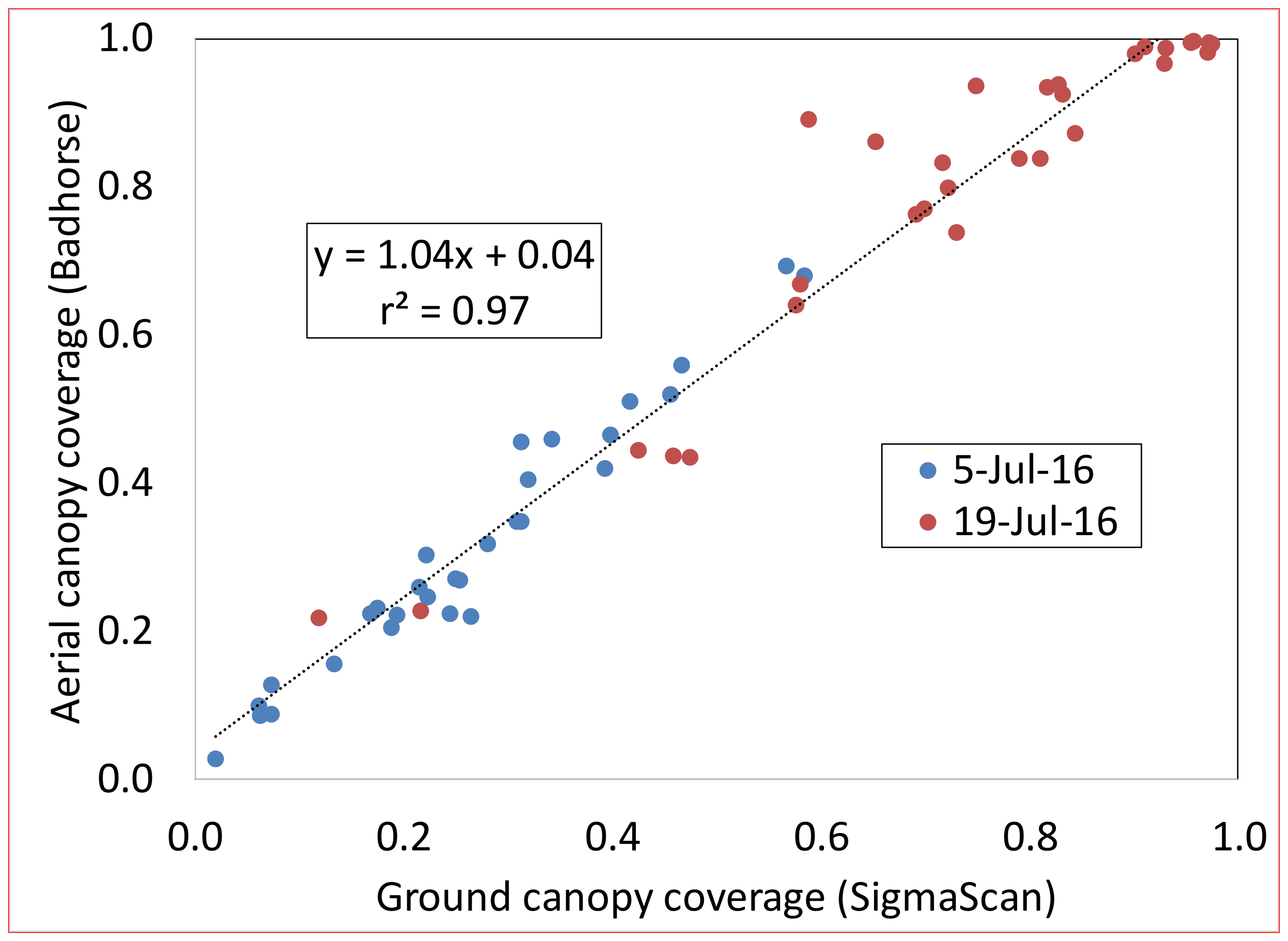


Figure 2. Aerial canopy coverage measurements using custom software, Badhorse, versus ground measurement of canopy coverage using SigmaScan Pro 5. Measurements were made on 5 July and 19 July 2016.

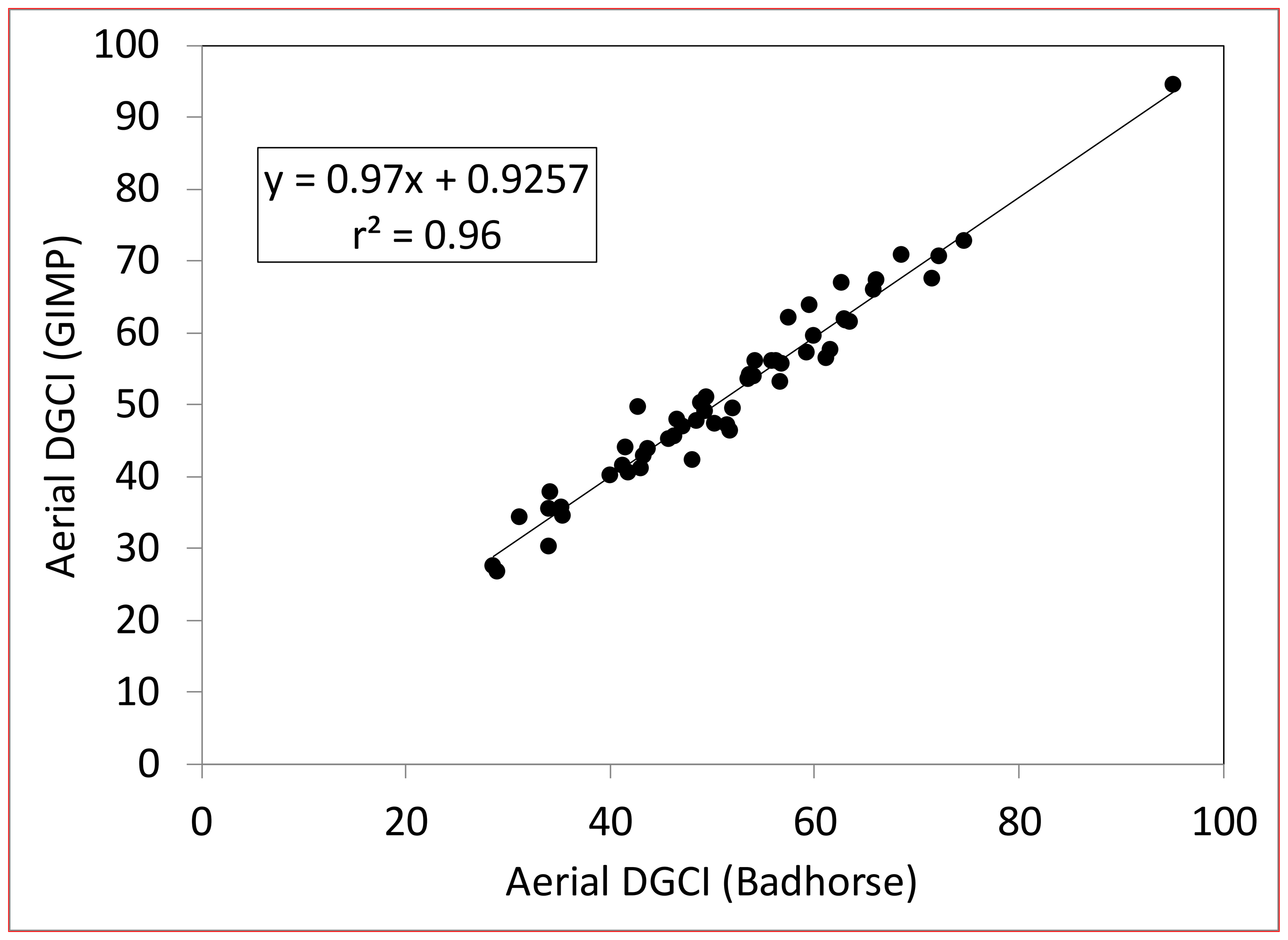


Figure 3. Aerial dark green canopy index (DGCI) measurements made with GIMP versus aerial DGCI measurements using Badhorse.

DISCUSSION

- Aerial measurements of canopy coverage and DGCI using Badhorse had near perfect agreement with measurements using SigmaScan or GIMP, respectively.
- Badhorse allowed entire experiments to be analyzed at once, greatly speeding up analysis.
- Similar options allow analysis of IR temperature.

REFERENCES

Rorie, R.L, L.C. Purcell, D.E. Karcher, and C.A. King. 2011. The assessment of leaf nitrogen in corn from digital images. Crop Sci. 51:2174-2180.

Purcell, C.J. and L.C. Purcell. 2016. Badhorse - A stand alone Java Application for the automated analysis of aerial images of crop fields. https://github.com/carlinpurcell/badHorse