Sensing tools for automated crop growth, disease and insect monitoring

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CRDC
COTTON RESEARCH AND DEVELOPMENT CORPORATION

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Introduction

In-season monitoring of broadacre crop growth and condition is required to aid on-farm management decisions. Agronomists typically conduct labour intensive manual crop scouting to assess crop vigour, growth rates, insect populations, disease onset, irrigation and fertiliser stress and maturity. USQ has developed multi-spectral machine vision systems to enable non-contact, repeatable assessment of crop features. The sensing apparatus could be mounted to tractor or drones, or fixed in the field for automated daily crop growth measurement.

Visible cameras:

NIR + visible cameras:
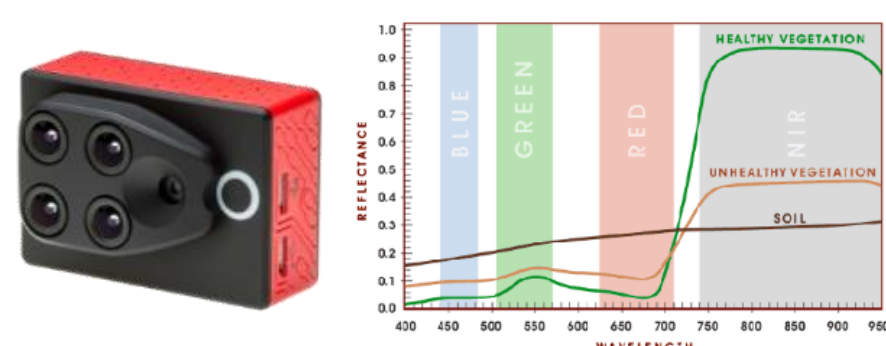
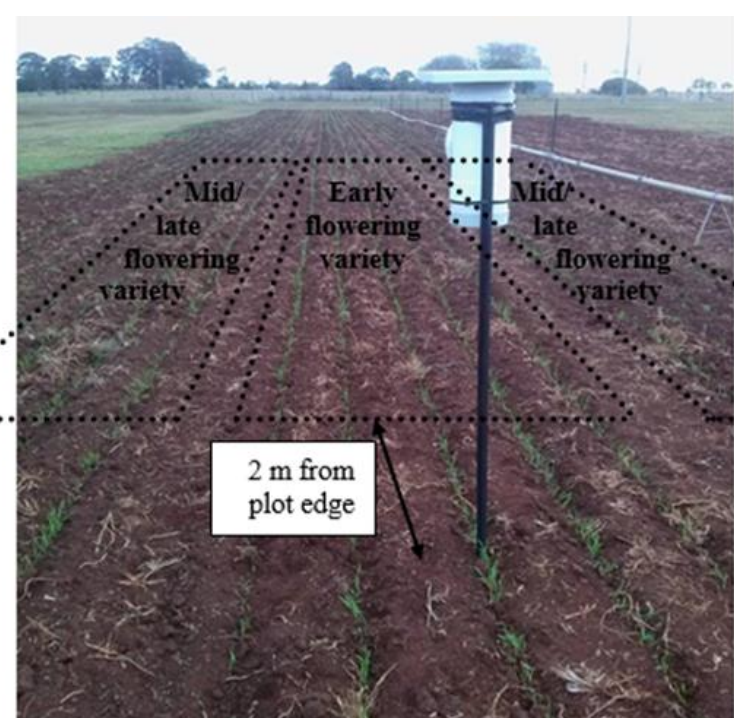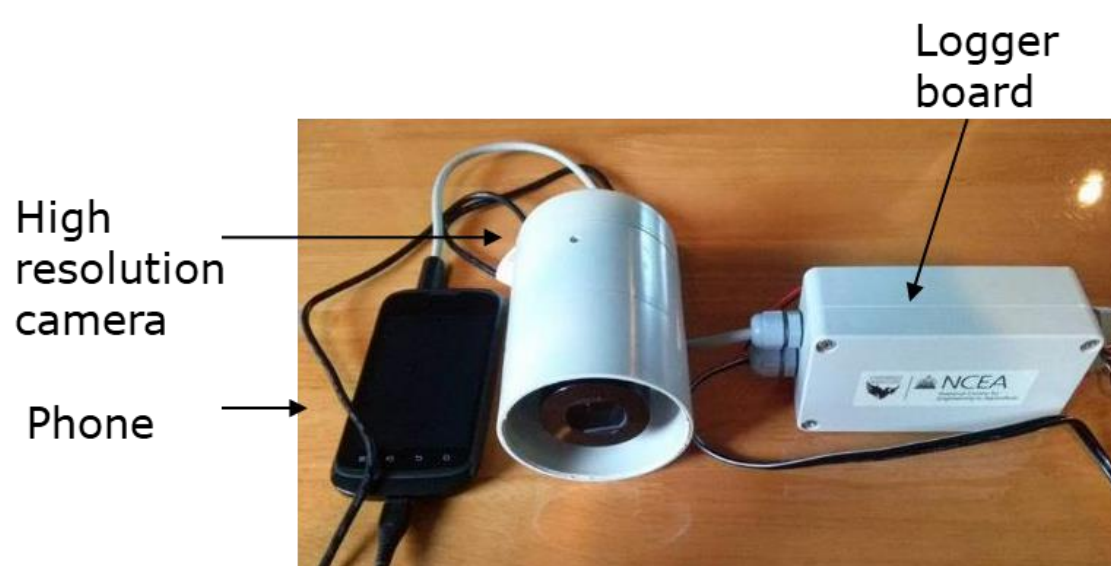**SWIR cameras:**

Thermal/LWIR cameras:

1. Variety trial monitoring

The National Variety Trials (NVT) for grain crops currently require manual observations of plots by Trial Service Providers. This often limits the frequency of variety observation and assessment. A Grains Research and Development Corporation project has developed and evaluated a smartphone-based monitoring and image processing system at four NVT sites in the Northern and Southern grain regions that:

- captures multi-spectral images from smartphone
- uploads the images to a webpage
- implements image analysis algorithms to detect wheat and chickpea flowering date to the day, canopy cover and height within 24-30 mm of three plots in front of the camera
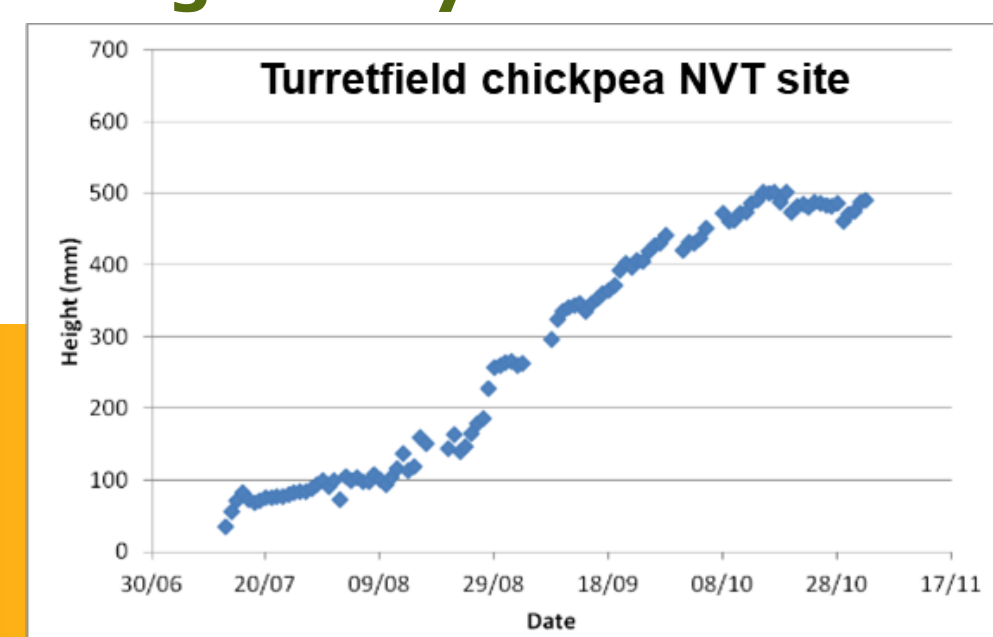
Machine vision system:

Logger board

High resolution camera

Phone

Mid/late flowering variety | Early flowering variety | Mid/late flowering variety

2 m from plot edge

Wheat at NVT site:

Image analysis results:

Turretfield chickpea NVT site

2. Insect pest monitoring

The insect pest silverleaf whitefly can cause significant economic loss to cotton crops if undetected or managed incorrectly. However, manual sampling conducted by agronomists is labour intensive. Accurate detection and spatial/temporal tracking of pests is critical for effective cotton integrated pest management strategy. A Cotton Research and Development Corporation-funded project is developing technologies for agronomists to:

- use machine vision in smartphone Apps to detect cotton pests and symptoms using infield cameras and software that automatically analyses imagery
- automatically count and classify stage of silver leaf whitefly from images of leaves captured in the field by agronomists
- accurately detect and quantify infestations of dominant pests in Australian cotton such as silverleaf whitefly, spider mites, aphids and mealybugs

Detection of silver leaf whitefly on cotton leaves:

SLW Nymphs

Image analysis
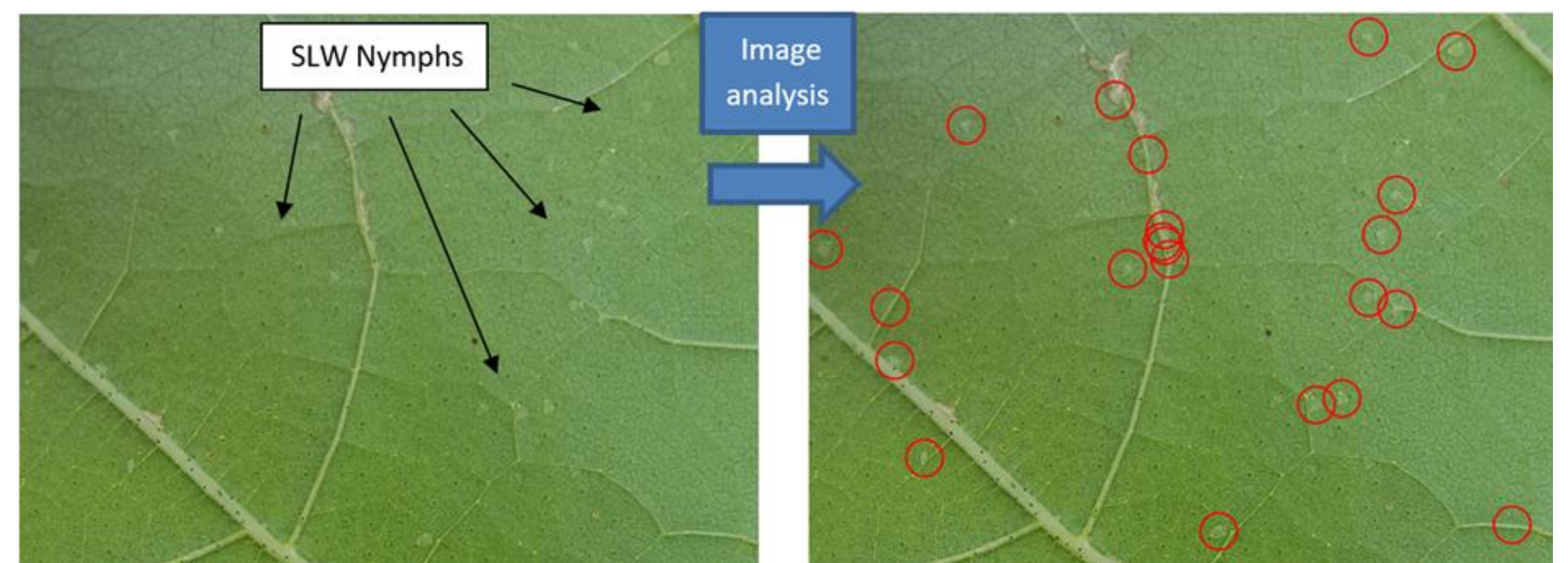
3. Grains disease detection

Wheat crown rot (Fusarium pseudograminearum) is responsible for 40% yield reduction in susceptible varieties, under conducive conditions. However, detection of this disease is difficult due to a lack of visible symptoms during the growing season. USQ is developing an automated detection approach that:

- uses the near-infrared spectrum to discriminate disease outside of the visible spectrum
- applies unique transformations for the pre-processing of hyperspectral data to create robust crop disease models with potential for drone-based disease detection camera systems
- shows promise for automated classification of crown rot in a wheat system with poor visible markers, using derived disease models
- performs as well as traditional data transformation methods, while using reduced sensor data

Model accuracies:

Accuracy vs Weeks after planting

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