An evaluation of smartphone applications for LAI estimation to facilitate canopy state assessment in vineyards

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1. Introduction

Crop development and foliar density as expressed with Leaf Area Index (LAI) are important source of information for disease prevention.

Canopy density in vineyards has been correlated with disease incidences, mainly concerning the impact of high density on intra-canopy ventilation and levels of humidity.

LAI data can be used together with other data sources (temperature, humidity, rainfall etc.,) to enhance disease predictive models and continuous monitoring of crops.

2. Aim

To improve the crowdsourcing aspect of data collection from farmers and agronomists during in-situ observations, this study was implemented aiming to evaluate the accuracy of LAI smartphone applications.

The applications selected for testing and evaluation were:

- **smart fLAIr** (sys.cs.uos.de/smartflair)
- **VitiCanopy** (viticanopy.com.au)

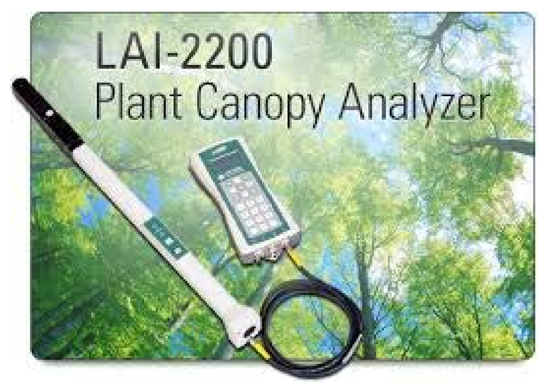
Smart-apps tested were selected based on their applicability, subscription pricing, user-friendliness and continued support from the developers among all available Android applications and were evaluated against LiCOR 2200C plant canopy analyzer (licor.com/env/products/leaf_area/LAI-2200C).

3. Methods

Sampling for this experiment was carried out in four plots applying smart farming services (gaiasense.gr/en/gaiasense-smart-farming), located in two irrigated commercial vineyards in Stimagka, southern Greece:

- 2 plots sampled after sunrise (early morning) and 2 after midday (before sunset), to assess the accuracy achieved under various light conditions
- 25 points / plot, 100 points in total
- 45° cap-view under clear-sky conditions used for LiCOR2200C measurements
- atmospheric scattering correction applied to LiCOR data following a 4A measurement sequence protocol
- various canopy states sampled considering foliar density

LiCOR 2200C equipment used during field LAI measurements (source: remotesensinglab.org).



Geo-tagged photographs of the LAI sampling locations, taken during field-measurements. A variety of canopy states was sampled, regarding foliar density and vegetation health.

4. Results

Statistical analyses and accuracy comparisons between LiCOR 2200C and LAI smpart-apps performed after excluding 10% of total acquired samples as outliers:

- VitiCanopy achieved greater accuracy compared to fLAIr (r=0.65 over r=0.25)
- VitiCanopy overestimated LAI values (mean diff = 0.74, p<0.0001)
- fLAIr generated slightly underestimated LAI values (mean diff=-0.24, F=0.0155)
- Per plot analysis showed that measurements acquired earlier during the day provided higher r correlation values
- Highest r between VitiCanopy and LiCOR data (r=0.64) found for the 1st plot just after sunrise. r gradually dropped during the day, which was not the case for fLAIr

	Overall (r) Correlation	Correlation (r) per plot			
		Early morning		After midday	
		Plot 1	Plot 2	Plot 3	Plot 4
fLAIr	0.25	0.19	0.36	-0.25	0.15
VitiCanopy	0.65	0.64	0.39	0.12	0.08

Table: Correlation coefficient (r) between LAI from smart-apps and LAI from LiCOR 2200C across plots.

5. Conclusions

- Ideal light conditions (under clear-sky) for accurately measuring LAI is earliest possible after sunrise
- Although r values remained low to moderate (0.08<r<0.64), findings indicate that VitiCanopy performs more accurately than fLAIr and can be used as an alternative to costly and sophisticated equipment (though, caution should be taken while standardizing optimal atmospheric/light conditions)
- Findings can be useful for disease predictive models, as well as farmers and agronomists who seek an accessible way to monitor LAI
- Future plans include integration of LAI measurements as an additional parameter within the Gaiasense's smart farming solution aiming to enhance information richness of the existing operational pest infestation risk index calculation algorithms for vineyards

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Scan QR code to access the abstract:

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