Principles and applications of Multiplex and Dualex: innovative tools in the service of viticulture and oenology

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Remote & proximal sensing of vegetation in the field

Type of functioning
ACTIVE
artificial light source
Reflectance or Fluorescence
PASSIVE
the Sun as light source
Reflectance or (Fluorescence)

Working distance
Proximal sensing
contact — small — medium — large
Remote sensing

Spectral Domain
UV — visible — NIR — SWIR — thermal — radio
Phen Car Anth Chl LMA Prot H2O
Layout of the presentation

*Acquiring information on the status of the vines*

with WHAT • Dualex & Multiplex
HOW • Hand-held vs. vehicle mounted
WHAT • Pigments in **leaves and fruits**
WHY • **Vigour** & **quality**
what ELSE • **Diseases** & research

Optical decision support tools

*leaf-clip*

**Dualex:**
- Chlorophylls
- Flavonols

*proximal sensor: leaves and grapes*

**Multiplex:**
- Chlorophylls
- Flavonols
- Anthocyanins
  (Stilbenes)
Type of measurement

- **Dualex**
  - **hand-held**
  - **leaves**

- **Multiplex**
  - **hand-held**
  - **leaves**
  - **grapes on vine**
  - **harvested grapes**

- **vehicle-mounted**
  - **leaves**
  - **grapes on vines**
  - **harvested grapes**

Pigments in viticulture and oenology - Optical indices

- **Chlorophylls in leaves & (grapes)** 
  - ≈ **Nitrogen**

- **Anthocyanins (leaves) & grape skin**
  - ≈ **Colour** ≈ **Phen**

- **Flavonols leaves & grapes**
  - ≈ **Phen**
  - ≈ **Light** ≈ **Nitrogen**
Vine N-status, leaf nitrogen, nitrogen balance index (NBI)

**leaf N** → **grape N** → **must N** → **fermentation**

**reserves** → next-year's N

**soil N**

*N-absorption influences:*
- cover crops
- rainfall
- temperature

**plot level action:**
- nitrogen deficiency diagnosis
- fertilisation & next-year's vigour
- forecast of must nitrogen

**Potential must nitrogen**

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**Forecast of must nitrogen**

**Plot**

- last 1/3
- middle 1/3
- first 1/3

**leaf chlorophyll @ flowering**

- $y = 8.8521x - 25.816$
- $R^2 = 0.948$

**must nitrogen @ harvest**

**leaf chlorophyll @ bunch closure**

- $y = 0.2342x + 1.9616$
- $R^2 = 0.958$

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**fertilisation & plot selection**
Vine management - zone definition & delineation

Vehicle-mounted canopy-level measurements

MAP generation

vigour (porosity)

plot level action:
- fertilisation
- vigour estimation

intra-plot action:
- missing vines
- plot homogenisation
- plot fractioning
- soil sampling & analysis
- fertilisation

viticultural practice & zone delineation

In-season in-situ grape analysis (1) maturation kinetics

Hand-held single-grape Multiplex measurements

red - phenolic maturity
anthocyanins (colour)

white - technological maturity
sugar & acidity

plot level action:
- harvest date
- plot selection
- plot allocation

Replaces laboratory analysis on 200-berries samples & avoids berry sampling problems

Anth

Chl

Flav

NBI

susceptibility (disease control)
In-situ grape analysis (2) quality zone delineation

Hand-held measurement

Vehicle-mounted Multiplex leaves removed

Map generation

quality forecast & selective harvesting forecast

intra-plot action:
- zones delineation
- plot fractioning
- subplot allocation
- selective harvesting

Seeing is believing
Harvested grape analysis - diagnosis & control

Hand-held at reception
single-grape measurement

Mounted on harvester
continuous measurement

plot level action:
• differential payment
• practice verification
• forecast verification
• selection & allocation

harvest map generation

intra-plot action:
• non-grape matter estimation
• on-the-go selective harvesting

quality diagnosis & selective harvesting

Map use summary: zoning and harvest allocation

Merlot @ Château Couhins, Bordeaux
FORCE-A's decision support optical tools for viticulture

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http://www.force-a.eu/fr/qualite_raisin.html

Multiplex measurements on berries in the laboratory

30 or 100 or 200-berries samples

NO extraction needed
Tools for research and new developments

UV-exited "blue" fluorescence

HCA stilbenes Fungi

Visible fluorescence image

Blue-green fluorescence image

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