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Application Note: Spectral Monitoring of Nitrogen Responses in Agave Using Vegetation Indices

Detection of gradually changing N-dosage in agave

Energy-rich agave plants serve as crops to produce alcoholic beverages, fibres, and renewable fuel. Despite their increasing importance, there is limited understanding of the relationship between agave plants and soil nutrients — particularly nitrogen. Therefore, current research focuses on optimising land preparation and planting, nutrition, weed and pest management, and harvesting and transport to support more sustainable agave farming systems.

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 agave grown under varying N-dosages. 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	**Field / Greenhouse Monitoring of Agave**
Target	Agave grown under varying N-dosages
Sensor	ScanCorder GP-VNIR (approx. 400–950 nm)
Index Type	15 key Vegetation Indices (e.g. NDVI, WBI3, RVI2)
Readout	Reflectance-based VI changes

Setup and data collection

Agave americana plants were cultivated in a greenhouse and treated with five different nitrogen dosages: 0, 50, 100, 200, and 300 kg ha^{-1} year^{-1} (n=6 per treatment). Spectral reflectance measurements were taken from the upper leaf surface 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

Fifteen vegetation indices showed significant variation across the nitrogen dosage gradient.

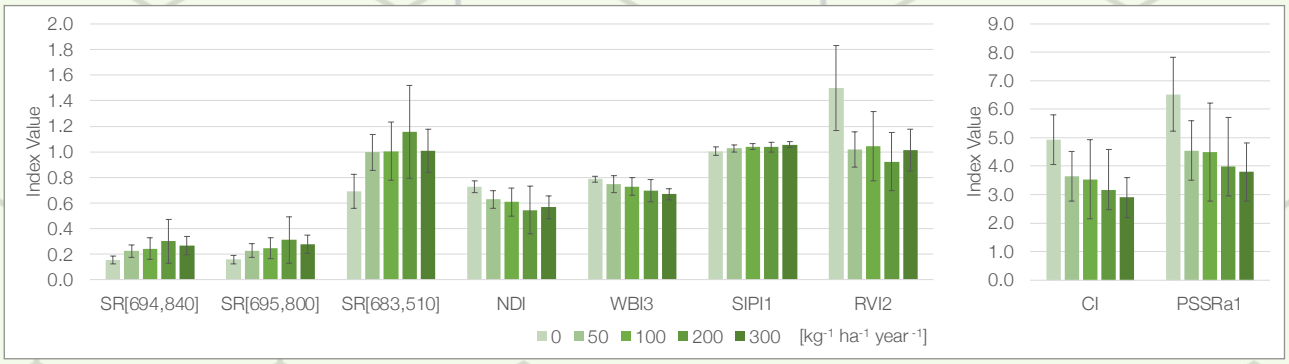

Figure 1: Values for selected VIs as calculated based on ScanCorder reflectance data. Error bars show standard deviation (n=6).

Table 1: List of significantly changed VIs (n = 15). Markers (* and #) indicate overlapping wavelength bands.

VI Name	VI Abbreviation	Physiological Target	Higher N-dosage
Carotenoid Reflectance Index 2	CRI2, CRI700	Carotenoids	▲ Increased
Simple Ratio 694/840	SR[694,840]	Stress general, Fluorescence	▲ Increased
Simple Ratio 695/800	SR[695,800]	Chlorophyll content	▲ Increased
Simple Ratio 683/510	SR[683,510]	Chlorophyll content	▲ Increased
Pigment Specific Norm. Difference A2, Lichtenthaler Indices 1, NDVIhyper*	NDI, Lic, NDVIhyper	Stress general, LUE, PS activity	▼ Decreased
Normalized Difference Vegetation Index 4*	NDVI[800,700]	Chlorophyll content	▼ Decreased
Pigment Specific Normalised Difference A1*	PSNDa1	Senescence	▼ Decreased
Water Band Index 3, Water Index, Plant Water Index	WBI3, WI, PWI	Moisture, Drought stress, WUE	▼ Decreased
Structure Independent Pigment Index	SIPI1	Chlorophyll a, Carotenoids	▲ Increased
Simple Ratio 493/678, Disease-Water Stress Index 4	RVI2, SR[493,678]	Ammonia	▼ Decreased
Simple Ratio 750/710, Zarco-Tejada & Miller (ZM), Combined Index#	CI, ZTM, SR[750,710]	Chlorophyll content	▼ Decreased
Simple Ratio 750/700, Gitelson and Merzlyak Index 2#	GM2, SR[750,700]	RGB, Chlorophyll	▼ Decreased
Simple Ratio 4#	SR[750,705]	Moisture	▼ Decreased
Simple Ratio 752/690#	SR[752,690]	Chlorophyll content	▼ Decreased
Simple Ratio 800/675, Pigment Specific Simple Ratio A1	PSSRa1, SR[800,675]	Senescence	▼ Decreased

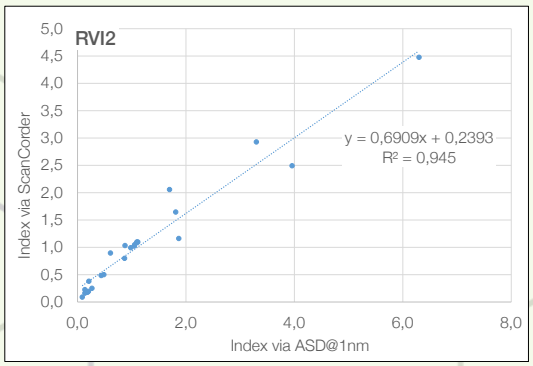

Figure 2: Regression curve for a selected VI (right) based on reflectance measurements taken on an X-Rite ColorChecker® calibration target (left, www.xrite.com) using either the ScanCorder or the ASD FieldSpec® 3. Blue dots represent the mean values (n=5) from individual scans of the 24 colour patches.

Full set of 15 regression plots available upon request.

References

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