Use of spectral information for red scale pest control

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INTRODUCTION

Reducing the use of pesticides is one of the main goals of current agriculture, which requires fast, precise and continuous assessments of crop pests**.**

Red scale (*Aonidiella Aurantii*) is a citrus pest with a high reproduction rate, orangish appearance, transversal dark brown band, and small size (0.6 – 0.8 mm) that causes huge damage worldwide. Currently, its propagation is controlled based on periodic manual time-consuming readings of chromotropic traps (Fig. 1) spread over crops. A magnifying lens is used to recognize and count the insects, allowing the farmer to decide the optimized pesticide application (doze, where, and when).

Fig. 1. Chromotropic traps for red scale.

In this work, a spectral and spatial analysis of red scales was carried out using spectrometric devices as well as microscopy and hyperspectral imaging technology as a means of studying the feasibility of using this information for their automated detection and identification.

METHODS

50 red scales, 50 other insects, and 40 white regions of the trap selected randomly in 8 chromotropic traps were characterized by:

- Measuring the spectral reflectance of the insects between 380 and 780 nm in 4 nm steps with a tele-spectroradiometer PR-655 SpectraScan attached to a Nikon ECLIPSE L150 microscope for different magnifications (5x, 10x, and 20x).
- Evaluating the spatial properties (shape and dimensions) of the insects based on images recorded with a uEye UI-1460-C camera coupled to the Nikon ECLIPSE L150 microscope.
- Using a hyperspectral imaging system based on LEDs to obtain a joint spectral and spatial characterization of the assessed insects from spectral reflectance images.

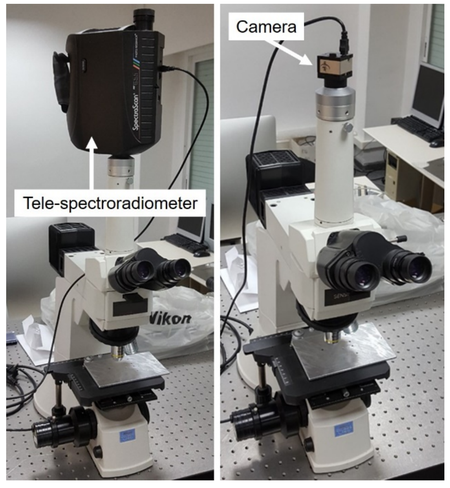

Fig. 2. Tele-spectroradiometer (left) camera (right) attached to the microscope.

RESULTS

Reflectance: Red scales showed higher reflectance values than other insects at longer (red) wavelengths (0.6 vs 0.4 at 780 nm). The white regions were very bright at all wavelengths (Reflectance > 0.6 along the measured region).

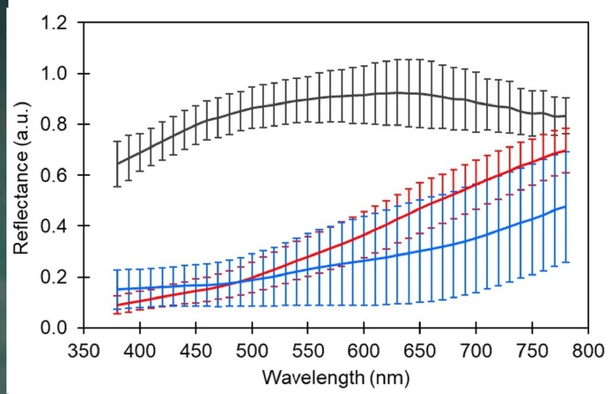

Fig. 3. Mean reflectance curves ± standard deviation of all the red scales (red), other insects (blue), and 40 white regions of the traps (gray).

Morphological features: Red scales were the smallest insects on the traps (required magnification of 20x for redscales vs 5x and 10x for other insects). Apart from the size, red scales presented a more elongated appearance.

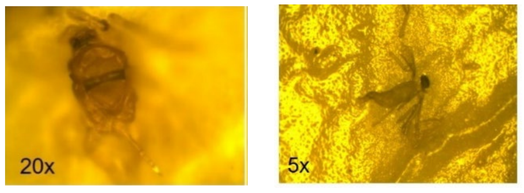

Fig. 4. Image of a red scale (left) and other insect captured with the camera attached to microscope.

Spectral imaging: At 410 nm (I_{410}), all insects are very dark, while a 774 nm (I_{774}), red scales appear brighter.

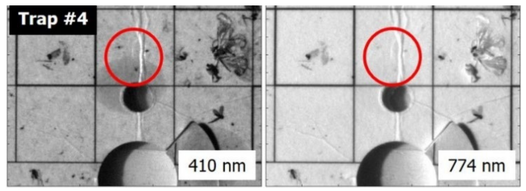

Fig. 5. Images at 410 nm and 774 nm for trap #4. Red circles indicate the location of red scales.

Using the ratio I_{774} / I_{410}, the reflectance was higher for red scales than for other insects (6.68 ± 2.03 vs 3.30 ± 1.66), and the red scales were classified with a sensitivity of 83.3%. When using the ratio R/B from RGB images, the reflectance for red scales and other insects is almost equal (6.30 ± 2.58 vs 6.10 ± 2.17).

CONCLUSIONS

- The spectral and spatial characteristics could be used for automated detection and identification of red scales in chromotropic traps.
- An increased reflectance at long (red) wavelengths was found for red scales in comparison to other insects.
- The reflectance ratio computed between long (red, e.g., 774 nm) and short (blue, e.g., 410 nm) was found to be useful to discriminate red scales from other insects.
- Since red scales are also linked to small sizes, spatial information provided by an imaging system was found to be useful to improve even more the detection of this pest.

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