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DEPARTMENT OF AGRICULTURAL ENGINEERING

Optical device evaluation for early diagnosis in vineyard.

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Precision Viticulture (PV)

PV: methodologies allowing site-specific vineyard monitoring and management.

Crop monitoring: data and information coming from direct surveys and observation of vegetation.

Multispectral Images e Vegetational Indices

- Vegetative vigour.
- Phenological phases.
- Nutritional state.
- Plant health.
- Production expectations.

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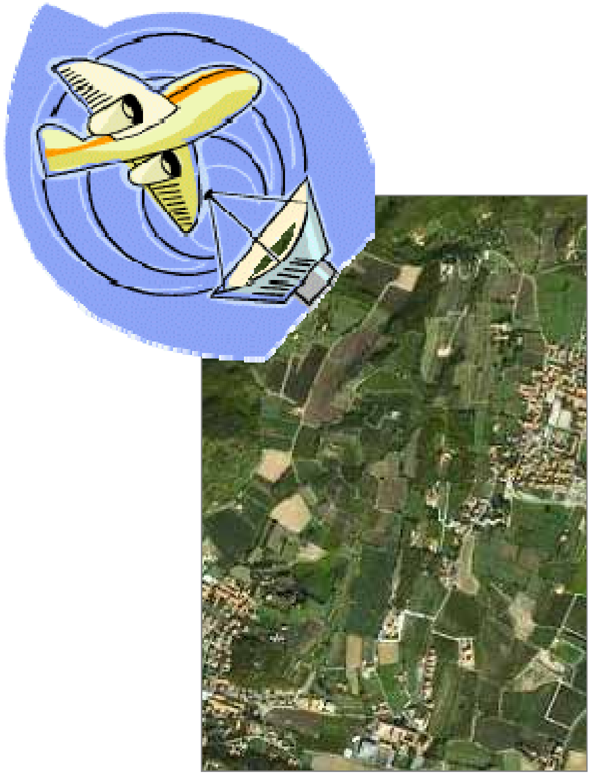
Technique for crop monitoring

REMOTE SENSING (RS)

- Canopy architecture in vineyard.
- Grass or soil presence in the inter-row space.
- Shadowing among the rows.
- High fragmentation of fields.



GROUND SENSING (GS)

Crop monitoring technologies which can be used in vineyard directly; they allow no-destructive data acquisition and measurements

Aim of the work

- Use of proximal sensing technologies.
- Evaluation of the GreenSeeker RT100 and of a portable spectrophotometer efficiency in detecting the dynamic diffusion of *Plasmopara viticola* Berk et Curt. Berl. & De Toni.
- Investigation of the possible use of optical devices in diagnosis application in vineyard.

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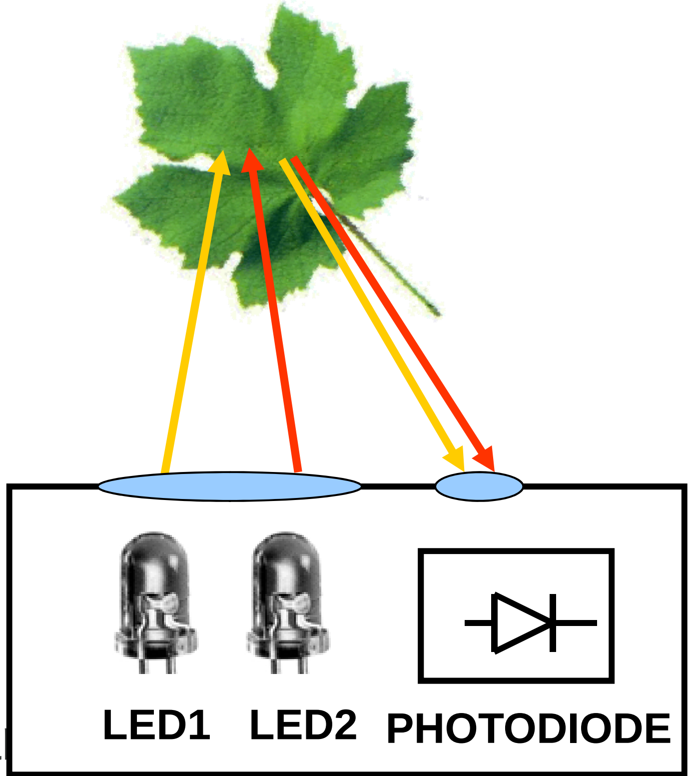
The GreenSeeker RT100

- Mobile system.
- Active lighting optical sensor (LED).
- Light emission in Red (650±10 nm) a
  NIR (770±15 nm) wavebands.
- Computing NDVI in real-time.
- Investigated surface: 60x1 cm (at a distance of 60 cm from the illuminated surface).



$$NDVI = \frac{(NIR - red)}{(NIR + red)}$$

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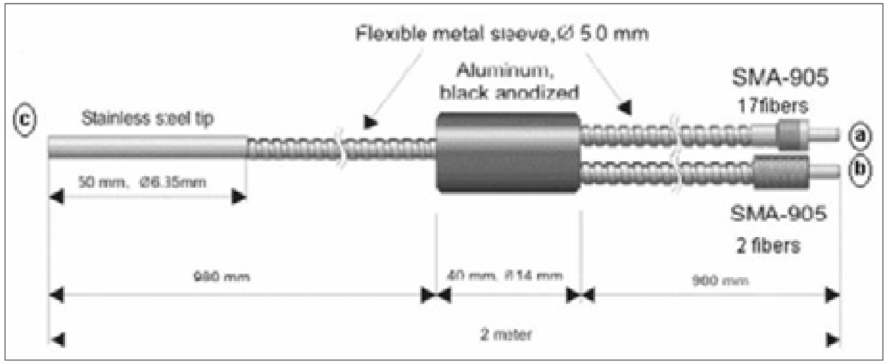
Spectrophotometer

- Vis/NIR range: 400-1000 nm.
- Lightening system: 50W halogenous spotlight with maximum emission at 500 nm.
- Fiber optic probe: 17 fibers carry light over the samples and 2 carry back radiation.
- Portable spectrophotometer: 450-980 nm; spectral resolution 0.3 nm
- PC for data acquisition.
- Battery 12 V.



Guidetti R., Beghi R., Bodria L. (2010). Evaluation of grape quality parameters by a simple Vis- NIR system. Transactions of the ASABE [53], 447-484.

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Grapevine downy mildew

- *Plasmopara viticola* Berk et Curt. Berl & De Toni.
- Optimum climate: 20-25°C with abundant rains in late spring.
- It impairs leaf physiology soon after the onset of infection.
- Extended necrosis on clusters.
- Pale yellow oil-spots on leaves that become necrotic and result in a premature defoliation of vines.

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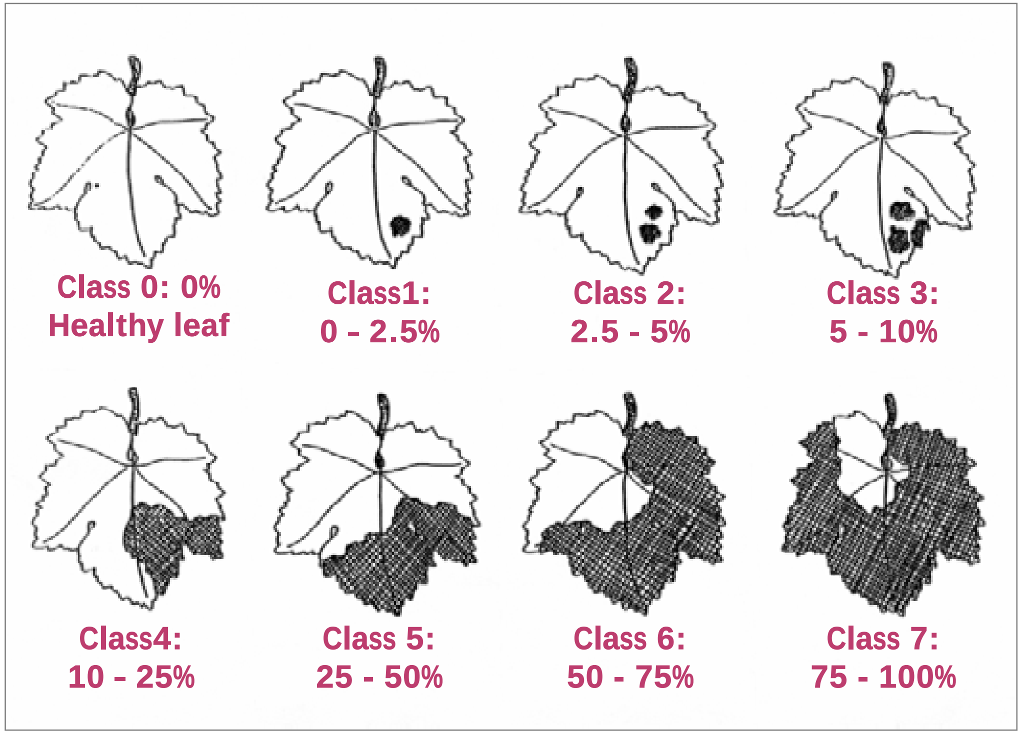
Grapevine downy mildew assessment

- According to the method described by Townsend & Heuberger (1943).
- Normally used for disease assesment in vineyard to calculate Percentage Infection Index (I%I).
- Classes based on the percentage of symptomatic leaf area.

Disease visual assessment.



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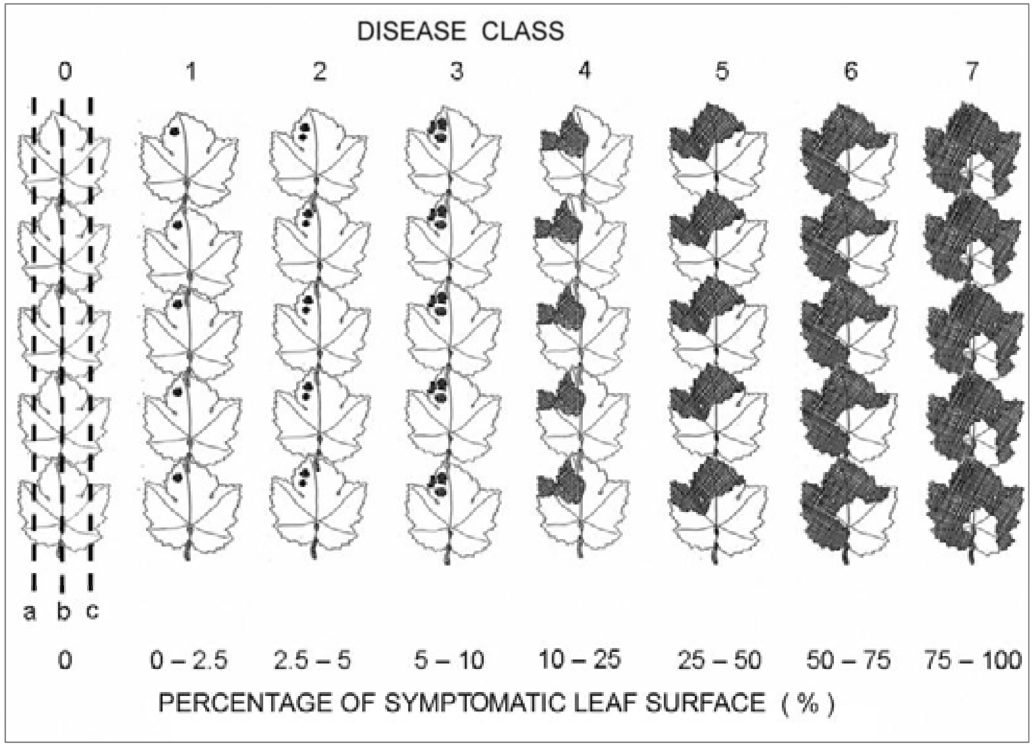
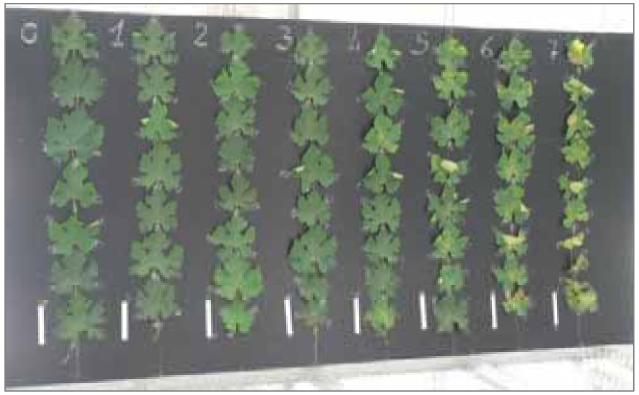
Materials and methods (1)

- Leaves from plants cv Cabernet Franc inoculated with the pathogen *P. viticola*.
- Homogeneous groups of leaves according to the classes of disease scale.
- Statically investigated by the GreenSeeker and the spectrophotometer.





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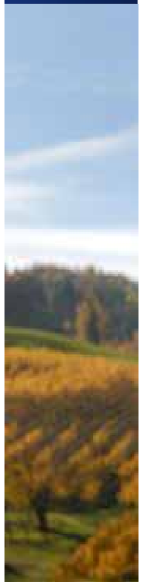


Materials and Methods 2

GreenSeeker

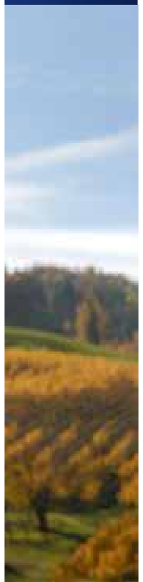
- Acquisition time: 5 s.
- Three different strips for each group.
- Average of the three measurements

Spectrophotometer

- 20 points were investigated in each group of leaves.
- Data acquired at 650±10 nm and 770±15 nm were extracted to calculate NDVI.

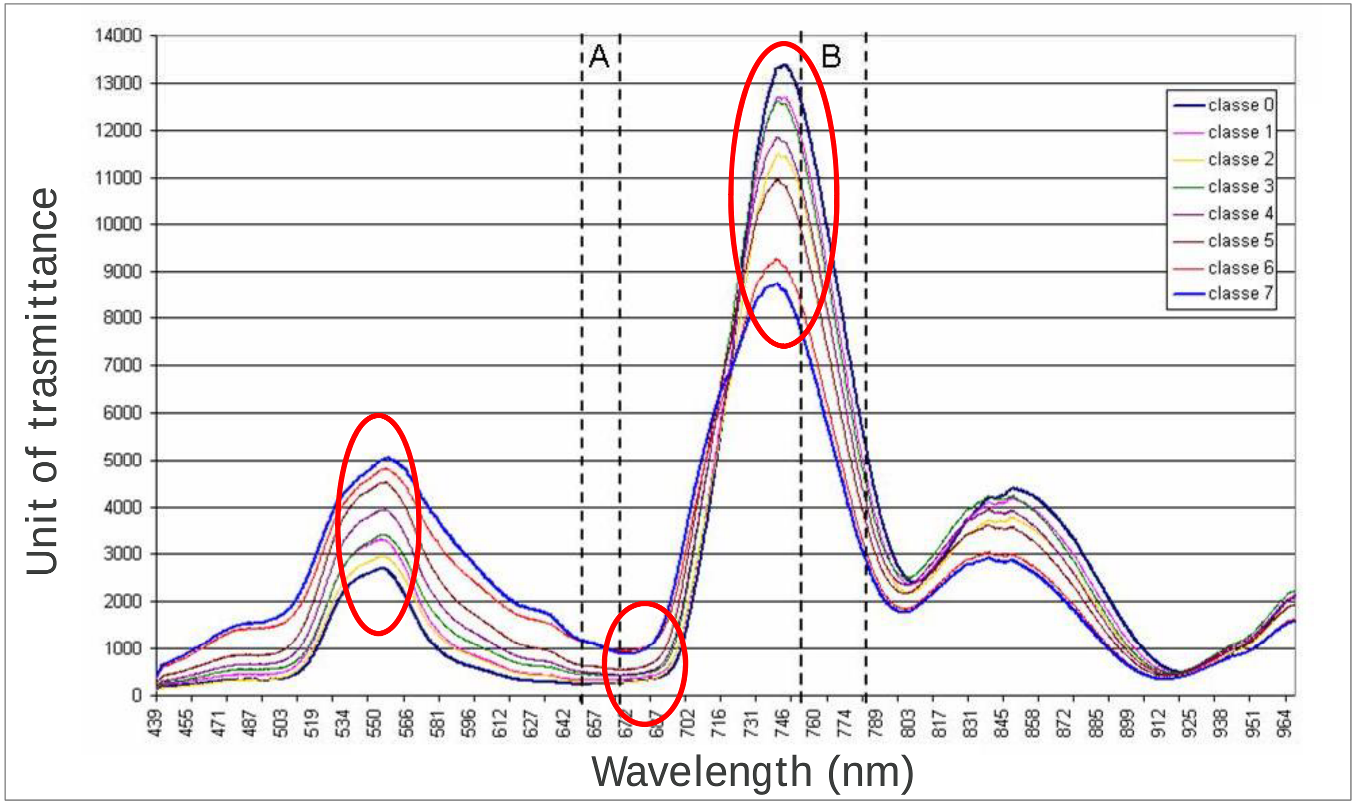
Data analysis

- Linear regression analysis between disease level and NDVI.
- Regarding the disease level the mean value of each class is considered.



Results and discussion (1)

- Each curve is the average of the 20 points collected in each class.
- Typical trend of leaf tissue: peak in green (550 nm) and NIR (740 nm), minimum in red (650 nm).
- Dotted lines highlight portion of spectra corresponding to wavelength investigated by the GreenSeeker.



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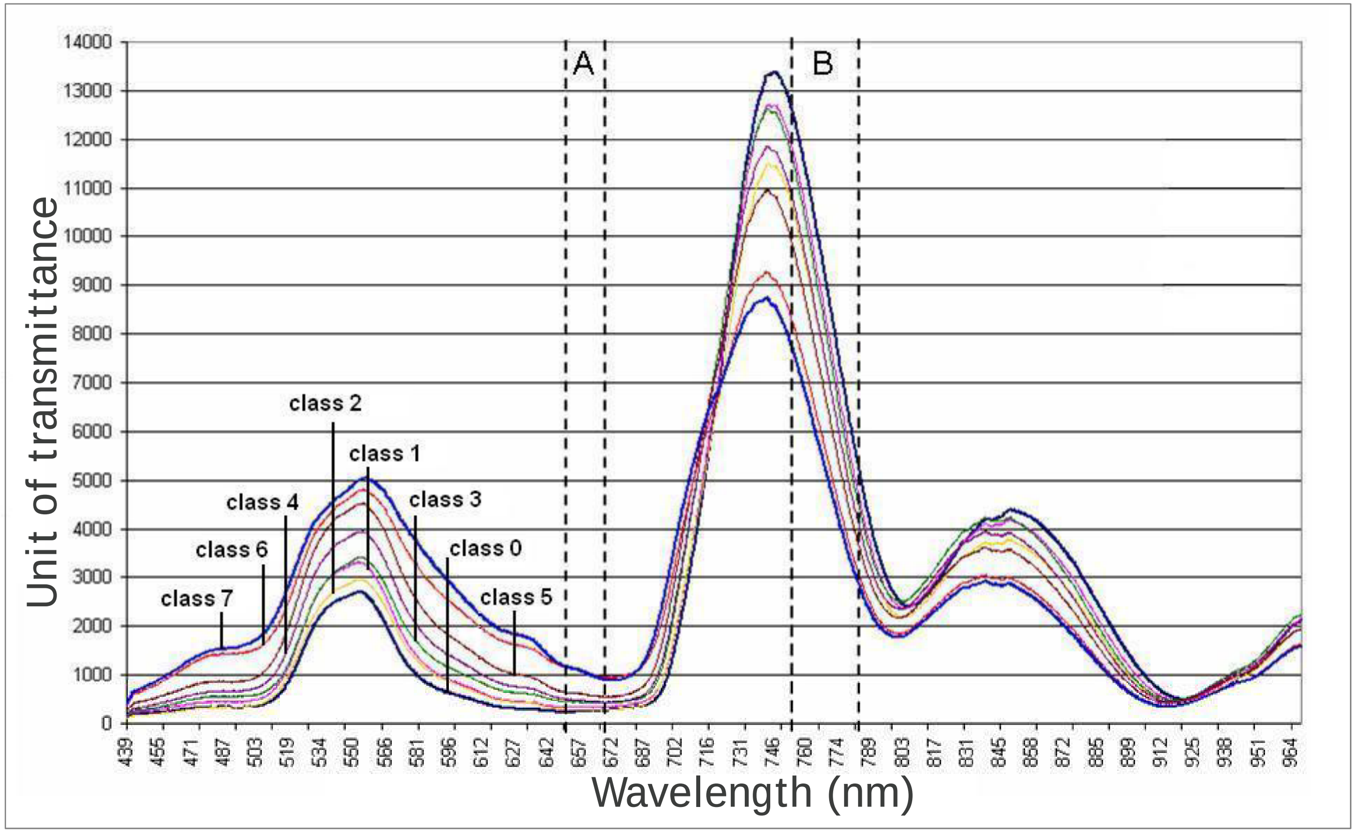
Results and discussion (2)

- Increasing reflectance in Vis and decreasing reflectance in NIR while the symptomatic surface increases.
- General functionality loss of leaf tissue after the infection.
- Mixing classes: 1 & 2 in Vis and 2 & 4 in NIR.



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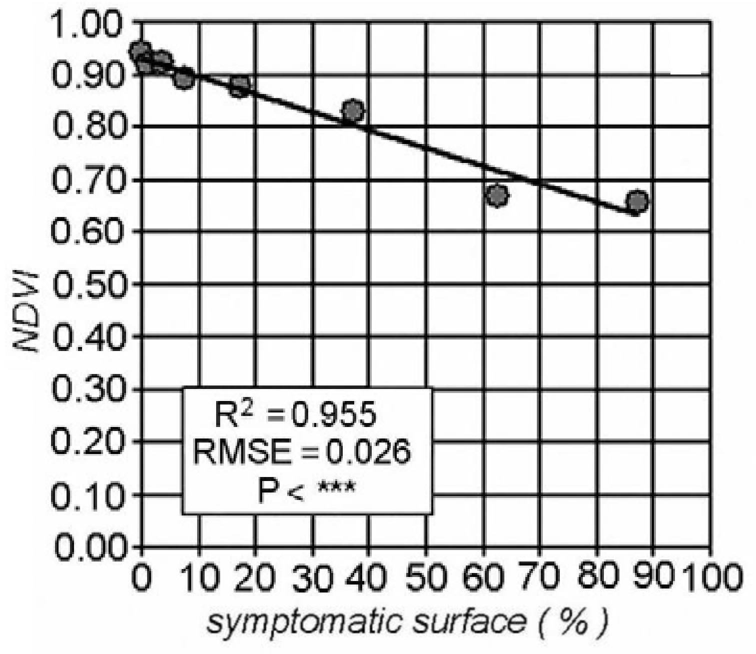
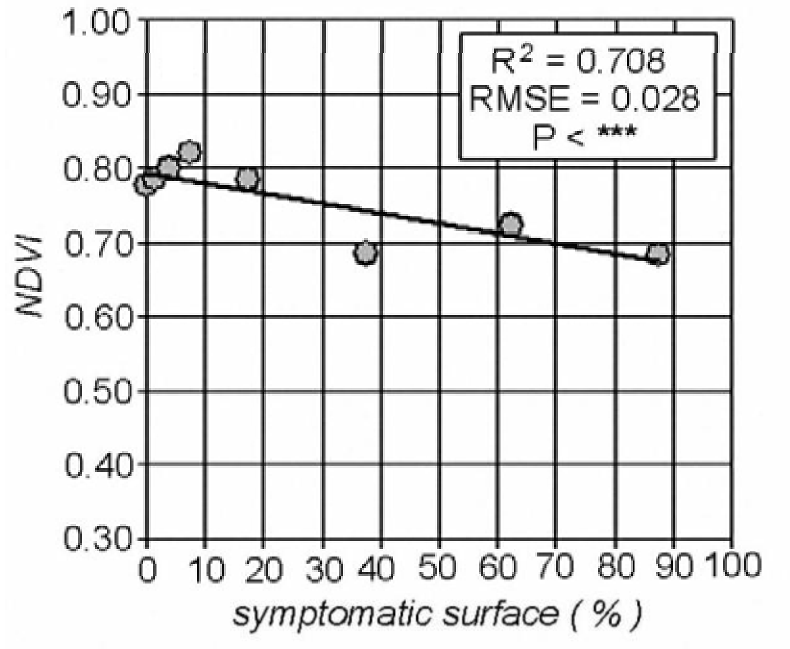
Results and discussion (3)

Spectrophotometer



GreenSeeker



- Decreasing relationship between the NDVI and symptomatic surface.
- Regression referred to the spectrophotometer is more significant than the one referred to the GreenSeeker.
- Decreasing trend of NDVI starting from class 4 (10-20% of symptomatic surface).

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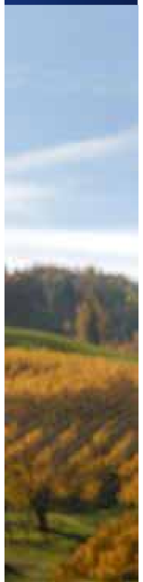

Conclusions

- Decreasing relationship between NDVI and percentage of symptomatic surface.
- Effect of physiological alterations of leaf tissue on NDVI variability values collected by the two tools.
- The spectrophotometer gives better results than GreenSeeker because of the high spectral resolution.
- Experimental data show a significant NDVI decreasing in correspondence of percentage symptomatic surface within a range of 10-20%.
- Results seems to indicate the possibility for the GreenSeeker to identify disease symptoms when they affect not less than 10% of leaf surface.

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Thank you for your attention!