# Application of Satellite-Derived Vegetation Indices for Frost Damage Detection in Grapevines

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## Abstract (250 words)

Wine grape production is increasingly vulnerable to freeze damage due to warming climates, milder winters, and unpredictable late spring frosts. Traditional methods for assessing frost damage in grapevines which combine fieldwork and meteorological data, are expensive, time-consuming, and labor-intensive. Remote sensing could offer a rapid, inexpensive way to detect frost damage at a regional scale. Remote sensing approaches were used to assess freeze damage in grapevines by evaluating satellite-derived vegetation indices (VIs) to understand the severity and spatial distribution of damage in several New York vineyards immediately after a frost event (May 17$^{th}$-18$^{th}$, 2023). PlanetScope 3m satellite images acquired before and after the freeze were used to map damage and measure changes in VIs for vineyards in the Finger Lakes region. We compared growers' data to time-series data of each index to assess how quickly satellite-derived VIs could detect changes in vegetation following the frost. We also used VIs to identify which varieties sustained the least amount of damage within an individual vineyard and compared these to grower-reported metrics. All indices showed vegetation decline after the frost, but index performance differed spatially within each vineyard. NDVI and EVI had higher sensitivity to freeze damage detection and time-series analyses showed a general delay in all indices for detecting vegetation changes following the frost. Studies to link other abiotic stress responses to hyperspectral signatures are ongoing with the goal of utilizing space-based imagery for evaluating historical impacts of climate stress and building prediction models for future climate resiliency.

**Keywords:** Remote sensing, Frost damage, NDVI, Satellite-based phenotyping