

EXTENDED ABSTRACT

VineAI: artificial intelligence for fungal disease management

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ABSTRACT

Early and accurate grapevine disease detection and surveillance are crucial for optimizing vineyard management practices. However, traditional disease control methods are often labor-intensive, costly, and challenging to scale across large areas. The objective of our study is to detect the three most common and destructive grapevine diseases in the United Kingdom (UK) using advanced machine learning models and high-resolution satellite imagery. The targeted diseases include Downy Mildew (*Plasmopara viticola*), Powdery Mildew (*Uncinula necator*), and Botrytis Cinerea. Disease data was collected by agronomists in Chardonnay and Pinot Noir vineyard blocks in four vineyards in the Southeast of England from August to October 2024, with each disease rated for severity and prevalence.

We investigated vegetation indices (VIs) and spectral band values extracted from high-resolution satellite imagery

such as Sentinel-2 (10m resolution) and PlanetScope (3m resolution) along with other environmental variables, obtained from SoilGrids and weather station data. The result shows these metrics provide essential information in differentiating infected grapevines from healthy ones. Using tree-based machine learning models, we achieved disease detection accuracies around 90% for each disease.

For all the diseases, the outputs of the model represent a disease probability at a per-pixel level, overlayed on the vineyard map. The resulting disease maps show spatial patterns of disease impact across vineyard blocks. These findings show the ability of AI models to accurately detect the disease occurrence in the vineyard and to predict the early infections of the disease in the vineyard with accuracy of 89.6%, 93.7% and 91.5% or Downy Mildew, Powdery Mildew, and Botrytis Cinerea, respectively.