Early pest detection in soy plantations from hyperspectral measurements: a case study for caterpillar detection

Matías Tailanián\(^a\), Enrique Castiglioni\(^b\), Pablo Musé\(^{ab}\), Germán Fernández Flores\(^a\), Gabriel Lema\(^a\), Pedro Mastrángelo\(^c\), Mónica Almansa\(^a\), Ignacio Fernández Liñares\(^a\) and Germán Fernández Liñares\(^a\).

\(^a\)CSI Ingenieros, Montevideo, Uruguay
\(^b\)Department of Signal Processing, Universidad de la República, Montevideo, Uruguay
\(^c\)CURE, Universidad de la República, Rocha, Uruguay

ABSTRACT

Soybean producers suffer from caterpillar damage in many areas of the World. Estimated average economic losses are annually 500 million USD in Brazil, Argentina, Paraguay and Uruguay. Designing efficient pest control management using selective and targeted pesticide applications is extremely important both from economic and environmental perspectives. Which that in mind, we conducted a research program during the 2013-2014 and 2014-2015 planting seasons in a 4,000 ha soybean farm, seeking to achieve early pest detection. Nowadays pest presence is evaluated using manual, labor-intensive counting methods based on sampling strategies which are time consuming and imprecise. The experiment was conducted as follows. Using manual counting methods as ground-truth, a spectrometer capturing reflectance from 400 to 1100 nm was used to measure the reflectance of soy plants.

A first conclusion, resulting from measuring the spectral response at leaves level, showed that stress was a property of plants since different leaves with different levels of damage yielded the same spectral response. Then, to assess the applicability of unsupervised classification of plants as healthy, biotic-stressed or abiotic-stressed, feature extraction and selection from leaves spectral signatures, combined with a Supported Vector Machine classifier was designed. Optimization of SVM parameters using grid search with cross-validation, along with classification evaluation by ten-folds cross-validation showed a correct classification rate of 95% consistently on both seasons.

Controlled experiments using cages with different numbers of caterpillars – including caterpillar-free plants – were also conducted to evaluate consistency in trends of the spectral response as well as the extracted features.

Keywords: Soy plant, defoliation, point spectrometer, spectral signature, UAV, multispectral camera, biotic stress, abiotic stress, Support Vector Machine.

1. INTRODUCTION

Damages produced by caterpillar in soy plantations is nowadays a major concern for producers since it incurs in significant losses, but also for environmental issues. Indeed, with the increase of soybean production, the application of pesticides and fertilizers has become a source of major impact on soil and potable water when plantations are close to rivers, since it causes the appearance of toxins and toxic algae. Recently in Uruguay, for instance, the government is paying important attention to this issue. From then on, the capability of precisely spotting the presence of caterpillars in soy plantations has become a major issue.

Further author information: (Send correspondence to Pablo Musé or Pedro Mastrángelo)
Pablo Musé: E-mail pmuse@csi-ing.com Pedro Mastrángelo: E-mail pmastrangelo@csi-ing.com
REFERENCES


