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Application Note: Detecting Smoke Contamination in Grapes Using Spectral Vegetation Indices

Early detection of smoke taint in grapes

Bushfires are an increasing threat to vineyards around the world. Even short-term exposure to smoke can result in “smoke taint” — a costly issue for grape and wine producers. Early detection is essential for timely decision-making and for protecting crop value.

Vegetation indices (VIs) derived from spectral reflectance are a fast, non-destructive way to monitor crop conditions. The ScanCorder, a compact and field-ready sensor covering the 400–950 nm range, enables the calculation of a broad range of published VIs. This allows rapid, entry-level assessment without the need to build complex machine learning models upfront.

In this note, we show that ScanCorder-based VI measurements can differentiate smoke-exposed grapes from untreated controls. To validate the general accuracy of calculated VIs, we compared ScanCorder measurements on a standardised calibration target with those from a lab-grade reference spectrometer.

Application summary

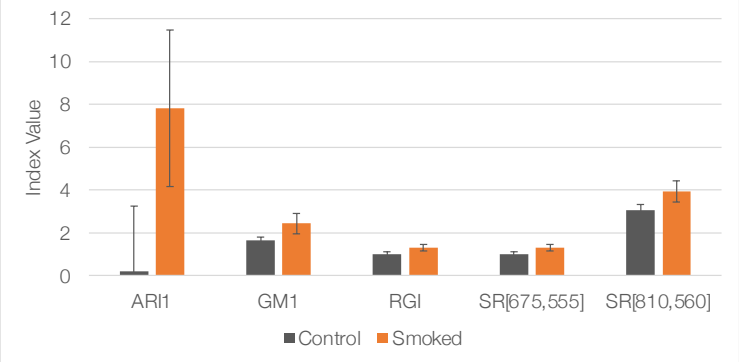
Application Area	**Vineyard Monitoring (Smoke Contamination)**
Target	Smoke-exposed grape bunches (Shiraz)
Sensor	ScanCorder GP-VNIR (approx. 400–950 nm)
Index Type	12 key Vegetation Indices (e.g. ARI, DWSI4)
Readout	Reflectance-based VI changes

Setup and data collection

Shiraz grape bunches (n = 10) were exposed to moderate smoke for 10 minutes in a custom-built chamber. Within 3 to 4 hours, spectral reflectance measurements were taken using the ScanCorder General Purpose VNIR (GP-VNIR) instrument. Spectral multipoint calibration was applied. A total of 37 vegetation indices were calculated using established equations from published literature.

Key results

Twelve vegetation indices showed significant differences between smoked and control grapes.



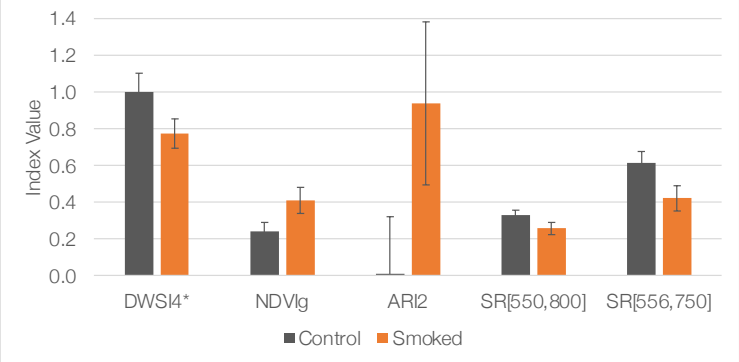


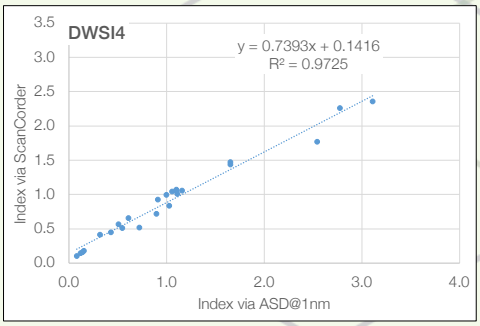
Figure 1: Values for selected VIs as calculated based on ScanCorder reflectance data. Error bars show standard deviation (n=10).

Table 1: List of significantly changed VIs (n = 12). Markers (*) indicate overlapping wavelength bands.

VI Name	VI Abbreviation	Physiological Target	Smoked Grapes
Anthocyanin Reflectance Index 1	ARI1	Anthocyanins	▲ Increased
Anthocyanin Reflectance Index 2	ARI 2	Anthocyanins	▲ Increased
Simple Ratio 550/680, Disease-Water-Stress-Index 4*	DWSI4, SR[550,680]	Moisture, Drought stress	▼ Decreased
Simple Ratio 554/677, Greenness Index 2*	GI, SR[554,677]	Chlorophyll, Greenness, RGB	▼ Decreased
Simple Ratio 750/550, Gitelson and Merzlyak Index 1	GM1, SR[750,550]	Chlorophyll content	▲ Increased
Normalized Difference 750/550 Green NDVI	NDVIg	Chlorophyll content	▲ Increased
Simple Ratio 690/550, Rel. Greenness Index, Red/Green Index	RGI	Carotenoids	▲ Increased
Red/Green Index*	RGR	Carotenoids	▼ Decreased
Simple Ratio 550/800	SR[550,800]	Stress general, LUE, PS activity	▼ Decreased
Simple Ratio 556/750, Chl-b	SR[556,750]	Chlorophyll b	▼ Decreased
Simple Ratio 675/555	SR[675,555]	Chlorophyll a	▲ Increased
Simple Ratio 810/560, Plant biochemical index	SR[810,560]	Biochemical compounds	▲ Increased

Figure 2: Regression curve for a selected VIs (right) based on reflectance measurements taken on an X-Rite ColorChecker® calibration target (left, www.xrite.com) using either the ScanCorder or the ASD FieldSpec® 3. Blue dots represent the mean values (n = 5) from individual scans of the 24 colour patches.

Full set of 12 regression plots available upon request.



Summary

Results demonstrate that ScanCorder measurements can be used to differentiate grapes according to smoke exposure based on various vegetation indices (i.e., no and medium smoke).

References

Wilkinson, K.L., et al. Assessing smoke taint in grapes and wine. ACS, 2012.

Zeng, Y., et al. Optical vegetation indices for monitoring terrestrial ecosystems globally. Nat Rev Earth Environ, 2022.

Radočaj, D., et al. State of major vegetation indices in precision agriculture studies: A review. Agriculture, 2023.