"Leaf to Landscape"
Identifying *Mycosphaerella* leaf disease in *Eucalyptus globulus* plantations using digital multispectral imagery

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Introduction

The fungal pathogen *Mycosphaerella* can cause significant leaf damage and defoliation in Australian commercial plantations of young *Eucalyptus globulus*. Significant financial losses may occur as a result of reduced wood volume and quality.

We investigated the spectral changes that result from increasing infection severity caused by *Mycosphaerella* on *Eucalyptus globulus* foliage for the purpose of developing a model to estimate infection severity from remotely acquired imagery.

Methods & Results

Leaf: Spectral measurements were taken from leaves infected with various severities of infection. An analysis of wavelengths sensitive to change in infection severity identified R678 and R550 as the most and least sensitive wavelengths respectively (Fig 1). These were combined to form a ratio (R678/R550) which was most successful ($p < 0.001$, $r=0.841$) in spectrally differentiating between infection severity classes.
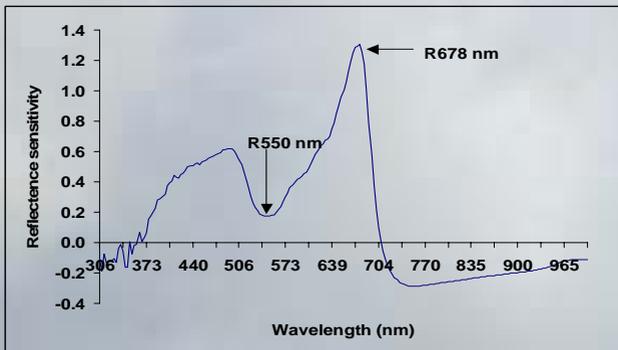

Fig 1. Reflectance sensitivity curve for highest infection damage (% leaf area necrotic) comparison. Sensitivity calculated using reflectance of healthy and most highly infected *E. globulus* foliage.

LANDSCAPE: During a flight over a plantation infected with *Mycosphaerella* a Digital Multi-Spectral Image (DMSI) was captured using four spectral bands identified as being important from the leaf analysis (Fig 2).

Image processing was completed in ENVI* by delineating reference trees (Fig 3) and correlating mean crown reflectance with the crown infection data measured in the field. Spectral bands and ratios successfully differentiated between crowns with different infection severities. R678/R550 was also the most disciminative spectral ratio at the crown scale!

Further analysis consisted of developing a *model* which when applied to the image can estimate crown infection from Low to High severity (Fig 4a). This estimation is then validated by comparison with observed data (Fig 4b).

Fig 2. DMSI – Real Image

Fig 3. Tree crown delineation of reference trees.
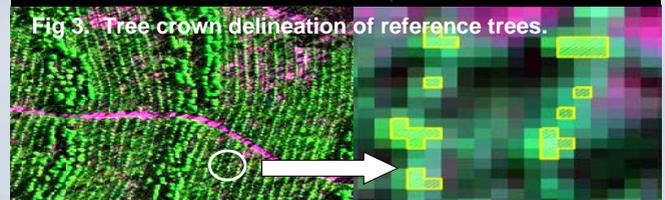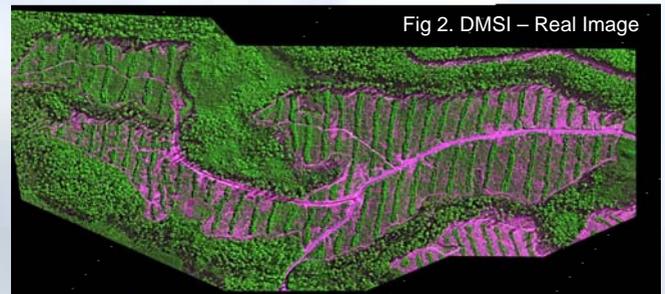
Discussion & Conclusion

The acquisition of DMS imagery can provide a non-destructive method with 100% coverage for monitoring the severity and spread of *Mycosphaerella* lead disease at the plantation scale.

The incidence and severity of MLD as interpreted from the image closely matches that measured in the field (Figs. 4a & 4b). All trees in the windrows were healthier than those in the bays and the highest disease severity was clearly localized in one section of the plantation. The next step will be to calculate the proportion of different infection severity classes in the plantation.

Fig 4a. DMSI-Predicted Infection Severity

High
Low

Fig 4b. Ground truth- Observed Infection Severity
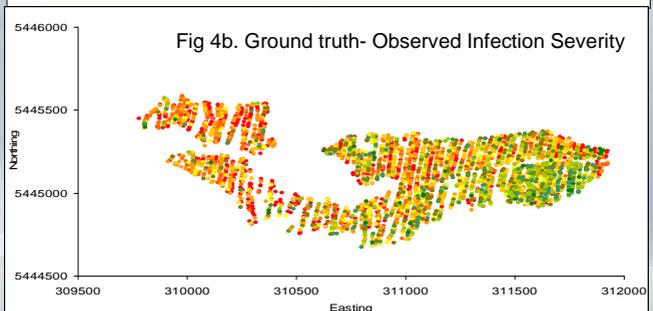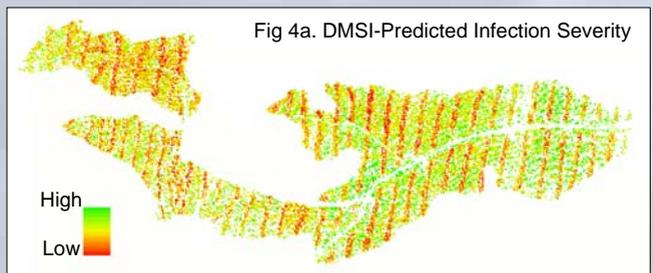
Note: Ground truth = 4% of the plantation was scored for infection severity