Grower Summary

CP 060a

Combined thermal and visual image analysis for crop scanning and crop disease monitoring

Annual 2012

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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HDC is a division of the Agriculture and Horticulture Development Board.

Project Number:	CP 060a
Project Title:	Combined thermal and visual image analysis for crop scanning and crop disease monitoring (HDC STUDENTSHIP)
Project Leader:	Dr Nasir Rajpoot
Contractor:	University of Warwick
Industry Representative:	Alan Davis
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Previous report/(s):	None
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Project Cost:	£64,650

Headline

New software is under development to create an accurate 3D thermal profile of a crop with the aim of accurately identifying temperature anomalies associated with plant stress. Early developments using data from water stress treatments indicate the potential for this approach.

Background

Infrared thermometers have been used since the early 80's to determine the temperature differences in plants and different parts of canopy by researchers for irrigation scheduling purposes. However, the development of thermal imaging cameras has extended the opportunities for more detailed and sensitive analysis of the thermal properties of plants and canopies. This has led to the development of different applications including early detection of water stress, plant disease and plant phenotyping. One of the major problems associated with thermal imaging in plants is temperature variation due to canopy architecture and other external factors. Leaf angles, sunlit and shaded regions, environmental conditions and the distance of the plant from the camera play a major role in the thermal image of the plants under observation. The major aim of this project is therefore to combine analysis of stereo visual images with thermal images to overcome these problems and allow a precise 3-dimensional thermal profile of a crop to be quantified. This would then help the development of an integrated crop scanning system to identify significant temperature anomalies, hence providing growers with early warnings of possible crop disease or stress problems.

Summary

1. An experiment with impatiens where different irrigation treatments were applied (no watering, watering to 100% or 80% of previous days water loss) showed that thermal imaging could detect water stress in the unwatered treatment which had higher overall mean temperature. However, the images collected with the particular thermal camera used were not of good enough quality for detailed quantitative analysis. The figure below shows the resulting images from the experiment. The top row of plants which were watered to 100% previous day water loss appeared to be at the lowest temperature. The middle row of plants which were no watered appeared to be at highest temperature and the bottom row of plants which were watered to 80% previous day water loss appeared to have temperature in between the temperature of top and middle row.

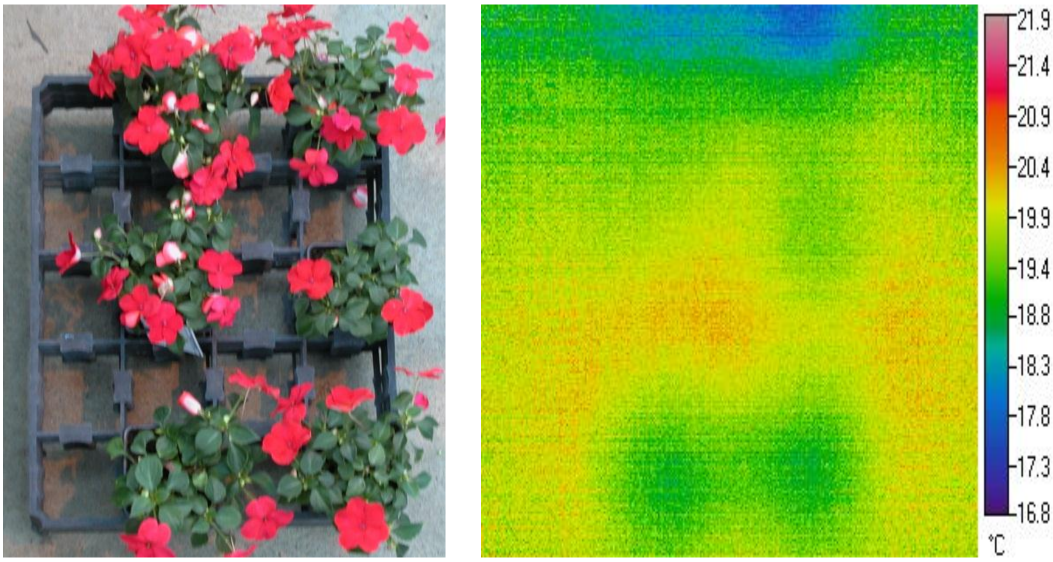

Figure 1: shows impatiens treated with different irrigation treatments. The top row was watered to 100% previous day water loss, the middle row was not watered and the bottom row was watered to 80% previous day water loss.

2. A new set up was developed to simultaneously capture stereo visual and thermal images of plants. Images of an *anthurium* plant were taken from the cameras at two different points horizontally displaced from each other. From the initial experiments it was observed that the plant regions which were higher from the ground appear to be at a higher temperature and the regions which were at an angle or further away from the camera appeared to be at a lower temperature. Quantitative analysis and modeling of the effect of height on plant temperature in the thermal image is currently underway which will help with the development of a rectified 3D thermal profile of a plant.

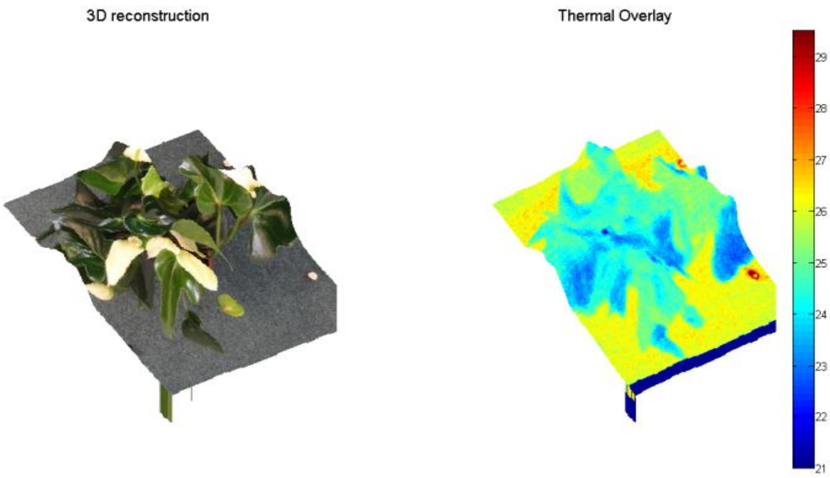

Figure 2: 3D reconstruction of plant and overlay of thermal image on the 3D reconstruction.

3. A new software application was developed and novel algorithms used to analyse high resolution thermal images of a spinach crop exposed to different irrigation regimes (image data provided by Ms. Hazel Smith and Prof. Gail Taylor at the University of

Southampton). Water-stressed treatments had a higher average temperature, higher within image temperature variation and a distribution closer to a normal distribution compared to non-stressed treatments. The differences in distribution parameters were particularly useful in identifying water stressed plants. The figure below shows a snapshot of the software along with some initial results of the statistical analysis. The results show that the images with different type of treatments can be identified by statistically analysing the thermal images. The software is a work in progress and algorithm is being enhanced to find a better separation between thermal image of plants from different treatments.

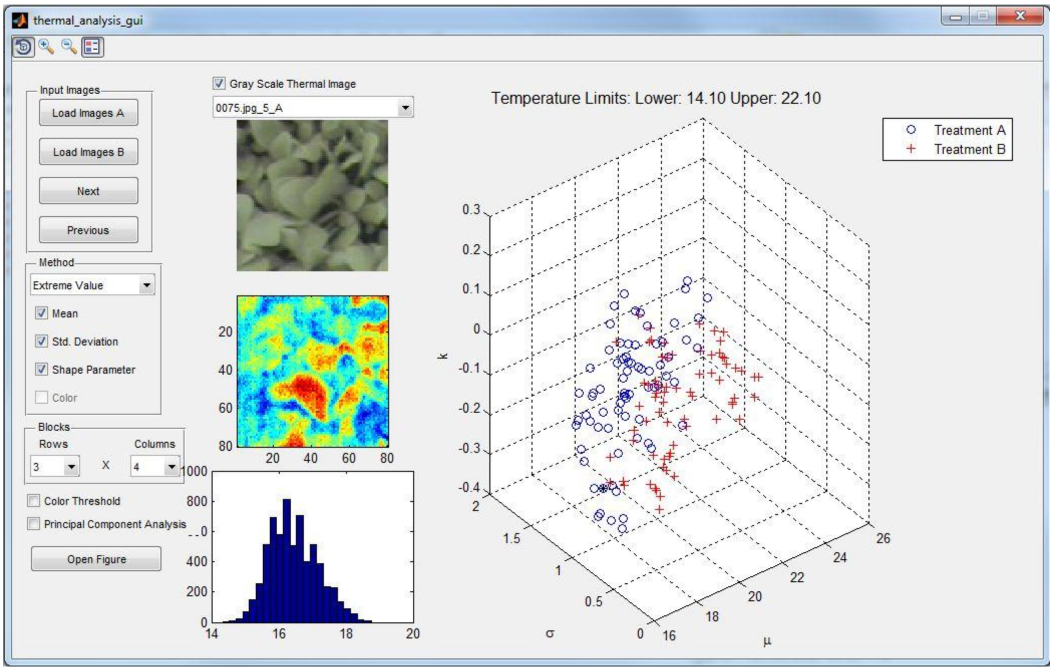

Figure 3: A snapshot of the software being developed to statistically analyse the thermal images of plants. The results show that the plants from different type of treatments can be separated by statistical analysis.

Financial Benefits

Financial assessment is premature at this stage, although it is anticipated that stress detection in different parts of the crop could help growers to water crops more efficiently and detect disease at an early stage facilitating timely action which would mitigate against crop losses and some of the costs associated with treatment.

Action point for growers

Glasshouse growers could consider options for installing an overhead system for monitoring their crop, pending further developments as this project progresses. The cost for a good thermal camera is around £15,000 – 20,000.