

**Measurement
to increase
productivity**

Digital imagery tracks lettuce growth

Photo: Amjed Hussain

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Biomass data gathered from low cost digital cameras is being assessed as a method of mapping the growth of vegetable crops.

Size and weight are the major determinants of price for lettuce. For the major supermarkets the lettuce head weight should be around 0.5kg, so growers want to maximise the production that meet this criteria. There is no premium for larger lettuces, so the aim is to place nutrients and water where they are most required to achieve even growth across a planting. Consequently, lettuce growers are interested in systems to monitor crop variability during the growing season.

At the National Centre for Engineering in Agriculture (NCEA), in collaboration with CRC Irrigation Futures (CRCIF) and Queensland Department of Primary Industries and Fisheries (QDPI&F) we are investigating the potential to monitor and map variability of lettuce growth between transplanting and harvest. Low cost digital cameras are being used to gather images during the season and software has been developed to convert the images to biomass data.

At the QDPI&F research station at Gatton an area of 92 by 11m was

cultivated into seven beds 1.3m wide and running the length of the plot. The whole area was sown to lettuce under sprinkler irrigation. Each bed was separated from the next by a 0.3m furrow and within the area two plots of 9 by 11m were established. In each of these two plots 42 sampling points were established.

Ten irrigations were applied after the lettuces had been transplanted (0, 2, 6, 9, 23, 35, 41, 47, 51, 55 days after transplanting). The amount of water applied to each plot varied at each application giving a total of

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20 irrigation rates. The aim was to create crop spatial variability and in both plots poor water distribution uniformities were tried.

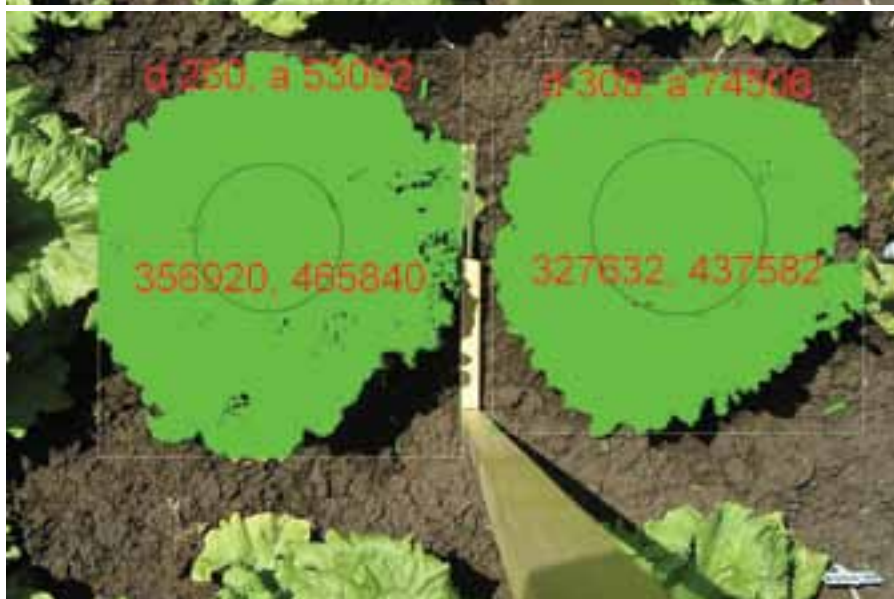
Two digital cameras were used to gather data during the trial. One was a 3.2 megapixel Olympus C-360 Zoom mounted 1.15m from the ground surface and perpendicular to the crop. This camera and setting gave a pixel resolution of one pixel represented 0.51mm. With this camera images were collected on ten occasions (7, 11, 16, 23, 31, 36, 42, 48, 53 and 57 days after transplanting) and on the same day two lettuces on either side of the image sampling point were physically measured.

On four occasions (23, 42, 48, 53 days after transplanting) images were acquired using a 5.0 megapixel Kodak CX7525 camera mounted on a 10m vertical mast and off-set boom. The camera was operated remotely from the ground. The pixel resolution for this camera and setting was less dense at 6.19mm.

Ground measurements of individual plants included in either resolution image were carried out on the same day as the image was gathered and at 53 and 57 days post transplanting.

A program was developed to measure the number of green pixels for each plant in an image. For the high resolution images taken at 1.15m from the ground the software was able to automatically identify individual plants and calculate the foliage area early in the season when there was no overlap of individual plant canopies.

The trial found a strong correlation between physical and image derived measurements of the lettuce canopy area. Generally this relationship improved during the growing season. Small leaf size early in the season may have contributed to the poorer correlation at earlier growth stages, however, canopy overlap at later growth stages also led to some



A digital camera mounted at 1.15m above the canopy was used to gather this image of lettuces and from this the number of green pixels was calculated. This technique was found to be more reliable than using images taken 10m above the canopy (see front cover). Photo: Amjed Hussain

inaccuracy. Between 16 and 31 days after transplanting the automatic detection software worked well but after day 31 it was not possible to use it due to canopy overlap.

A significant correlation between physical and image derived measurements for lettuce head diameter were also observed suggesting that this approach may be suitable for lettuce yield monitoring, possibly as part of a real-time digital video acquisition system.

As might be expected the correlation between physical measurements and the images acquired at the higher resolution at 1.15m was better than those acquired at 10m above the soil surface.

This work has now demonstrated the potential to use proximal vision sensing for lettuce yield mapping. However, further work is required to determine the optimal combination of camera resolution and height and to refine the software and image acquisition procedure to obtain real-time infield measurements.

Search the web for this paper - Evaluation of a proximal vision data acquisition system for measuring spatial variability in lettuce growth.

For more information
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