Sustainable grape and wine production in the context of climate change
Bordeaux, April 10-13, 2016

New plant phenotyping technologies in a changing climate

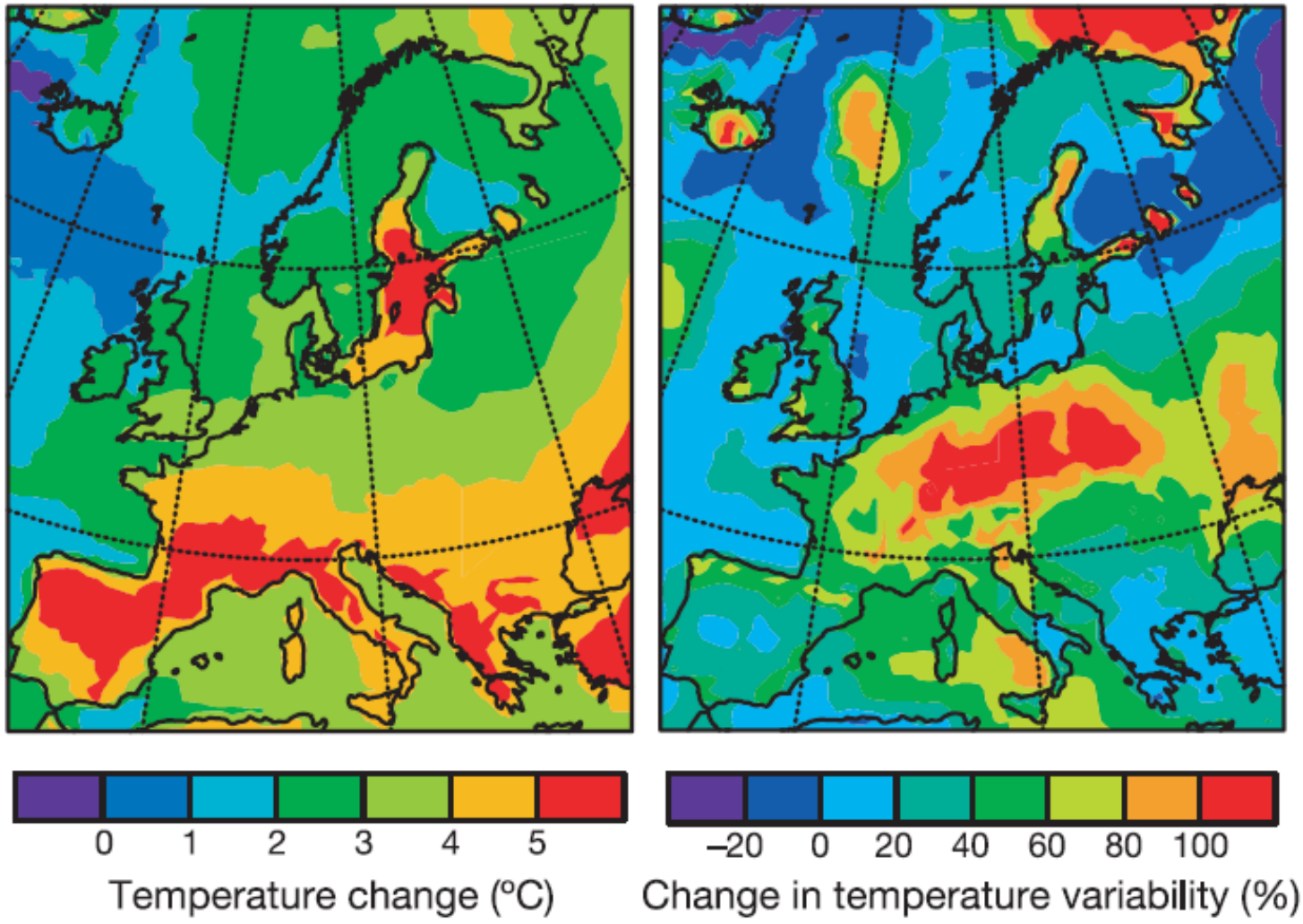
Javier Tardaguila and María P. Diago

Instituto de Ciencias de la Vid y del Vino

Televitis PRECISION VITICULTURE

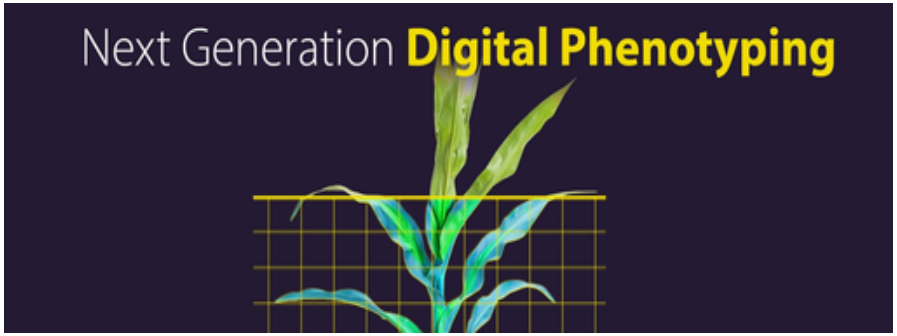
UNIVERSIDAD DE LA RIOJA

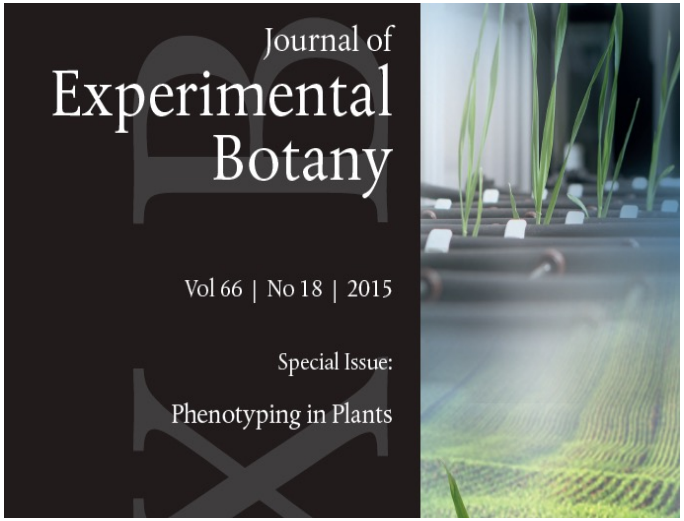
Understanding climate variability and climate change



Schär et al., 2004 Nature

Plant phenotyping





Review

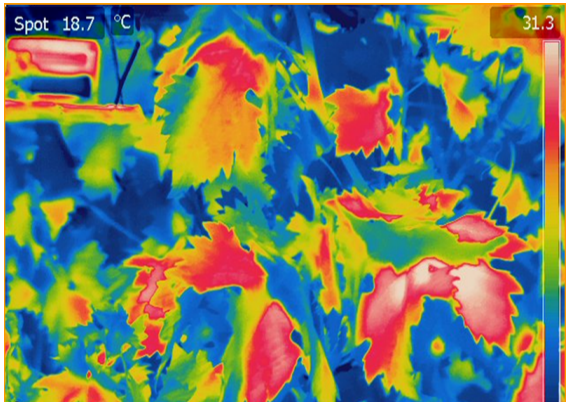
Cell PRESS

Field high-throughput phenotyping: the new crop breeding frontier

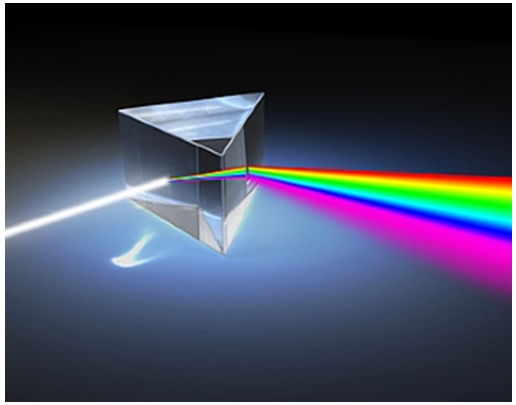
José Luis Araus[1] and Jill E. Cairns[2]

Trends in Plant Science January 2014, Vol. 19, No. 1

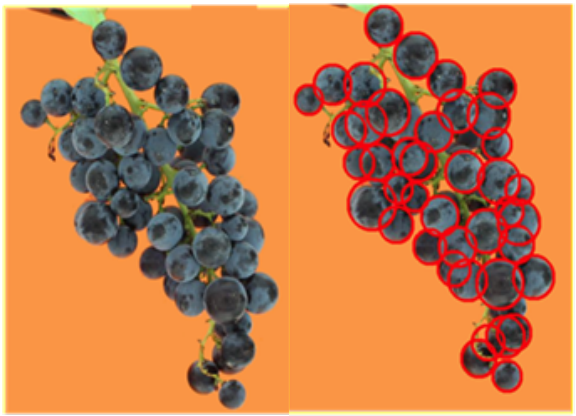
New vine phenotying technologies



Thermal imaging



Spectroscopy

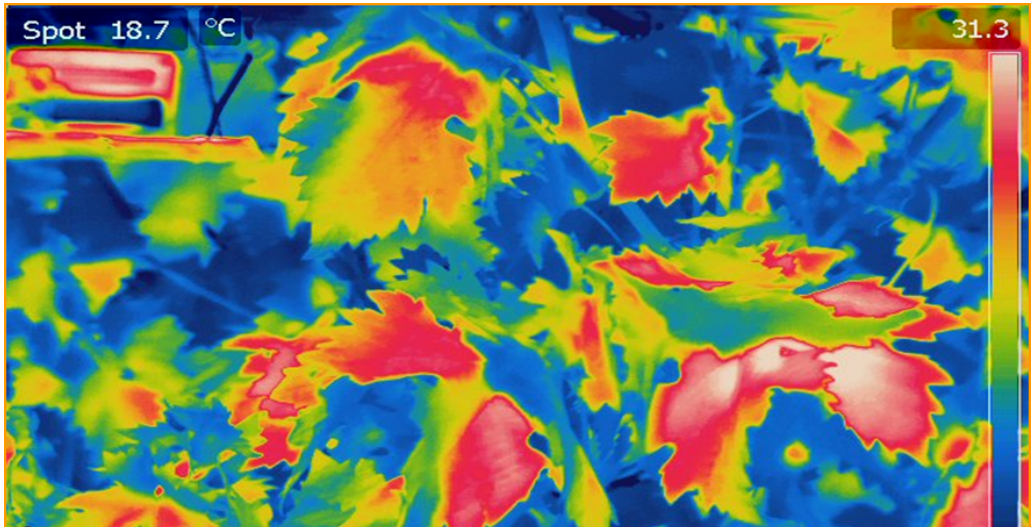


Machine vision

Non-invasive and hand-held sensors

Proximal and remote sensors in viticulture

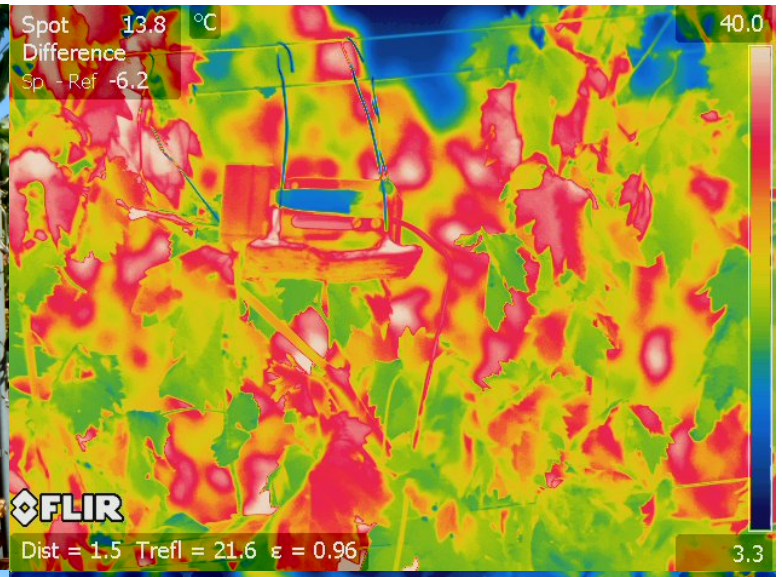
Thermal imaging



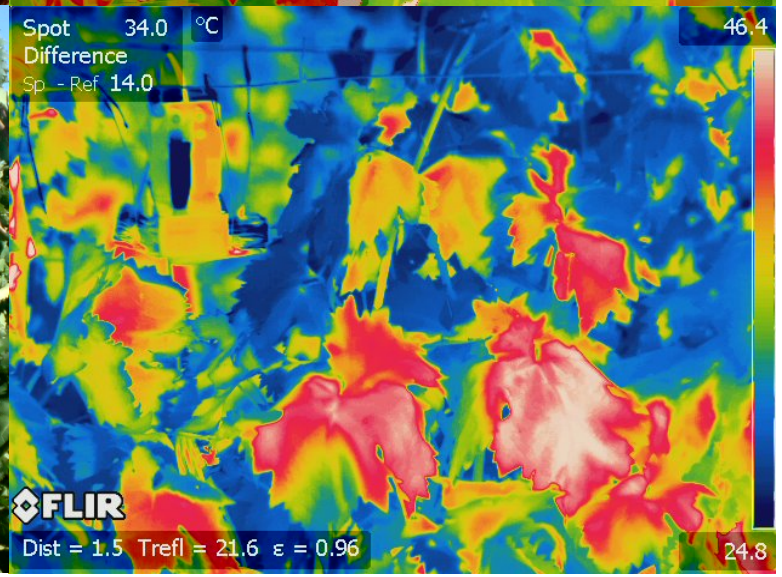
Water stress and climate change

Thermal imaging to assess vineyard water status

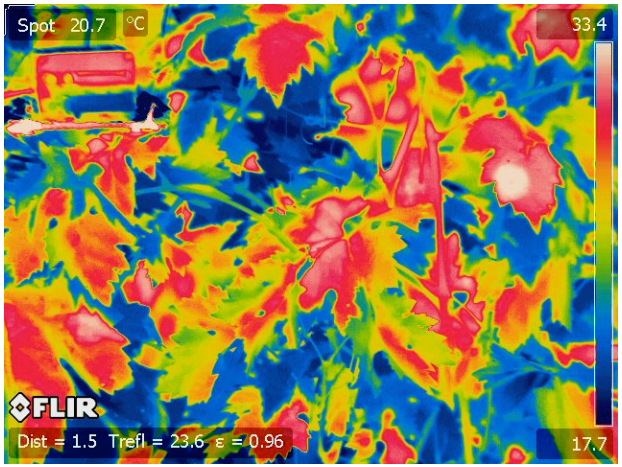
Stress



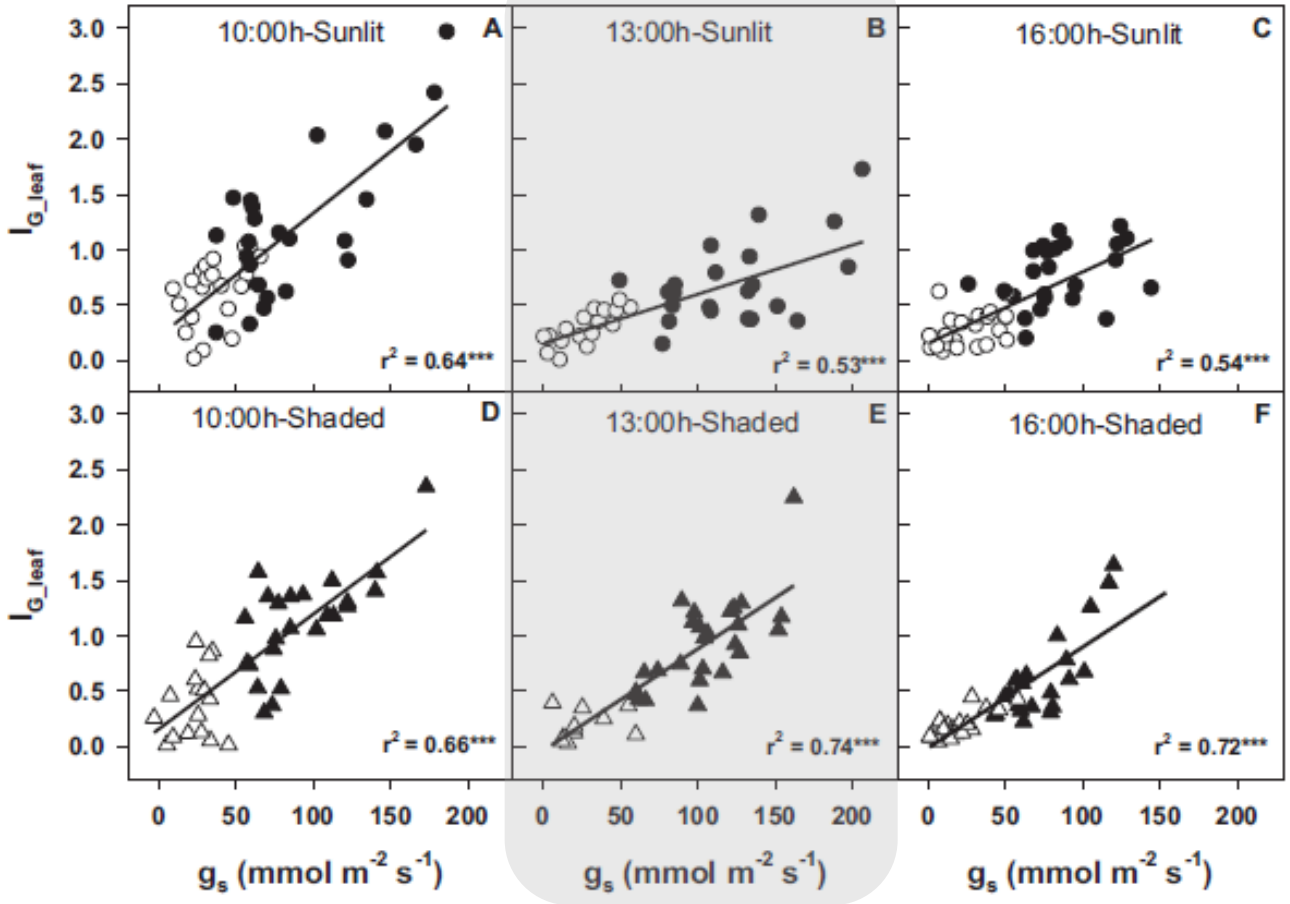
No stress



Hand-held thermal imaging sensor



Thermal imaging to assess vineyard water status

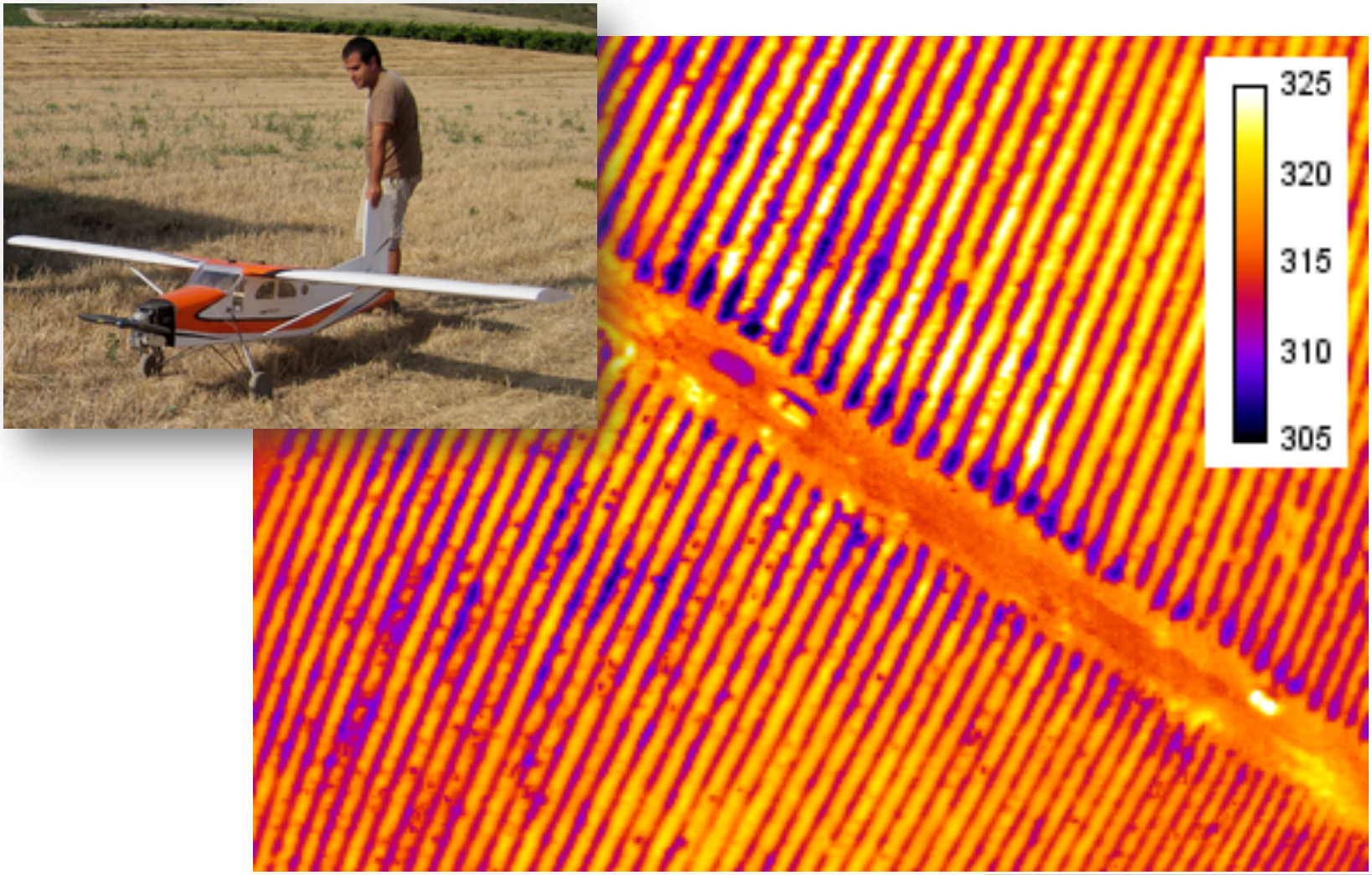


Mid-day

Not exposed side of the VSP

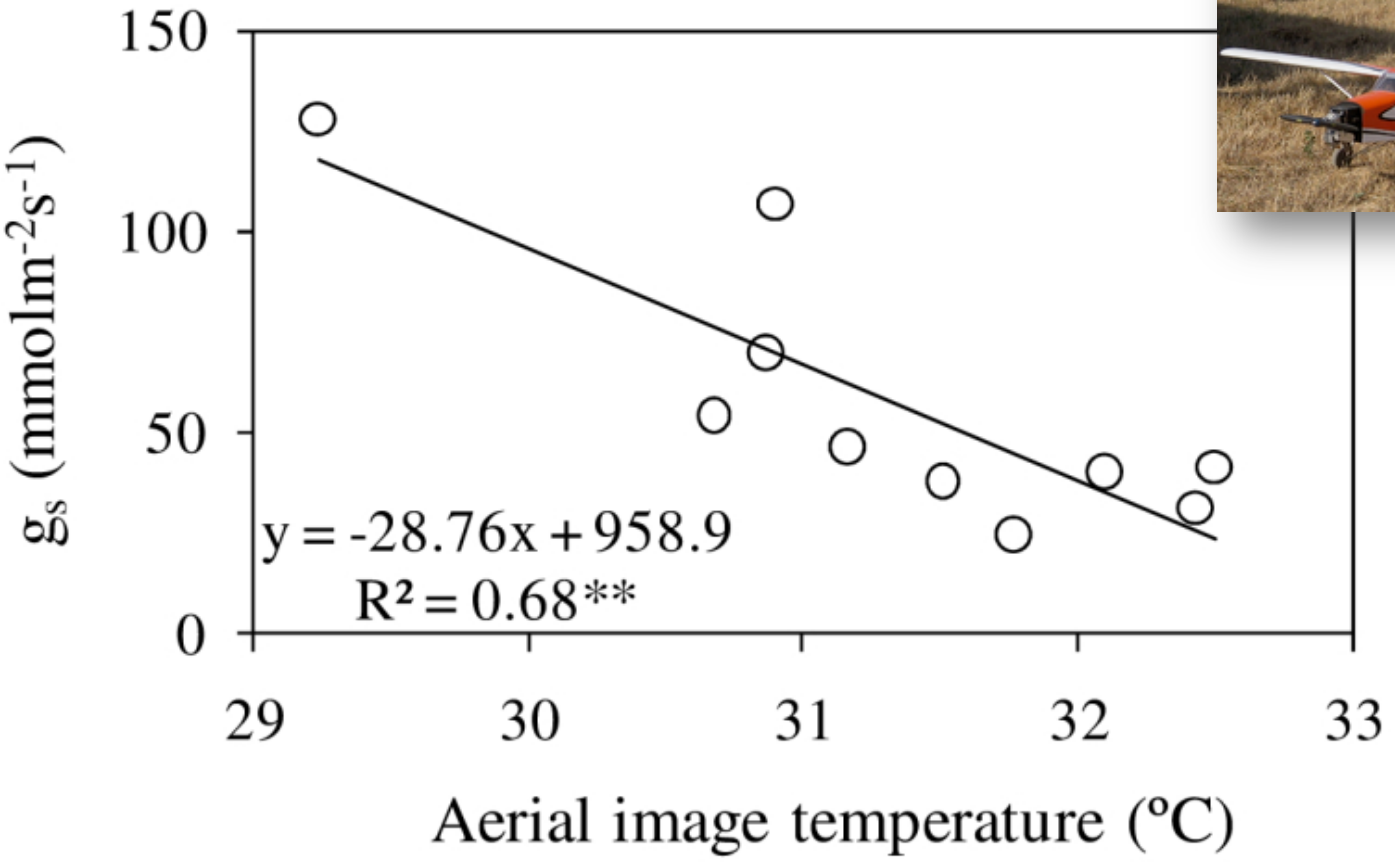
Pou et al., 2014 AWM

Thermal image obtain by UAV of the vineyard



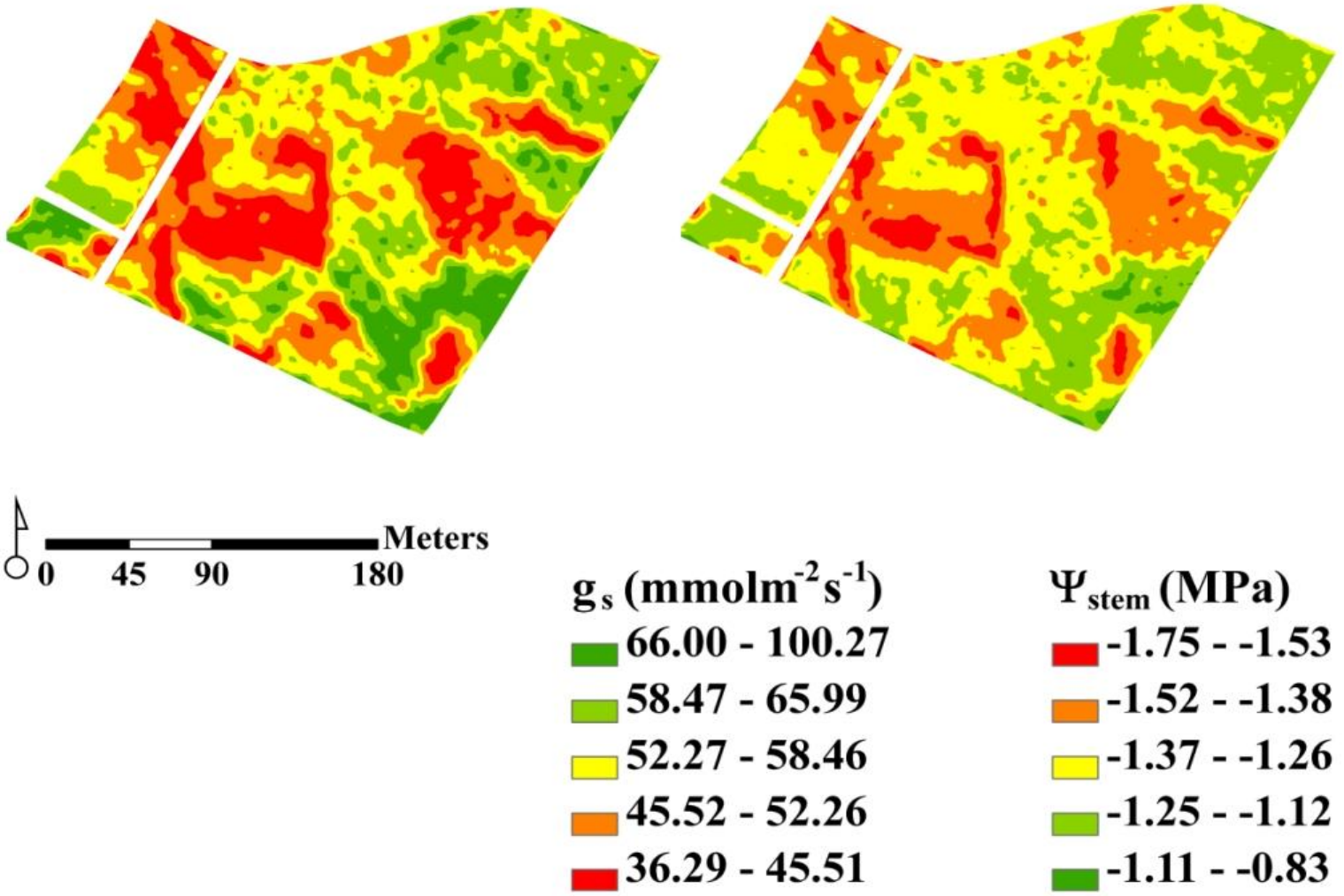
Baluja et al, 2012 IS

Aerial image temperature (UAV) and g_s



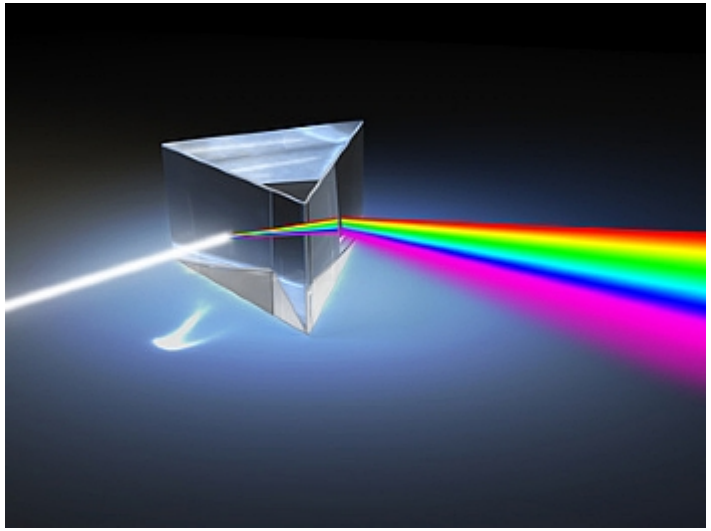
Baluja et al, 2012 IS

Mapping of vineyard water status



Baluja et al, 2012 IS

Spectroscopy



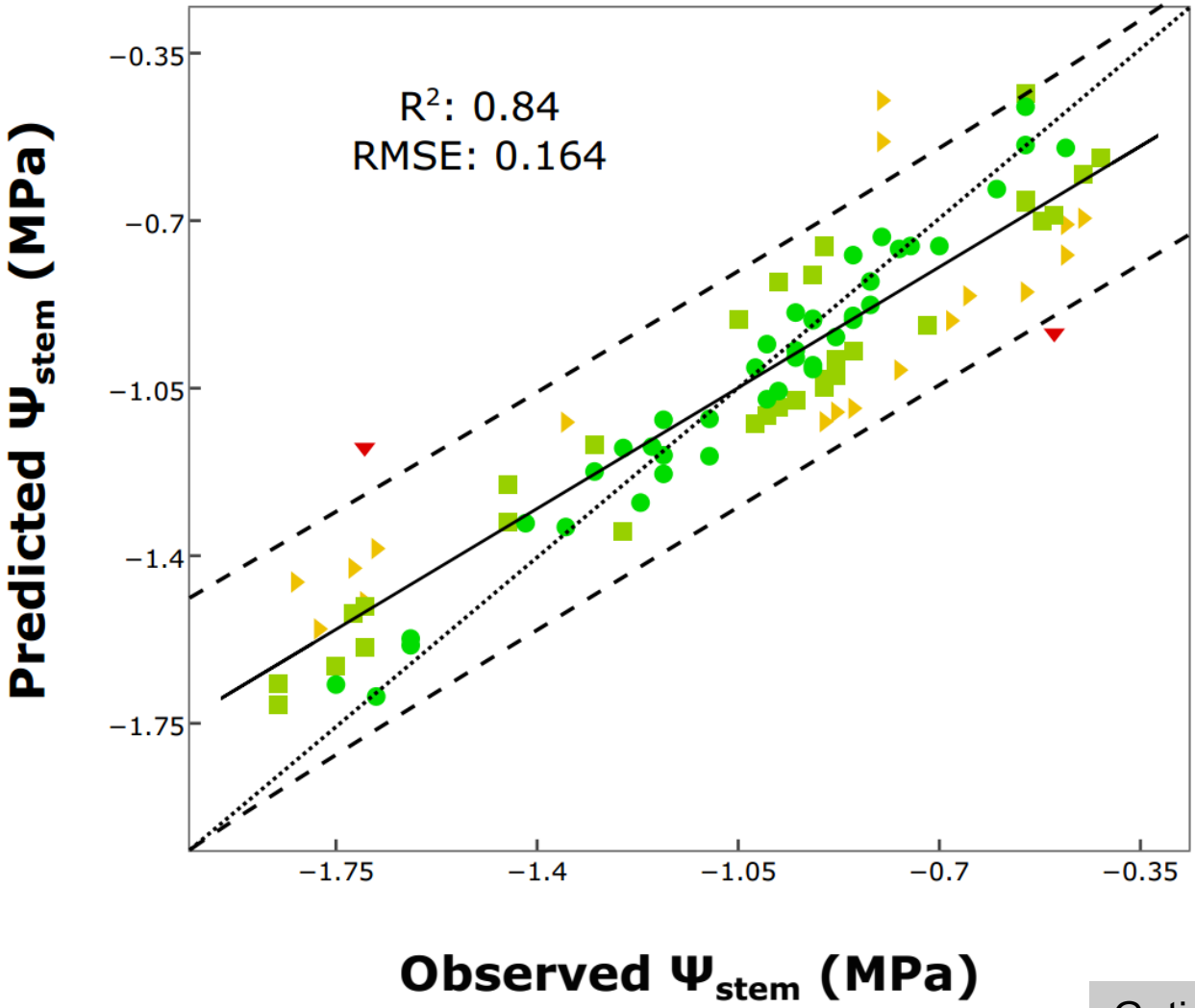
Hand-held NIR measurements in the vineyard

Handheld NIRS MEMS equipment
(MicroPHAZIR™ RX Analyzer)

- Spectral region: 1600 – 2400 nm
- Spectral resolution: 8 nm
- Analyze mode: Reflectance

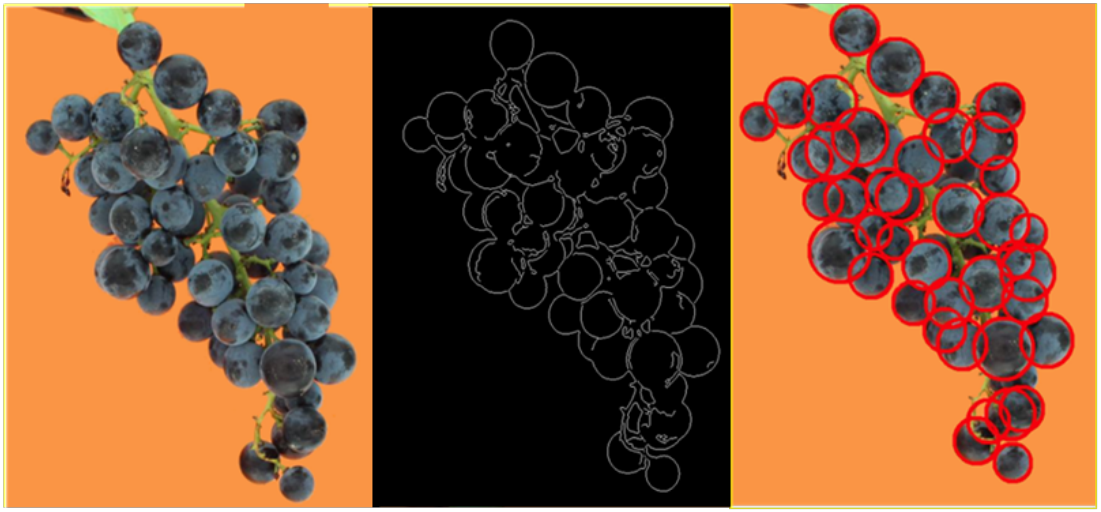
- Sample presentation: Adaxial and Abaxial leaf
- Five spectra for each leaf surface

Hand held NIR spectroscopy for vine water status assessment

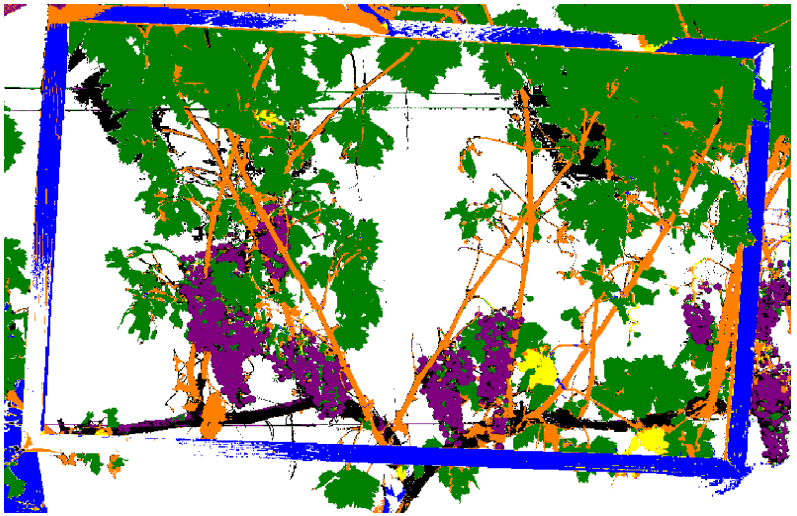


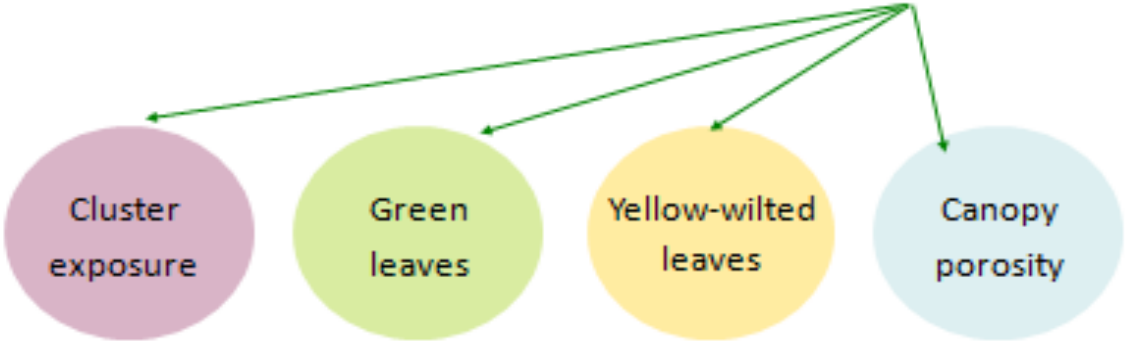
Gutierrez et al., 2016 Sensors

Machine vision



Machine vision in viticulture

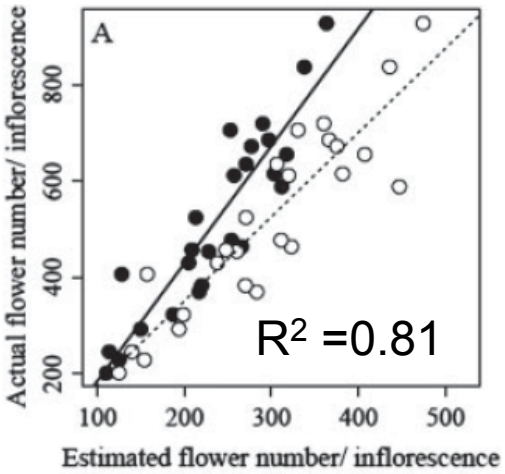




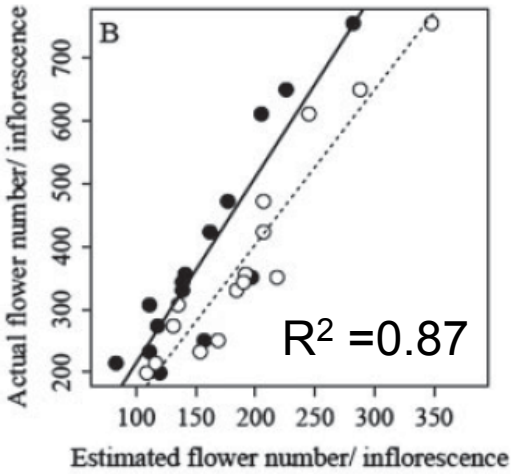
Tardaguila et al, 2010 AJEV

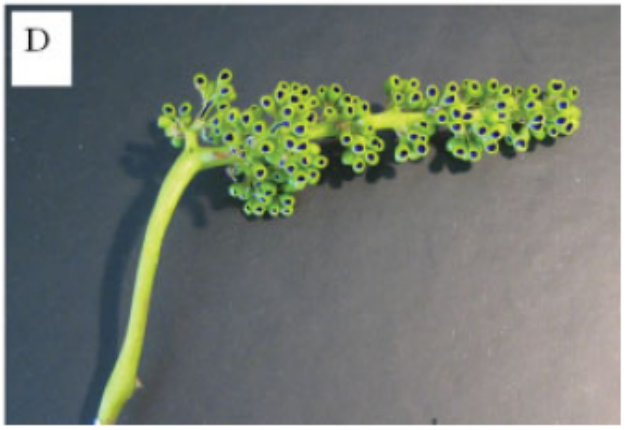
Assessment of flower number under field conditions by machine vision

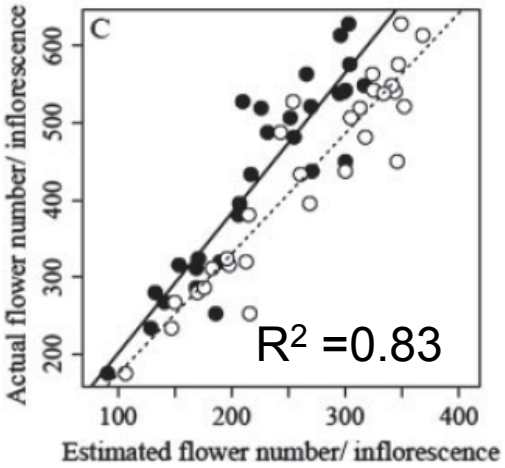
Graciano



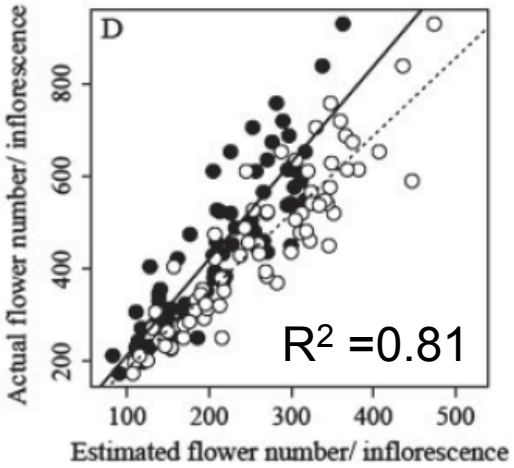
Carignan







Tempranillo



All varieties

Precision = 92.9% correctly detected

Diago et al. (2014a) J. Sci. Food Agric. 94, 1981-1987


vitisFlower
vitisFlower
Estimación del número de flores por inflorescencia de la vid mediante análisis de imagen
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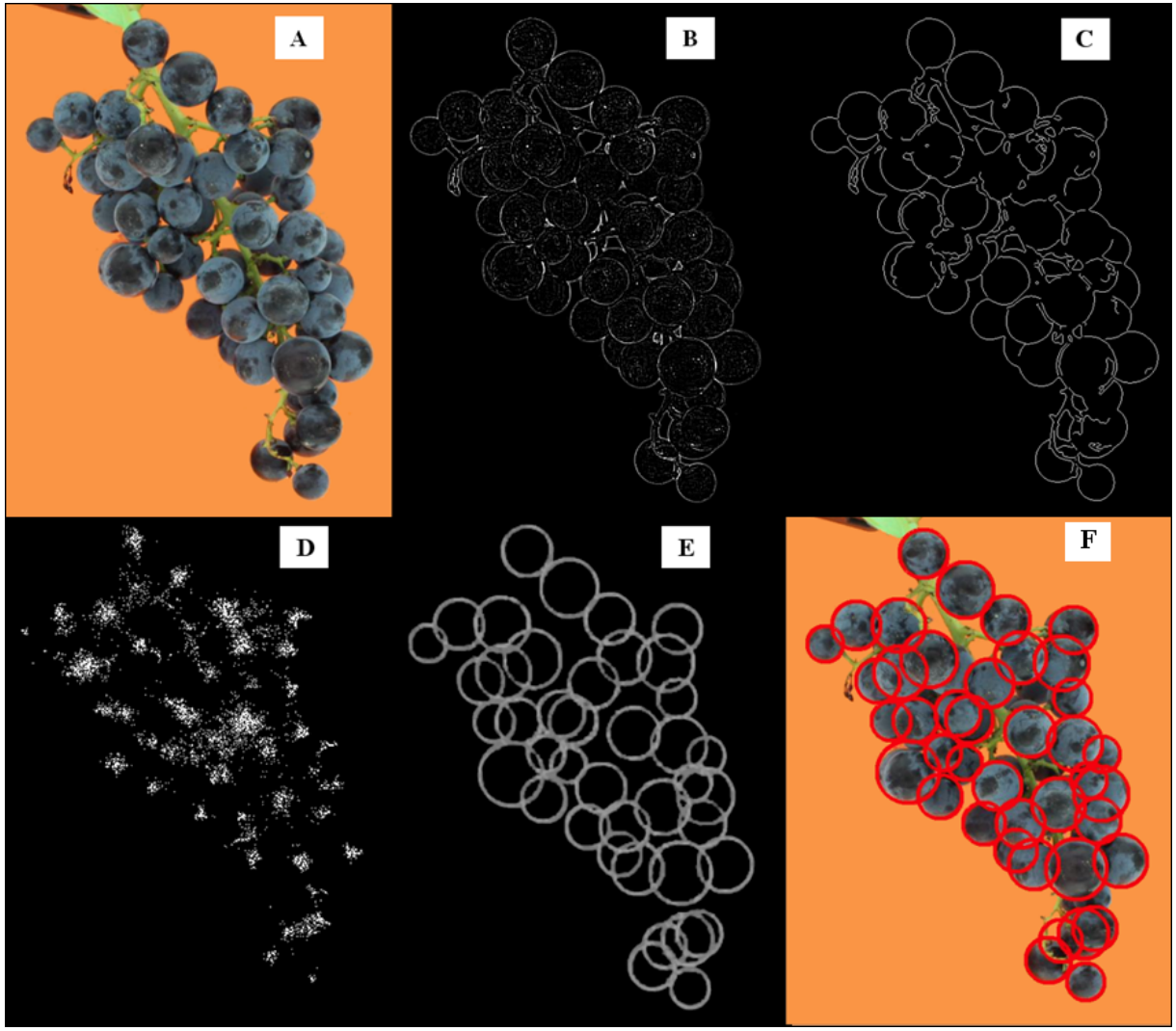
Berry number and cluster weight by image analysis under lab conditions



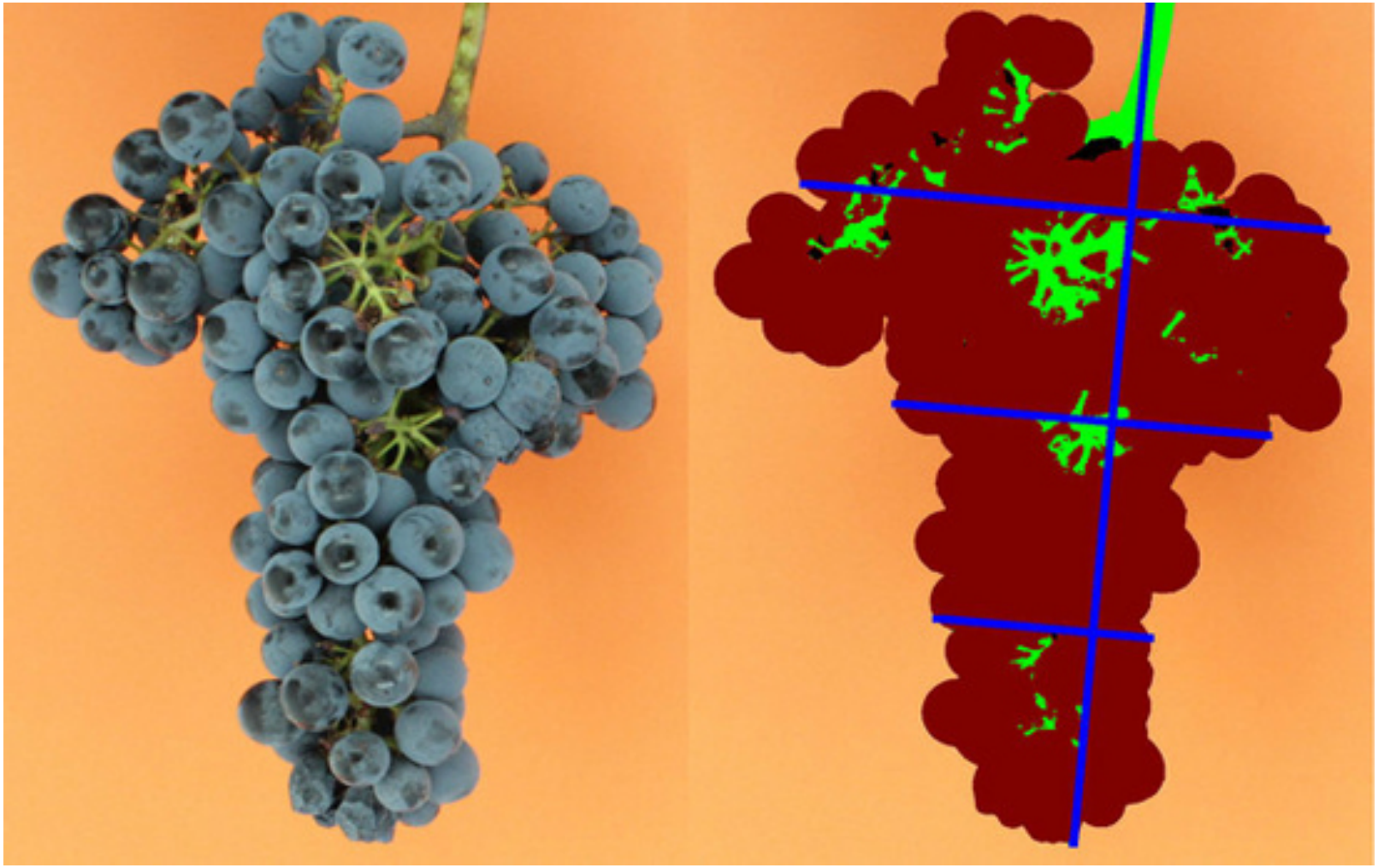
Diago et al., 2015 JSFA

Berry number and cluster weight by image analysis under lab conditions

Variety	Berry Number per Cluster Prediction, R^2	Cluster Weight Prediction, R^2
Bobal	0.95	0.91
Cabernet Sauvignon	0.76	0.75
Carignan	0.95	0.65
Grenache	0.79	0.85
Merlot	0.69	0.69
Mourvedre	0.94	0.91
Tempranillo	0.91	0.97

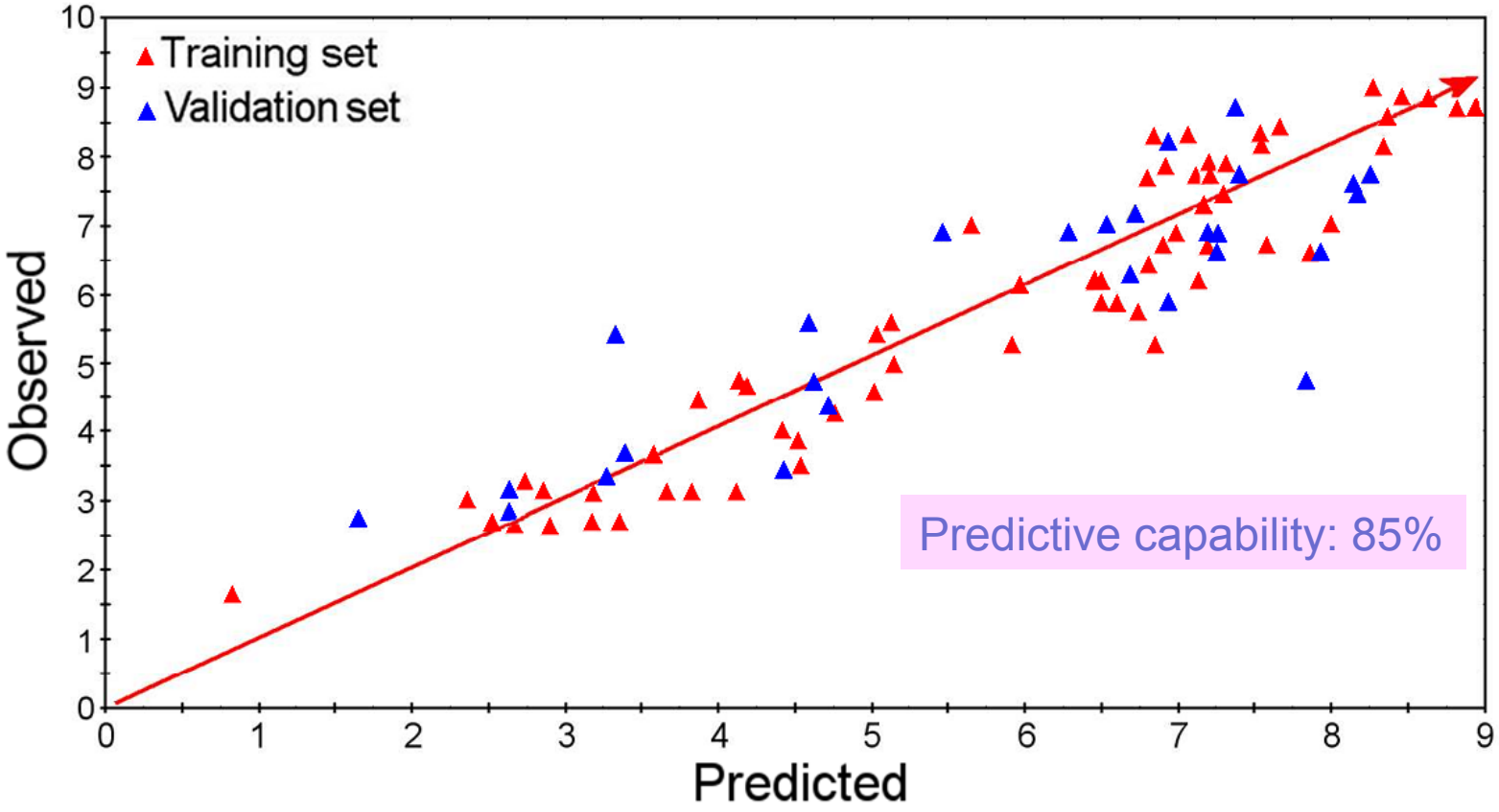
Diago et al., 2015 JSFA

Cluster compactness assessment by image analysis



Cubero et al., 2015 AJGWR

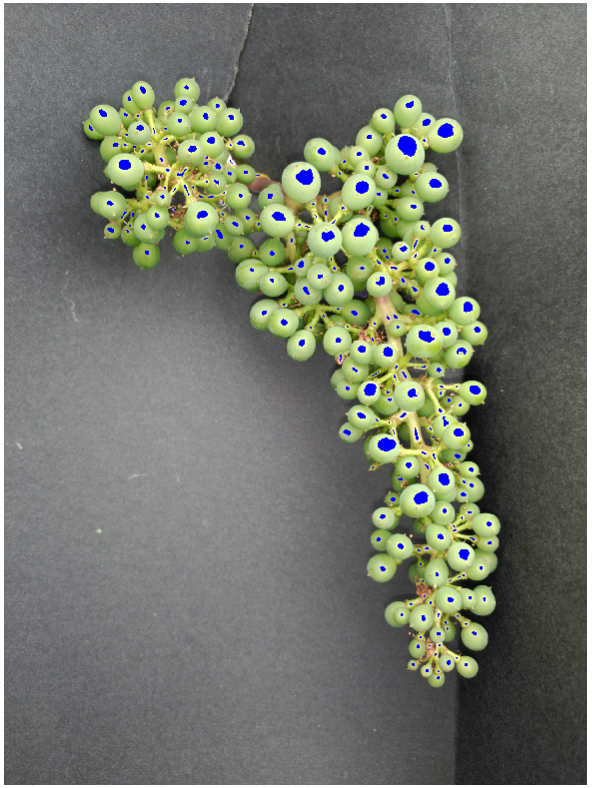
Cluster compactness assessment by image analysis



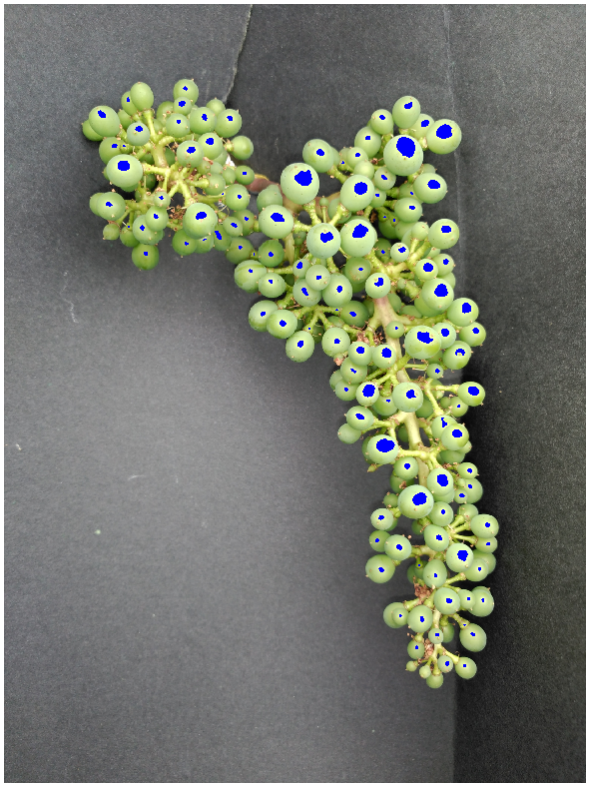
Cubero et al., 2015 AJGWR

Berry number per cluster by image analysis under field conditions

Original image



Extraction of berry candidates



Final result after false positive filtering

Canopy assessment on-the-go by machine vision

Pruning weight assessment on-the-go

VineRobot, a new multi-sensor platform for vineyard monitoring

VINEROBOT

VineRobot

VINEROBOT

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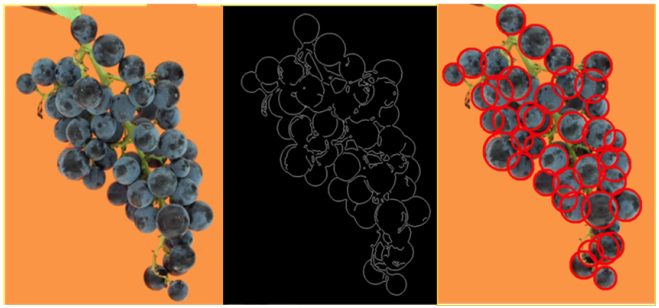
Conclusions

- Plant phenotyping is even more crucial in scenarios of high environment variability occurring under climate change
- New, non-invasive sensing technologies, including computer vision, thermography and spectroscopy can be used in viticulture
- Several non-invasive sensors can be embedded and mounted on a vehicle or in a robot for field high-throughput plant phenotyping, enabling the assessment of multiple viticultural features simultaneously



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