PhenoVation
Life Sciences

Colour imaging of plants for detection of minute colour deviations

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Introduction

The CropReporter uses LED (light emitting diode) induced direct fluorescence imaging technology to image the plant health/stress status by calculation of F_v/F_m (variable fluorescence over saturation level of fluorescence). Within a short time interval (≈800 ms) multiple images are captured. For each pixel of the fluorescence image F_v/F_m is calculated and presented as an image that correlate with the quantum yield of PSII photochemistry. The advantage of the technology lies in the imaging of photosynthetic parameters of whole plants within a short time interval and detectable before it can be seen by eye.

Inside the CropReporter there is place for 6 different optical filters. With these filters the following images can be made:

- Separate red, green and blue images
- Chlorophyll absorption images
- Anthocyanin absorption images
- Near Infra Red (NIR) images.

The CropReporter captures spectral images by using a 6 position optical filter wheel. For colour it uses red, green and blue information. The software reconstructs these images into a 3x14 bit colour image with a spatial resolution of 1.4MP (Fig. 2A). Plant parts contain chlorophyll and show fluorescence (Fig. 2B), this property is used to discriminate the plant from the background. By using only pixels from the colour image that show fluorescence, a new image is being calculated showing the plant without background (Fig 3A). Using information on the red, green and blue parts of the plant that display a change in colour, like in this case yellowing and browning, can be calculated and the corresponding pixels are coloured red (Fig. 3B). It is also possible to mark the parts of the plant that display a dark green colour (Fig. 4).

Figure 1. CropReporter for side view imaging of monocotyledons. Using high intensity red light emitting diodes fluorescence images are being captured, white light emitting diodes together NIR lighting are being used for spectral imaging at six different filter bands. Images are captured at a resolution of 1.4 Mp and 14 bit digital grey values.

Figure 2. A) Colour image constructed from separate red, green and blue images of a rice plant (Oryza).. B) Image showing the chlorophyll fluorescence image that is used to discriminate the plant from the background.

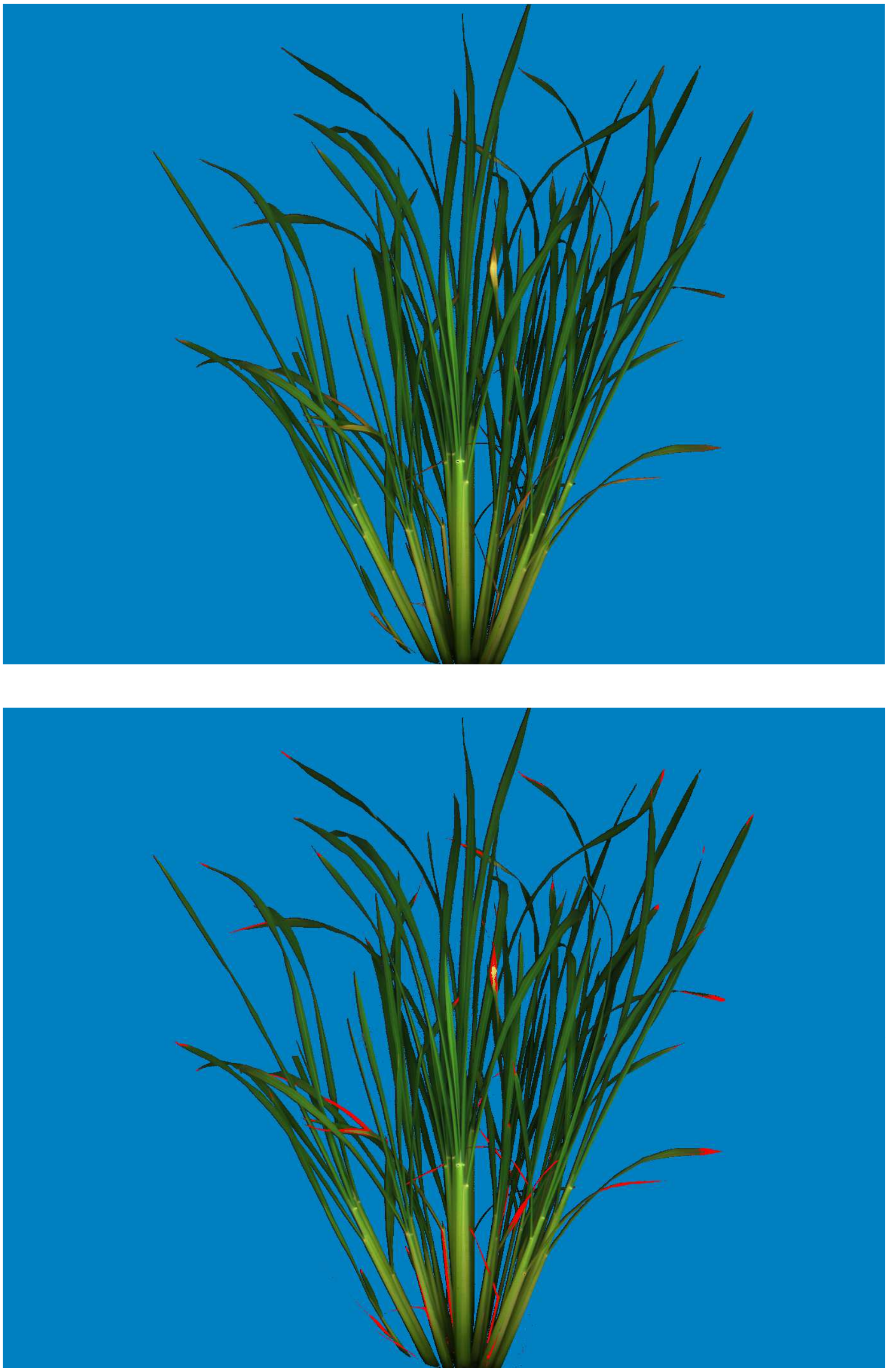

Figure 3. A) Colour image separated from the background using pixels that show chlorophyll fluorescence from figure 1B only. B) Image showing the overlay on the colour image of plant parts that show either yellowing or browning (in red false colour).

Figure 4. Image showing the overlay on the colour image of plant parts that show dark green colour (in red false colour).

Advantages

A normal RGB colour camera used in current phenotyping are 8 bit camera's. The CropReporter uses a 14 bit camera. Comparison of the two cameras shows how accurate they can measure a colour:

Normal RGB camera : 2^8= 256 grey values for one color.

CropReporter :2^{14}=16.384 grey values for one color.

This calculation shows that the CropReporter captures the different colours 64 times more precise than a normal RGB camera. This could be very important to detect early yellowing of the leafs.

Conclusion

The CropReporter was able to capture high resolution colour images and separating the colour image from the background by using information of the chlorophyll fluorescence. Parts of the plant that show a specific colour can be highlighted as an overlay superimposed onto the colour image.

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