ON-FARM MONITORING AND MAPPING OF CROP DEVELOPMENT

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In an attempt to understand variability in crops, mobile phone photos were processed to assess canopy size. Preliminary results show considerable promise and the hope is that the tool can be made widely available.

Onions grown in New Zealand have a potential yield of around 100t/ha. However industry statistics show the mean national yield in a good year is about 50 t/ha and in an average year only 35t/ha. Onions are going missing, but where? There is much room for increased yield at probably little extra cost.

An onion crop was grown at the LandWISE MicroFarm at the Centre for Land and Water in Hastings. Planted on 7 June 2014, it was affected by heavy rain immediately after drilling. Prolonged wetness and a thick soil crust are believed to have caused much of the loss. However there was also a distinct pattern matching the three bed planter used, with the centre rows performing better than the outer rows of each pass (Figure 1).

Figure 1 Onions beds showing patchy establishment and better results in each third row - matching centre unit of three bed planter

We do not know how much variation might be related to other factors such as genetic variability, subtle soil variations, pests and diseases or nutrient differences.

Regardless of cause, areas of greatly reduced canopy, and ultimately greatly reduced yield, suggest different levels of fertiliser application are economically and environmentally justified.

A prerequisite for detailed nutrient planning and variable rate application is spatial knowledge of final yield. We applied fertiliser at three intervals, 2 August, 27 September and 24 October 2014. Could canopy size provide guidance for reducing these applications? Would it be economic to do so?

Overhead photos of the crop were taken across 18 crop beds on 1 October, 28 October and 14 November 2014. The images were processed to determine the percentage of green pixels as an estimate of ground cover (Figure 2).

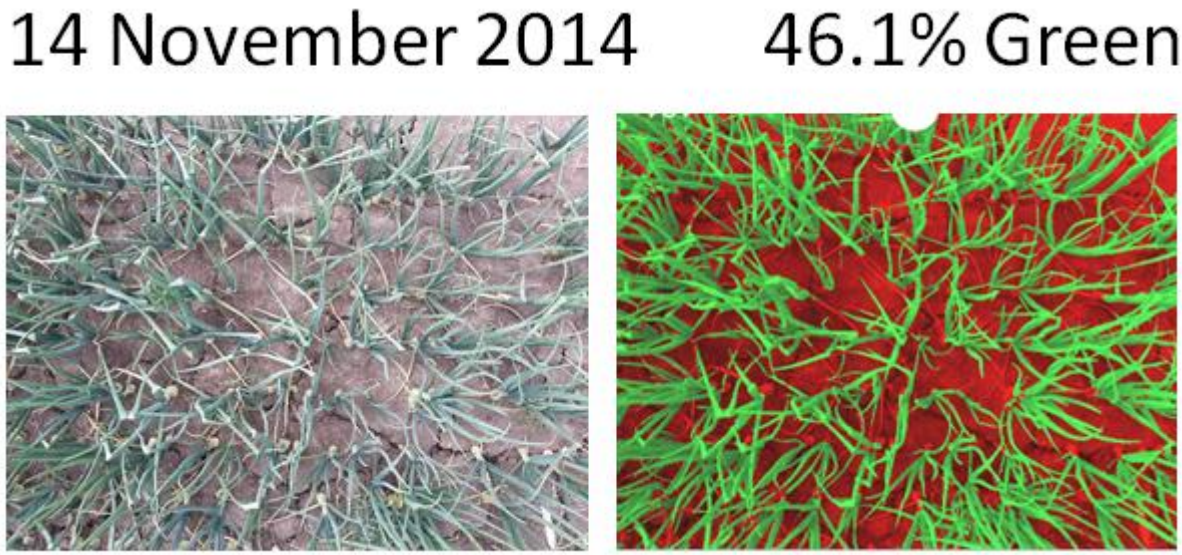
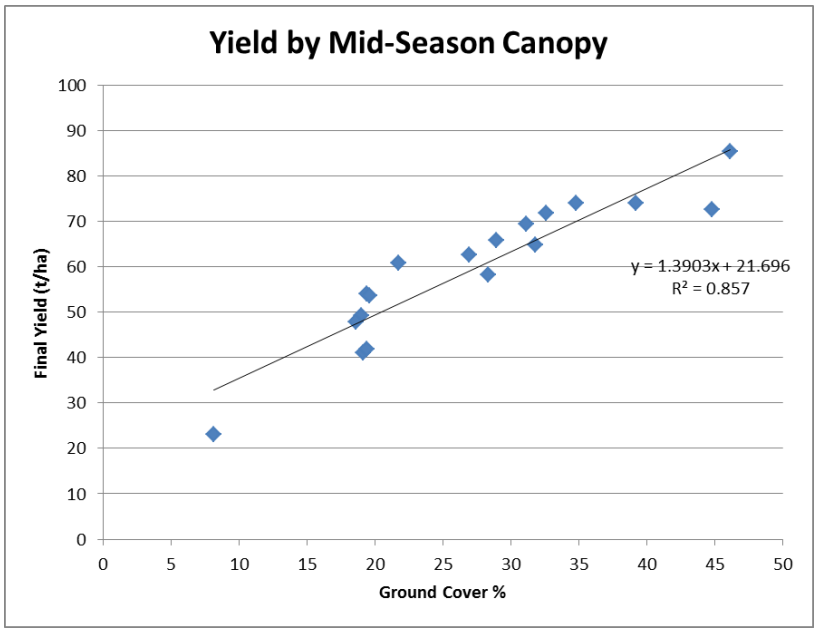


Figure 2 A standard smartphone image and a processed equivalent used to determine onion ground cover percentage at five leaf stage

The crop was lifted on 8 January 2015 and fresh weights taken from each bed. These final yield results were compared to images taken during crop development.

Data collected on 14 November show good correlation with final yield; $R^2 = 0.86$ (Graph 1). The average ground cover at this stage was 26.3% with a range of 8.1 – 46.1%. Note, however, these data were collected three weeks after our final fertiliser application.



Graph 1 Comparison of brown onion final yield against canopy ground cover at five leaf stage on 14 November

To make meaningful decisions about reducing fertiliser application, information is required early. At this stage the plants are very small (Figure 3). It was difficult to identify onion plants in the photographs taken on 1 October.

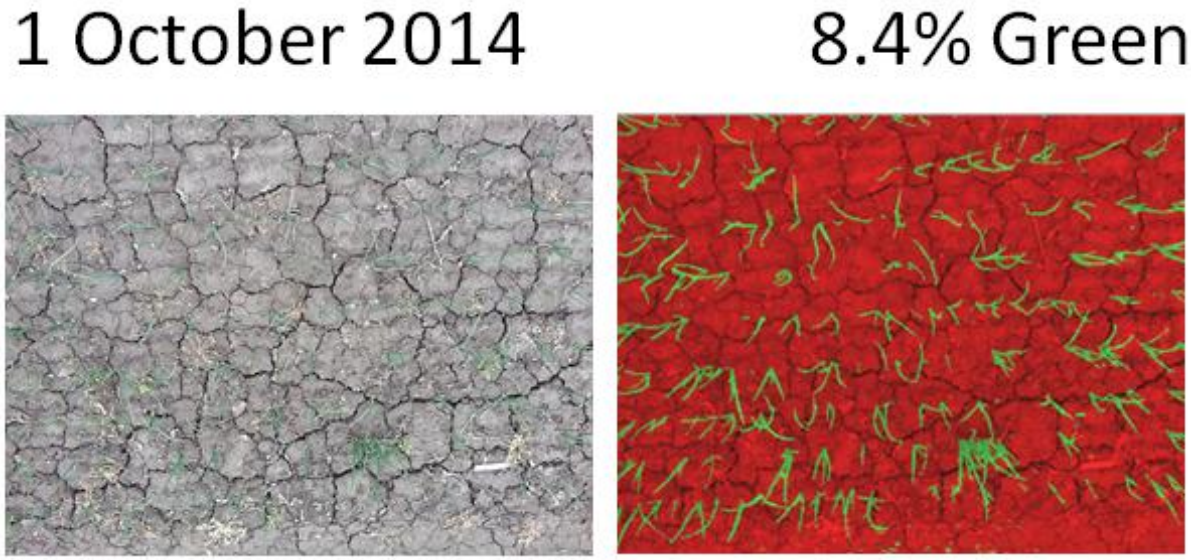
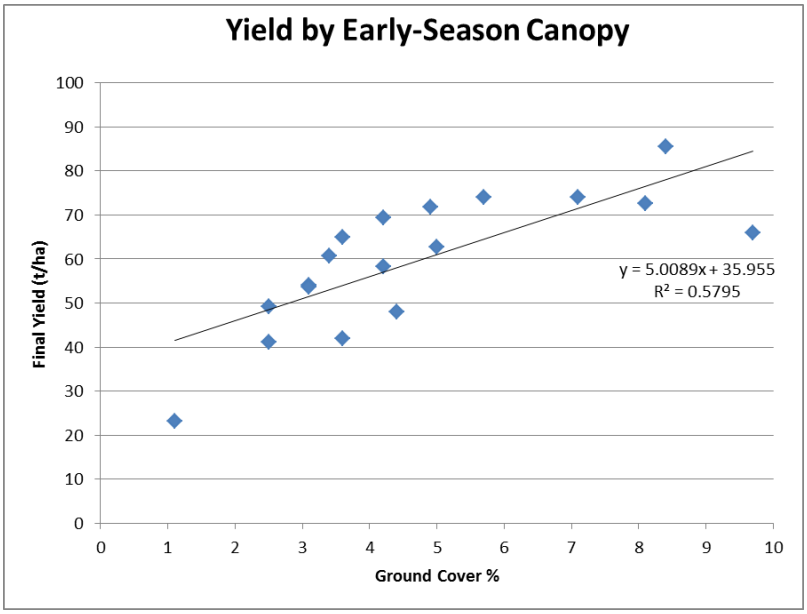


Figure 3 A standard smartphone image and a processed equivalent used to determine onion ground cover percentage at early three leaf stage

Once the images were processed, the leaves stood out clearly and a percentage ground cover could be readily determined. The average ground cover at this stage was 4.6% with a range of 1.1 – 9.7%. These data showed reasonable correlation with final yield; $R^2 = 0.58$ (Graph 2).



Graph 2 Comparison of brown onion final yield against canopy ground cover at early three leaf stage on 1 October

The image for data point 9.7%, 66t/ha stands out (Figure 4). When the image was investigated the "greenness" was found to have a significant contribution from surface algae. Eliminating that data point improved correlation; $R^2 = 0.71$.

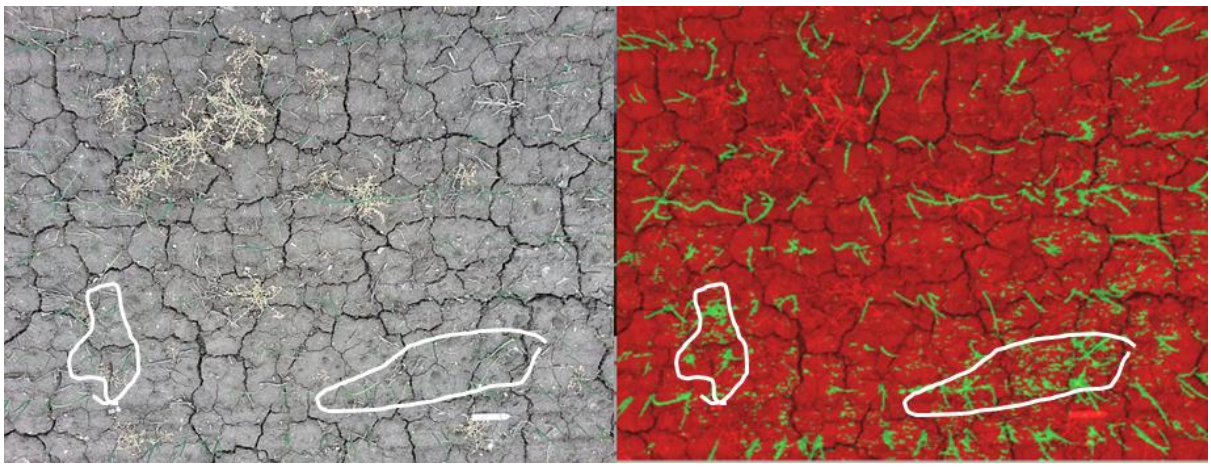


Figure 4 Raw and processed digital photographs showing areas where surface algae contributed to the "greenness" score

These data were collected four days after the second fertiliser application, which could easily have been delayed. They were collected three weeks before the third fertiliser application. We suggest simple image analysis can provide satisfactory timely information for adjusting rates and variable rate fertiliser application in onion crops.

To investigate the potential to create canopy maps, we used a smart phone to automatically capture GPS referenced images. The images were processed and displayed on Google Earth (Figure 5).

Figure 5 Collected georeferenced data showing onion canopy groundcover percentage three weeks prior to lifting.

As is evident, there is a strong spatial pattern that could allow variable rate application. The accuracy of the smartphone GPS is about 5 – 10m, which is not sufficient to correctly locate the images and subsequent ground cover factors within the correct onion bed.

The technique would be satisfactory for open field applications, especially where the spread pattern of the fertiliser applicator is 20m or more.

If we determine to individually address nutrient applications bed by bed, the GPS accuracy is inadequate. To address this, we developed our software to read an accurate external GPS stream fed into the smartphone to better locate each image point.

The image processing has also been compressed to operate on an iPhone, so the entire crop analysis and mapping operation is possible using a device owned by almost half of all farmers.

We thank the LandWISE MicroFarm sponsors and supporters for access to the onion crop.