IDENTIFYING PHYSIOLOGICAL DIFFERENCES IN HIGHLY FRAGMENTED VINEYARDS USING NIR/RGB UAV PHOTOGRAPHY

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Introduction

Remote sensing is applied in large vineyards optimizing monitoring and management strategies. The cost of todays available sensors and transport platforms such as autonomous 4x4 vehicles (**Fig.1 A, B**) and GIS-directed unmanned aerial vehicles (UAVs, **Fig. 1 C-E**) provides producers with numerous possibilities to survey their crops . Especially flexible are small and mini UAV platforms (Gomez and Green, 2014, Green et al., 2015) that allow producers of small and fragmented vineyards to benefit from the technological progress. Aerial NIR/RGB photography can be used to identify e.g. vine vigour, water status, yield, and, to some extent, pest and disease attacks (Green, 2012). This paper correlates UAV-based NIR/RGB imagery with growth status measurements.

Methods

Study Area: 0.35 ha terraced vineyard, 13 rows, 140 grapevines each (Fig. 2).

Experimental Setup: ten sequential arranged subplots with vines trained alternating with seven (V1) and nine (V2) canes.

Cultivar: Pinot noir GM20-13 growing on rootstock Couderc 3309.

Training System: one-sided Guyot.

Measurements: Photosynthesis; leaf chlorophyll/anthocyanin/flavonol content, canopy air temperature / rel. humidity, airborne drone-based canopy NIR/RGB reflectance, oenological parameters (total soluble solids, pH, total acids, extractable anthocyanin content, berry weight), **Fig. 3**.

Fig. 1: Selected platforms for remote sensing of vineyards. Remotely controlled 4x4 equipped with GoPro Camera, C and D, rotary wing UAVs DJI Phantom and AR Drone of Parrot Ltd; E, swingletCAM of Sensefly used in the present study

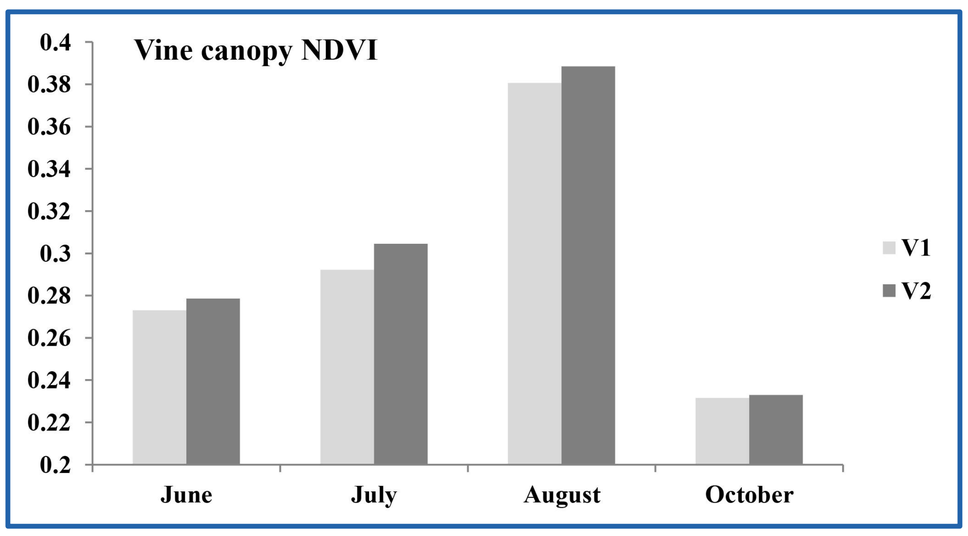

Fig. 4: Average NDVI differences of V1and V2 based on UAV-taken imagery

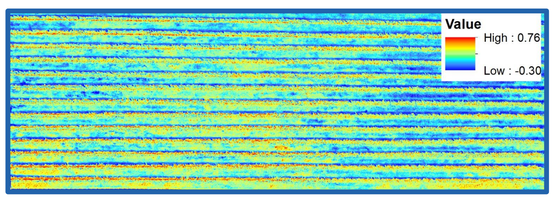

Fig. 5: NDVI colored image of of July of experimantal vineyard.

Results

- Growth differences induced by management method V1 and V2 were detected in NDVI, average shoot weight, canopy temperature and rel. humidity, grape berry extractable anthocyanin content and total harvest weight (**Fig. 4, & Tab. 1**).
- Values of NDVI V1<V2 corroborate the results indicatively of V1 producing a less-dense canopy

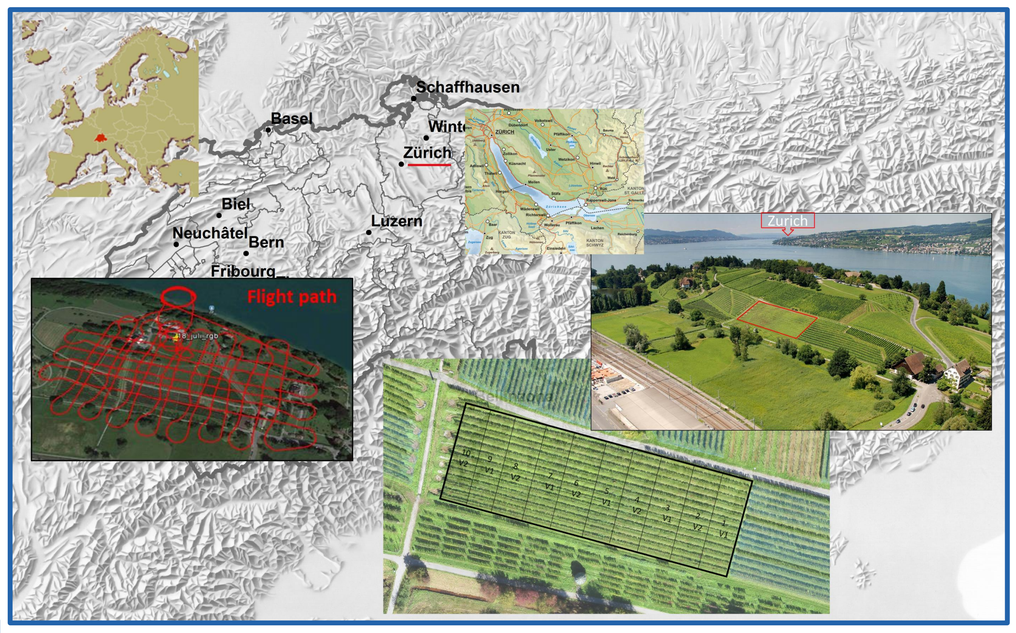

Fig. 2: Location of experimental vineyard. The vineyard was separated into ten plots with alternating different training methods leading to differences in vine vigour. Lower left: flight path of SwingletCAM

Tab. 1: Result summary of canopy management trial. Physiological and enological differences of variant one and two

Variant	AvgCanes/Vine	AvgShoot Weight(g)	TotalHarvest Weight(kg)$	AvgHarvest Weight(g)/ Shoot$	Berry Weight(g)$	BSN(%) ofHarvest$	SumCanopy %rH<80%$	SumCanopyDay Temperature Difference(°C)$	SumCanopyNight Temperature Difference(°C)$
V1	*7.2	a53	533	75	1.684	12	75951	149	-89
V2	*9.3	a44	821	90	1.534	10	77017		

Avg, average; BSN, bunch stem necrosis; *statistically significant p<0.005; a, statistically not significant; $, no statistics conducted

Conclusions & Further Research

- Today, UAV-based imagery is affordable allowing it to be used by small and medium companies
- Canopy management differences are detectable using simple UAV-based imagery
- Future investigations:
  - Fit for purpose flight altitude
  - Include oblique angles allowing the inspection of bigger canopy portion
  - Test different vegetation indices
  - Management trials for ground-truth

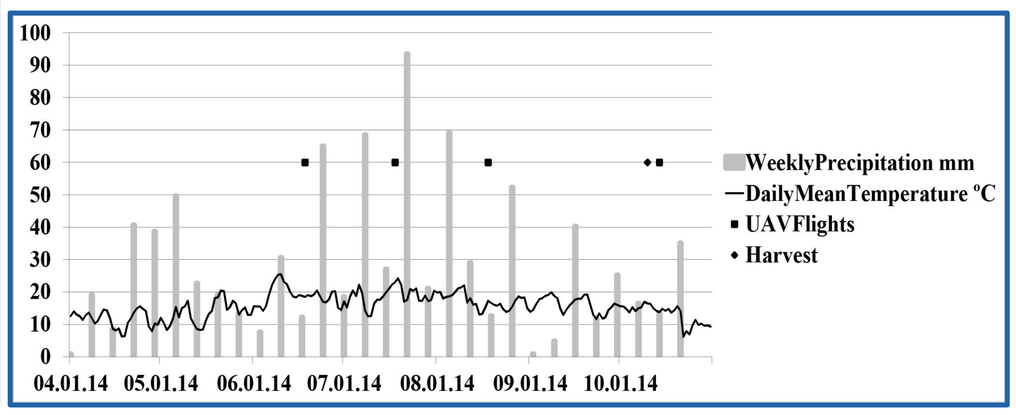

Fig. 3: Seasonal weather conditions and flight schedule

References:

Green, D. R., Gómez, C., et al. (2015). Airborne and Ground-Based Platforms for Data Collection in Small Vineyards: Examples from the UK and Switzerland. ***EGU General Assembly 2015***. Vienna, Austria.
Gómez, C. and D. R. Green (2014). Small-Scale Airborne Platforms for Oil and Gas Pipeline Monitoring and Mapping. REDWING/AICSM – ***Unpublished Report***. UCEMM – Univ. of Aberdeen, UK.
Green, D. R. (2012). Geospatial Tools and Techniques for Vineyard Management in the Twenty-First Century. **The Geography of Wine.** P. H. Dougherty, Springer. Netherlands: 227-245.

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