

Rapid Estimation of Canopy Cover in Durum Wheat Using Digital Images

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Introduction

There is increasing demand for simple, rapid methods to evaluate crop growth under field conditions, especially as a means to assist dissection of interacting effects of genetics, environment and management on crop growth and development. Simple digital color (RGB) images of crop canopies can be analyzed to estimate canopy cover. We assessed canopy cover using digital images of a diversity panel of 260 accessions of durum wheat (*Triticum turgidum* Desf.), originally from different countries across the wheat-growing areas, in a 2016 field experiment at Maricopa Agricultural Center in Arizona. This diversity panel has been previously genotyped using a high-density single-nucleotide polymorphism (SNP) assay.

Methods

- Simple metal A-frame camera stand (Fig 1) was used to ensure a nadir (overhead) view and constant height, and hence field of view.
- Field of view was matched to the 0.76 m plot width to provide an unbiased sample area.
- Manual photographs (Lumix DMC digital camera) were taken of each plot at two positions within the plot.
- Photo sets of all field plots were taken on 7 dates at weekly intervals. Stand counts (plants per meter) were measured in the field at 26-28 DAP for baseline data.
- Canopy cover was estimated from each image using a batch script implemented in ImageJ (1.49V) that segmented images based on hue and brightness (Fig 2).

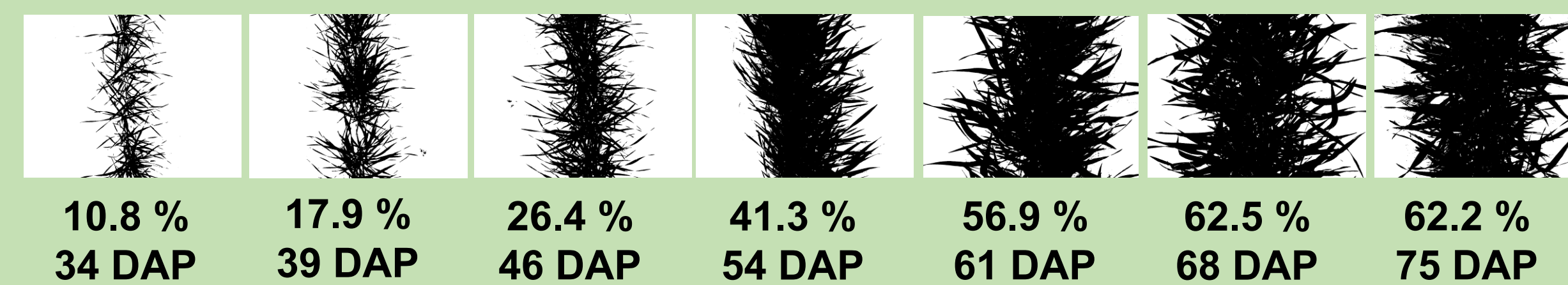


Figure 2. Binary outputs for individual RGB images taken on 7 dates during crop growth, then segmented based on hue and brightness using a batch script implemented in ImageJ.

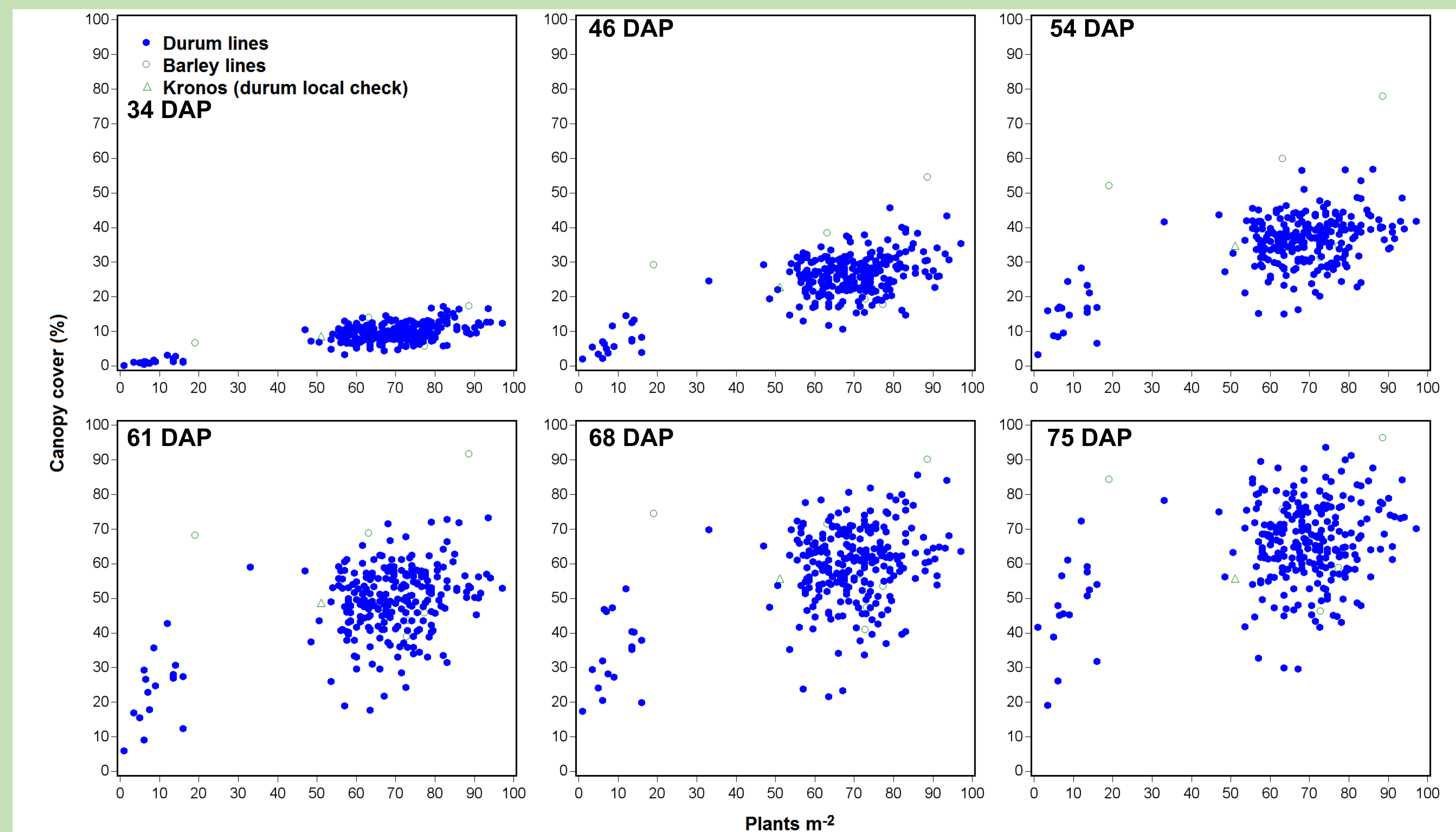


Figure 3. Scatter plots relating canopy cover to plant density for 6 sample dates during crop development for 260 accessions of a durum wheat diversity panel. Symbols differentiate the durum accessions, the check line (Kronos durum variety), and 10 barley lines.



Figure 1. Metal A-frame stand used to estimate canopy cover from nadir RGB images of 260 accessions of a durum wheat diversity panel in a small-plot field experiment.

Bubble level

Remote shutter release

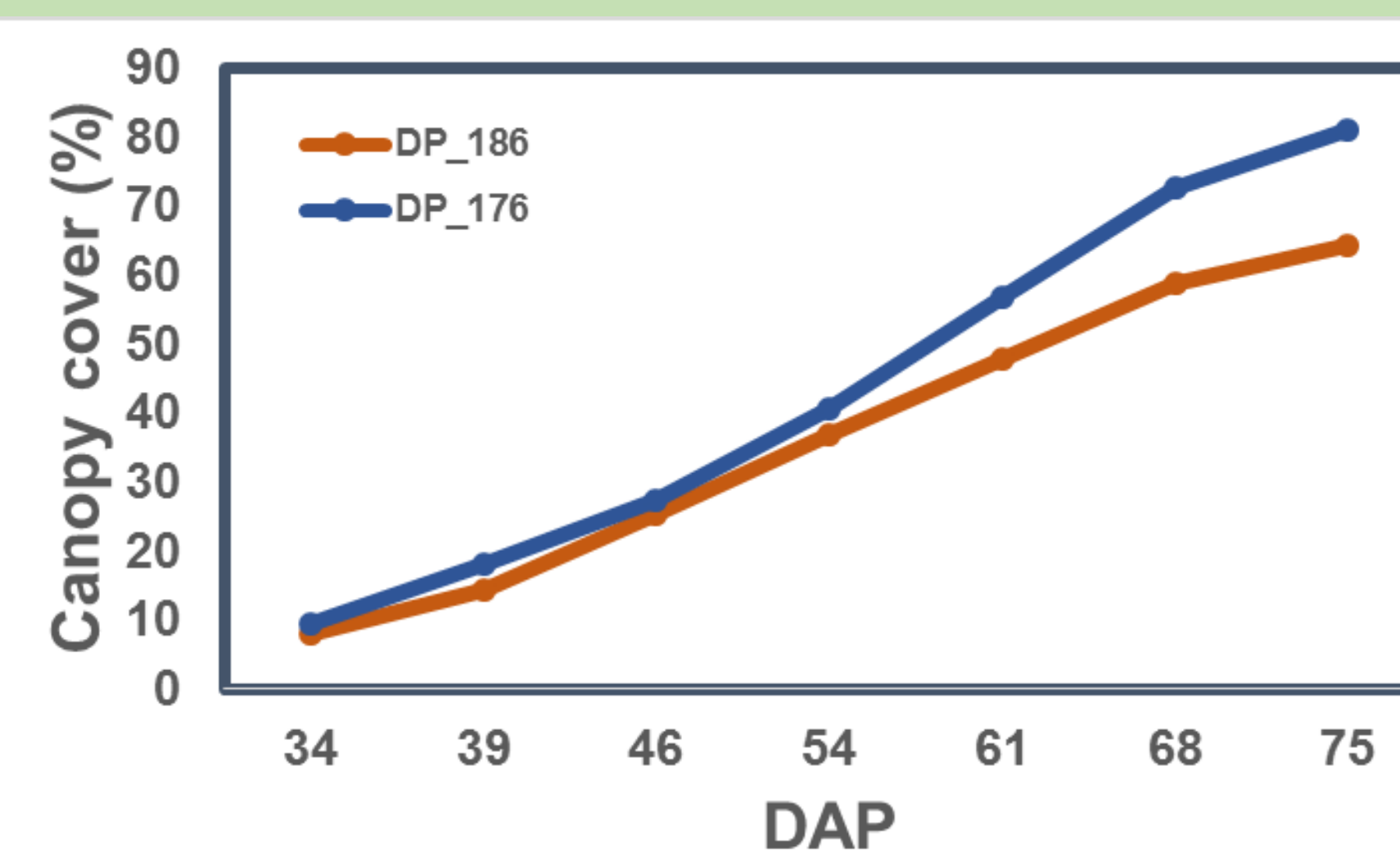


Figure 4. Growth curves for two durum wheat accessions showing growth rate differentiation beyond 54 days-after-planting.

Results

- Approximately 200 images could be recorded per hour in the field.
- Image analyses of canopy cover for 600 images could be completed in approximately one hour on a laptop computer.
- Early canopy cover correlated to stand counts ($r = 0.71$, $p < 0.001$ at 34 DAS).
- Time trends showed large differences among lines for rate of growth and maximum cover (Figs 3 and 4).

Discussion

The method shows value as a simple and low-cost option for field-based phenotyping to better understand the impacts of abiotic conditions and climate on genotypes and crops. Minor issues were found with leaves of weeds being included in cover estimates and with variation in lighting.

