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Remote monitoring of coffee leaf miner

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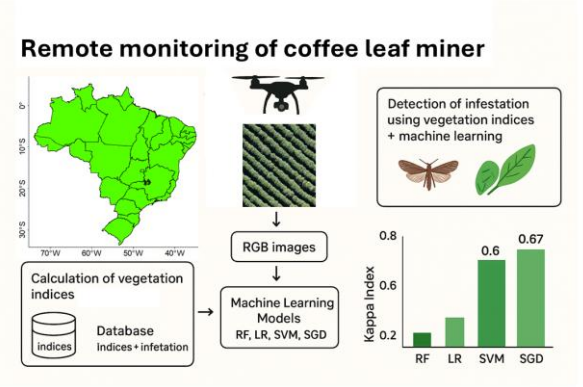
Introduction

The sustainable production of coffee crops is a global concern among producers. Pests such as the coffee leaf miner (Leucoptera coffeella (Lepidoptera: Lyonetiidae)) affect both the productivity and quality of coffee, leading to significant economic losses. Therefore, to avoid further damage, it is essential to maintain proper monitoring of coffee plantations in order to identify and mitigate problems caused by infestations. This study aimed to remotely assess coffee leaf miner infestations in coffee plantations using machine learning and vegetation indices.



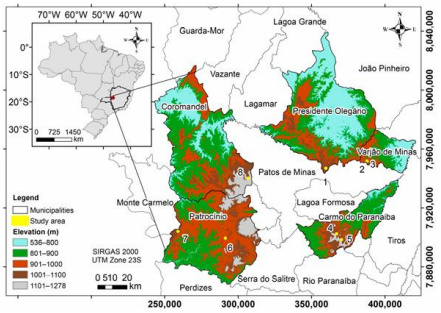


Figure 1: Location of the study areas. Adapted from Vilela et al., 2024

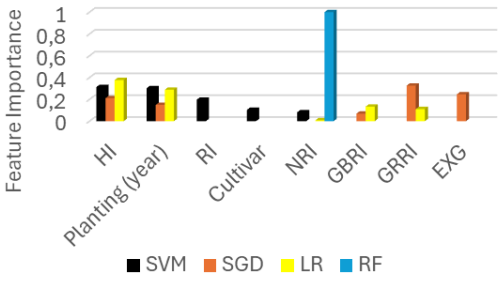


Figure 2: Key variables for predicting coffee leaf miner infestation

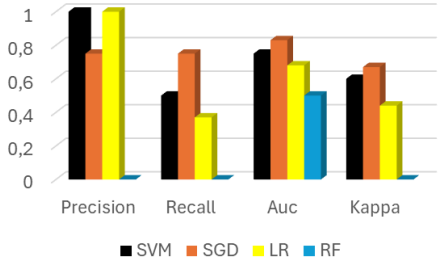


Figure 3: Performance metrics for the classification algorithms.

Materials/Methods

Coffee plants cultivated between 2008 and 2021 were selected, representing five cultivars (Paraíso, Paraíso 2, IAC 125, IPR 100, and Catucaí 144). Thirteen vegetation indices were calculated (Normalized Redness Intensity -NRI, Excess Green Index - EXG, Green Red Ratio Vegetation Index - GRRI, Green Blue Ratio Index - GBRI, Red Blue Ratio Index-RBRI, Woebbecke Index-WI, Normalized Pigment Chlorophyll Ratio Index-NPCI, Normalized Green–Red Difference Index - NGRDI, Redness Index-RI, Primary Colors Hue Index-HI, Green Leaf Index-GLI, Spectra Slope Saturation Index-SI, Normalized Blueness Intensity-NBI) based on aerial images (R-red; G-green; B-blue) captured by drone. The algorithms employed included Random Forest (RF), Stochastic Gradient Descent (SGD), Support Vector Machine (SVM), and Logistic Regression (LR).

Results/Discussion

Remarkably, both the SVM and SGD models demonstrated superior performance in estimating coffee leaf miner infestations, with kappa indices of 0.6 and 0.67, respectively. The combined use of vegetation indices and crop data increased the accuracy of coffee leaf miner detection. The RF model performed poorly, while the SVM and SGD models performed better.

Conclusion/Perspectives

Remote monitoring of coffee leaf miner infestation can be carried out using vegetation indices and agronomic data. The machine learning models showed varying performance. The SVM and SGD models achieved the best results.

References:

Vilela, E.F.; Silva, C.A.d.; Botti, J.M.C.; Martins, E.F.; Santana, C.C.; Marin, D.B.; Freitas, A.R.d.J.; Jaramillo-Giraldo, C.; Lopes, I.P.d.C.; Corrêdo, L.d.P.; et al. Detection of Coffee Leaf Miner Using RGB Aerial Imagery and Machine Learning. AgriEngineering 2024, 6, 3174-3186. https://doi.org/10.3390/agriengineering6030181