Spectral Analysis for Weed Identification in Rice Fields

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INTRODUCTION

Site Specific Weed Management (SSWM) has been recognized as a method to reduce herbicide use for a more sustainable weed management. Local application of herbicides aided by weed mapping allows the reduction of herbicides without impact on yield production.

In this study, we assess weed recognition in rice fields through hyperspectral data and calculated vegetations indices.

Specifically, we focus on weed species that are present in rice fields such as *Echinochloa crus-galli*, and *Persicaria maculosa* or species present in the levees such as *Digitaria sanguinalis* and *Potentilla reptans.*

METHODS

Field study

3 locations (NW Italy) | Palestro, Olcenengo, Livorno Ferraris

Hyperspectral readings

- Spectral Evolution® RS-5400 spectroradiometer
- Readings on topmost leaf of at least 12 plants/species

- Spectral signature
- Vegetation indices
  - Normalized difference vegetation index (NDVI 705) (Gitelson and Merzlyak, 1994)
  - Carotenoids Index (CARI) (Zhou et al., 2017)
  - Enhanced Vegetation Index (EVI) (Huete et al., 1997)

Species discrimination based on leaf reflectance (software: PAST)

Species of interest

Echinochloa crus-galli (ECHCG)

Digitaria sanguinalis (DIGSA)

Oryza sativa (ORYSA)

Persicaria maculosa and Persicaria lapathifolia (POLSS)

Potentilla reptans (PTLRE)

RESULTS

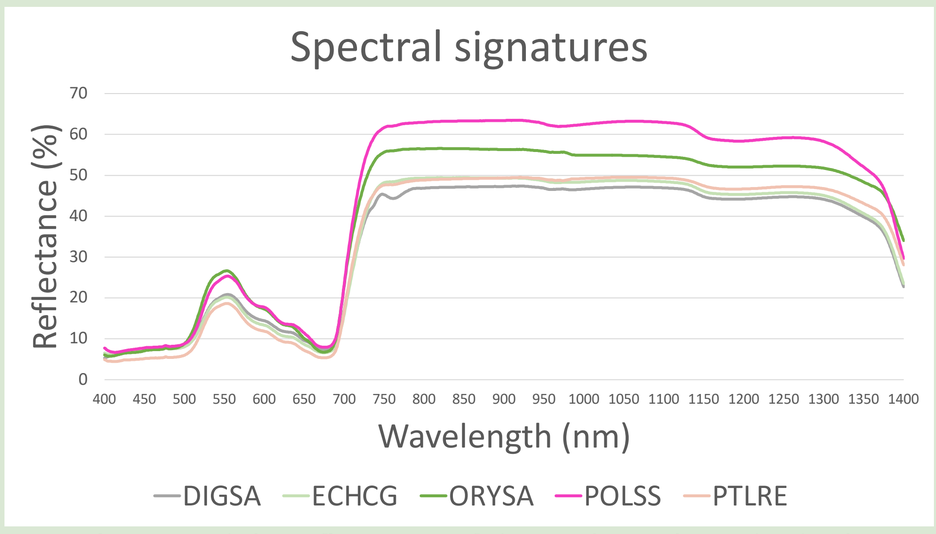


Figure 1. Light reflectance of rice and weed species in the range 400 – 1400 nm.

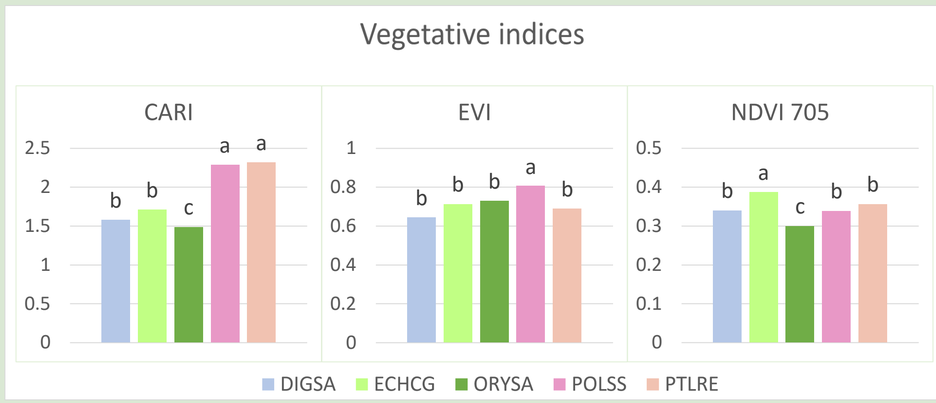
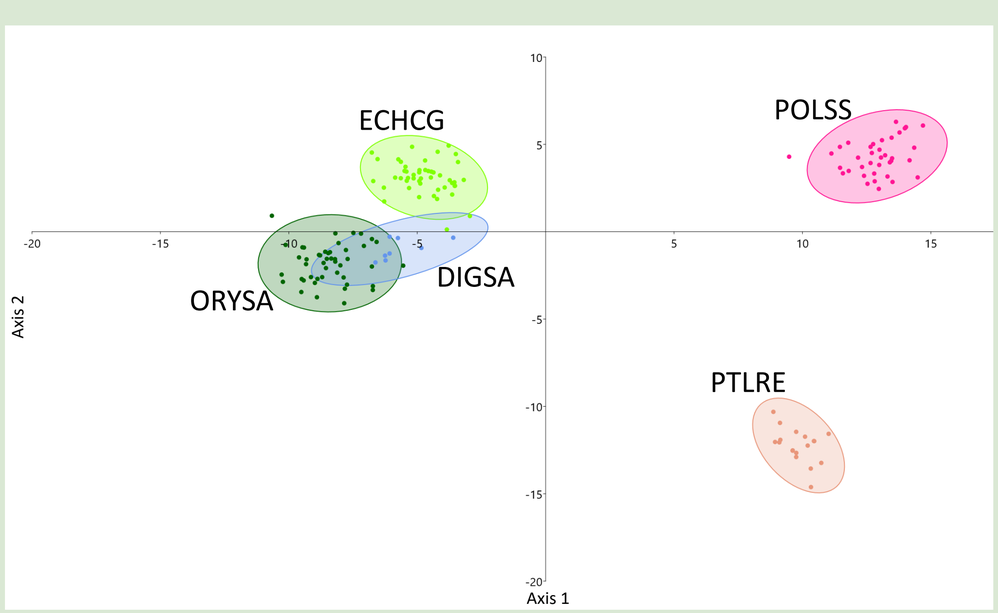


Figure 2. Vegetative indices calculated for the different species. For each index, the letters indicate homogeneous statistical groups.

- The spectral signatures (**Figure 1**) showed variation especially in the range 400-1400 nm.
- POLSS shows a **higher reflectance in the range 700-1400 nm** as typically occurs in dicotyledonous species compared to monocots (Jacquemoud and Ustin, 2019).
- The analysis of the vegetative indices allowed the **distinction between rice** plants **and weeds** by creating statistically homogenous groups (**Figure 2**).
- **The carotenoid index (CARI) resulted in the most categories** (3) by discriminating between the dicots POLSS and PTLRE, the monocots ECHCG and DIGSA, and ORYSA.
- **The Enhanced Vegetation Index (EVI)** was significantly higher in **POLSS** compared to the other species.
- **NDVI 705** allowed **a distinction among** the **grasses** (DIGSA, ECHCG, and ORYSA).
- The Linear Discriminant Analysis (LDA) resulted in a linear model that distinguishes between ORYSA, POLLA, POLPE, and ECHCG with an **accuracy rate of 92%.**
- The model considers 4 coefficients based on the reflectance data between 400-1400 nm represented in their corresponding axes (**Figures 3 and 4**).
- **Axis 1 describes 64% of the variability** between species, and when combined with axes 2 or 3 describes 85% or 74% of the observed variability, respectively.
- **Axis 1** allows the **distinction between monocots and dicots** with negative scores for the first and positive scores for the latter (**Figure 3**).
- A clear distinction can be observed between POLSS and PTLRE through axis 2 (**Figure 3**).
- Even though the combination of axes 2 and 3 describes only 30% of the variability, it shows a better discrimination between the grasses DIGSA, ECHCG, and ORYSA (**Figure 4**).



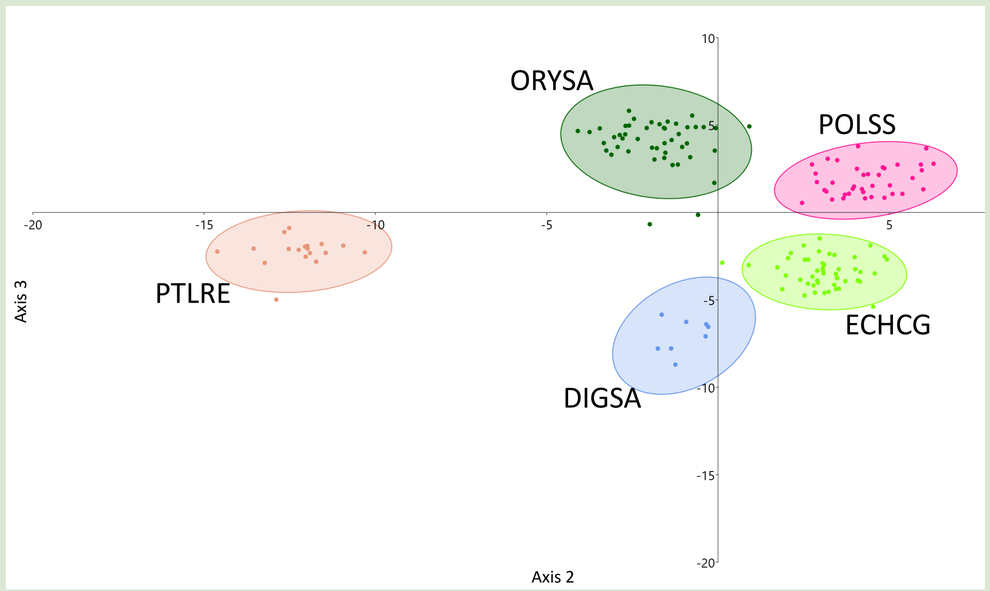


Figure 4. Rice and weeds discrimination with leaf reflectance: axes 2 – 3 at 95% confidence interval

CONCLUSION

This study substantiates the potential of spectral analysis for the distinction between rice and weed species, especially through the development of distinctive indices after discriminant analysis.
Further studies are necessary to include other species and to upscale the methodology to hyperspectral scans acquired via drone flights.

REFERENCES

Gitelson A. and Mark N. M. 1994. "Spectral Reflectance Changes Associated with Autumn Senescence of Aesculus Hippocastanum L. and Acer Platanoides L. Leaves. Spectral Features and Relation to Chlorophyll Estimation." Journal of Plant Physiology 143 (3): 286–92. https://doi.org/10.1016/S0176-1617(11)81633-0.

Huete A. R., Liu H. Q., Batchily K., and van Leeuwen W. 1997. "A Comparison of Vegetation Indices over a Global Set of TM Images for EOS-MODIS." Remote Sensing of Environment 59 (3): 440–51. https://doi.org/10.1016/S0034-4257(96)00112-5.

Jacquemoud S. and Ustin S. 2019. "Leaf Optical Properties." https://doi.org/10.1017/9781108686457.

Zhou X., Huang W., Kong W., Ye H., Dong Y., and Casa R. 2017. "Assessment of Leaf Carotenoids Content with a New Carotenoid Index: Development and Validation on Experimental and Model Data." International Journal of Applied Earth Observation and Geoinformation 57 (May):24–35. https://doi.org/10.1016/j.jag.2016.12.005.

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