A smarter way to count cotton pests

■ By Dr Derek Long, University of Southern Queensland

OVER the past five years, there has been significant growth in the use of machine vision in agricultural applications such as weed detection and identification. These machine vision systems have made it practical to map field variability on a large scale and enable the improved application efficiency of water and chemicals. A team, including myself, Dr Alison McCarthy from the University of Southern Queensland and Dr Paul Grundy from the Queensland Department of Agriculture and Fisheries with the support of the CRDC, is working to adapt machine vision techniques into a smartphone app for counting and tracking of silverleaf whitefly (SLW) and cotton aphid populations in cotton.

The app is expected to make pest sampling faster and more consistent between different observers and will also link in with yield loss models for pests such as cotton aphids or spray decision trigger points for silverleaf whitefly.

There is also potential to implement entire new decision models to use the expanded datasets that will be generated through the app. Current models were formed to use data that could be obtained by someone glancing at a leaf for only a few seconds. A scoring system was created for cotton aphids so that one could quickly estimate the infestation level of a leaf from 0 to 5. This yield loss model can be updated with greater granularity using a full count of the aphids on each leaf.

An update to the SLW decision model using nymph counts is underway in CRDC funded research, led by Dr Richard Sequeira, which will replace the current sampling practice which targets whitefly adults.

There are challenges with taking machine vision techniques originally proven in controlled conditions and applying them through a smartphone on commercial cotton farms. The translucent SLW nymphs become invisible to the camera when viewed in direct sunlight, so a protocol for taking pictures of leaves in shade was developed.

The quality of the images depends greatly on the quality of the auto-exposure, auto-focus and high dynamic range (HDR) in the smartphone used, so many budget smartphones and even flagship smartphones of some brands are not suitable for this application. Machine learning algorithms have been shown to achieve over 90 per cent detection accuracy on SLW nymphs in controlled conditions, and so 90 per cent accuracy is the target to achieve under field conditions on cotton farms.

Initial testing started with glasshouse trials prior to the 2018–19 cotton season. Cultures of SLW nymphs and cotton aphids were used to recreate a wide range of population sizes, nymphal stages, combinations of SLW and aphids on leaf, and severity of leaf damage from other pests. These image sets were used for initial algorithm training to detect SLW nymphs and cotton aphids as well as initial validation of classification accuracy of the two pests on the same leaf.

Data collection also took place on commercial cotton farms in southern Queensland and northern New South Wales in the 2018–19 cotton season. Images were collected using the image capture protocol, based on the use of an iPhone SE and Samsung Galaxy S7 – two flagship smartphone models from 2016. The resulting image sets were used for initial validation of pest detection accuracy.

A 75 per cent detection accuracy on SLW nymphs in the field was achieved during the first year of data collection. It is anticipated that the initial results will be improved upon with further data collection in coming seasons, bringing performance closer to what has been achieved in controlled conditions.

The app is currently moving into a closed beta test, with a group of about a dozen agronomists and researchers. The test group will provide an initial round of user feedback on structure and function of the app as well as providing crucial data collection to capture more cotton growing regions and range of lighting conditions. The nymph counting algorithm will become available for industry-wide testing in a public demo app to be released in late 2020.

CRDC and the project team are looking for a partner to take the app forward into a full release, including maintaining the app and integrating it into their services. See the Expression of Interest call on CRDC's website for more information.

FIGURE 1: Result of smartphone counting of SLW nymphs

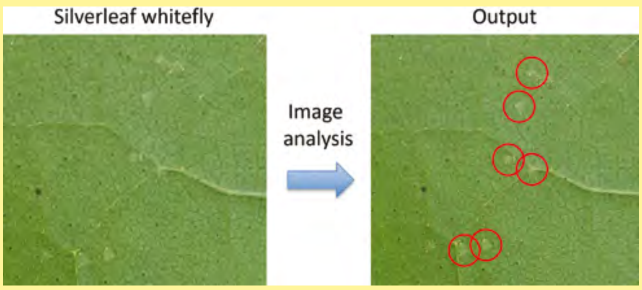
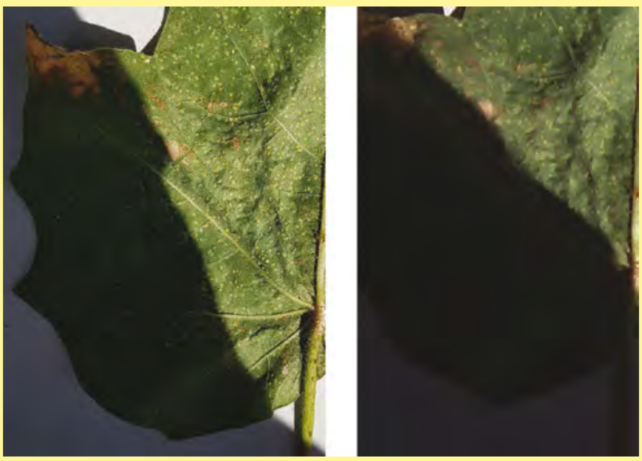


FIGURE 2: Samsung S7 (left) and ZTET816 (right) showing differences in HDR implementation



Nymphs are not visible in the shaded area with the ZTE.