

Low-cost assessment for early vigor and canopy cover estimation in durum wheat using RGB images

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Abstract

Early vigor and canopy cover is an important agronomical component for determining grain yield in wheat. Estimates of the canopy cover area at early stages of the crop cycle may contribute to efficiency of crop management practices and breeding programs. Canopy-image segmentation is complicated in field conditions by numerous factors, including soil, shadows and unexpected objects, such as rocks, weeds, plant remains, or even part of the photographer's boots (many times it appears in the scene); and the algorithms must be robust to accommodate these conditions. Field trials were carried out in two sites (Aranjuez and Valladolid, Spain) during the 2016/2017 crop season. A set of 24 varieties of durum wheat in two growing conditions (rainfed and support irrigation) per site were used to create the image database. This work uses zenithal RGB images taken from above the crop in natural light conditions at different stages of growth, eleven and twelve acquisition dates for Aranjuez and Valladolid respectively were used. The images were taken with Canon IXUS 320HS camera in Aranjuez, holding the camera by

hand, and with a Nikon D300 camera in Valladolid, using a monopod. The normalized difference index (NDVI) was measured in the same plot and almost all data were measured at the same date when images were taken.

The algorithm for early vigor and canopy cover area estimation uses three main steps: (i) Image decorrelation (ii) CIE Lab space transformation (iii) segmentation using an automatic threshold based on the image histogram. The first step was chosen to enhance the visual interpretation and separate the pixel colors into the scene; the colour space transformation contributes to further separate the colours. Finally, an automatic threshold using Otsu method allows for correct segmentation and quantification of the canopy pixels (Figure Abstract). The percent of area covered by the canopy was calculated using a simple algorithm for counting pixels in the final binary segmented image. Canopy cover area results from different dates were used to calculate a numerical integration using the trapezoidal method. Pearson correlation, linear regression and cross-validation were used to analyse the relationship between early vigor, canopy cover area, numerical area integration, Breedpix software results and grain yield. The comparative results demonstrate the algorithm's

effectiveness through significant correlations between early vigor, canopy cover estimation and NDVI against grain yield.

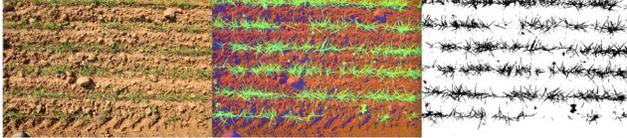


Figure abstract. Example of the main image processing steps.