

UV and PAR regime in vineyards of Tuscany

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The rationale

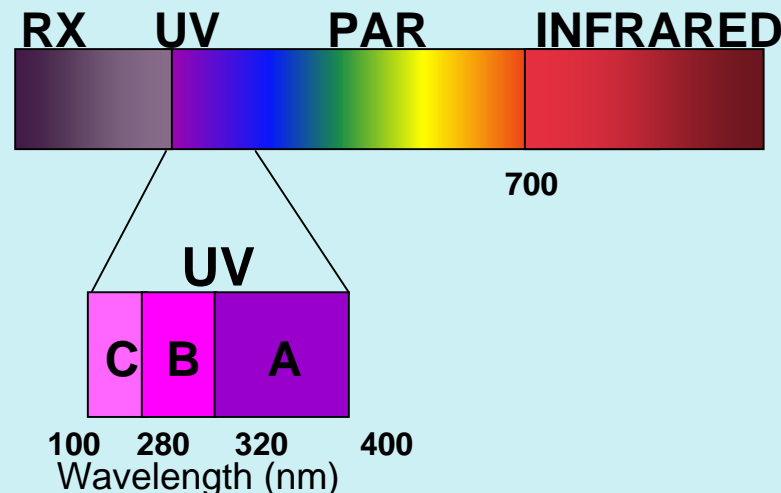
- Viticulture is one of the main agricultural activities not only in Tuscany and several wines are characterized by very high quality.
- The quality of the final products (grape and wine) depends on several environmental parameters and **light quality** is one of this.
- In (red) grapes **UV** may stimulate the synthesis of secondary metabolites that are determinant for the quality level of the wine (flavour and taste)



Aims of the research

To investigate on:

- **UV** and **PAR** levels on grapevine rows with different orientation
- different diffusive capacity of solar radiation components (**UV** and **PAR**) inside vineyards, mainly focusing on impact on **UV/PAR ratio**



Main effects of UV radiation on plants

UV/PAR ratio was one of the parameter monitored in the study because the effects of **UV** on plants seems to be related to PAR level (which is considered to have a photorepairing effect).

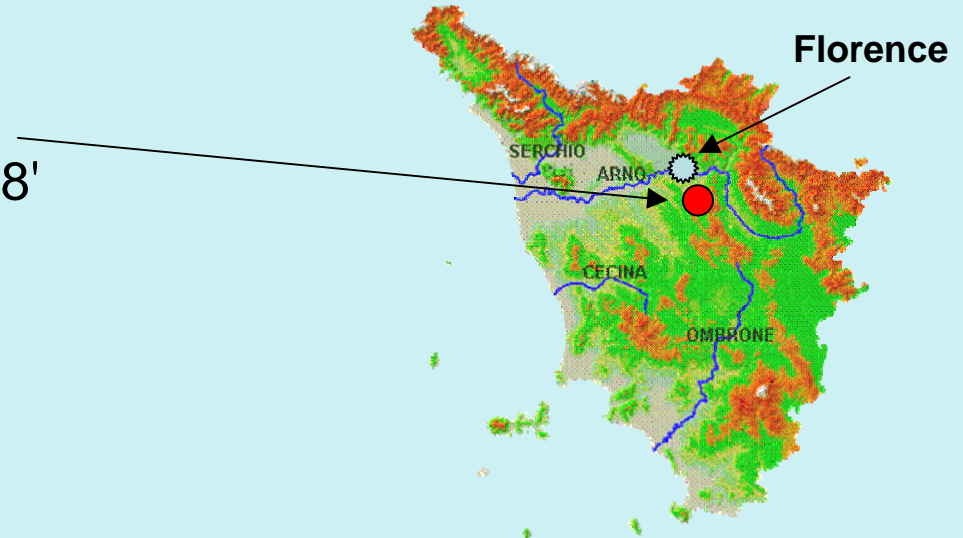
- **UV-B radiation** effects:
 - At high levels it can reduce photosynthesis activity
 - Can induce modification on plant architecture and morphology
 - Can modify the plant-parasites and plant-diseases interactions both for the effect on pathogens and for alterations induced on plants (chemical and morphological)
 - Can increase the content of chemical compounds involved in quality determination (particularly, phenols and flavonoids)
- Recently it was demonstrated also an **UV-A radiation** effect on plants growth

Location of the experiment

The research consisted in **UV** and **PAR** measurements on two vineyards characterized by different row orientation

Location: Bagno a Ripoli

(Lat.: 43° 41' 58" N, Long.: 11° 18' 48" E), Tuscany, Italy



Site A : Vineyard Mondeggi

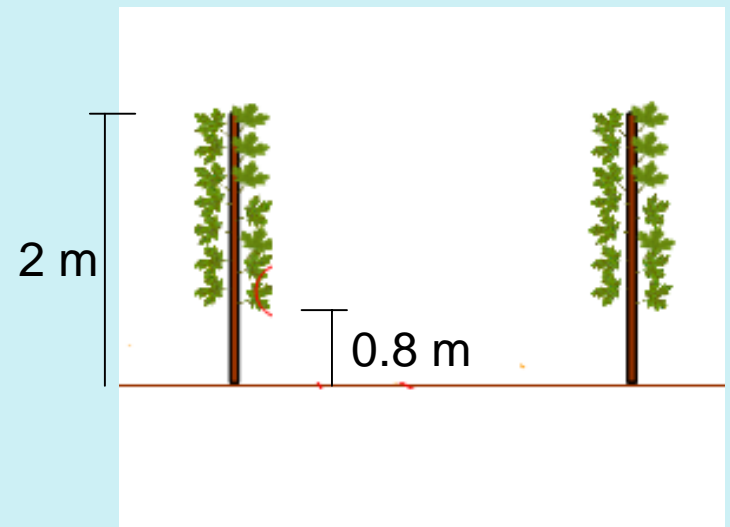
Site B: Vineyard Poggio Casciano

Grapevine variety: Sangiovese

Growing System: single cordon trained

Spacing between rows: 3.1 m (A), 3 m (B)

Spacing between plants 1 m

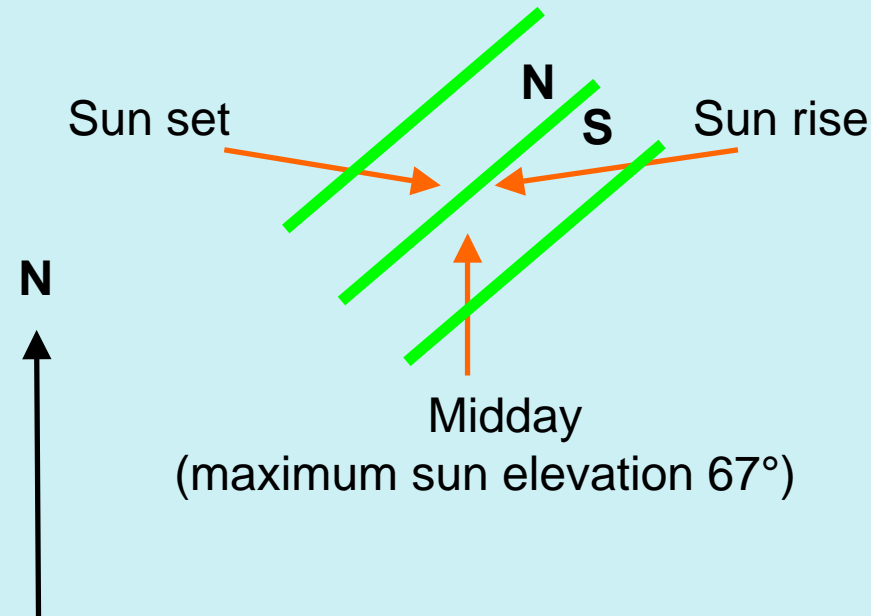


Rows orientation

SITE A

15 July 2005 (Mondeggi's vineyard)

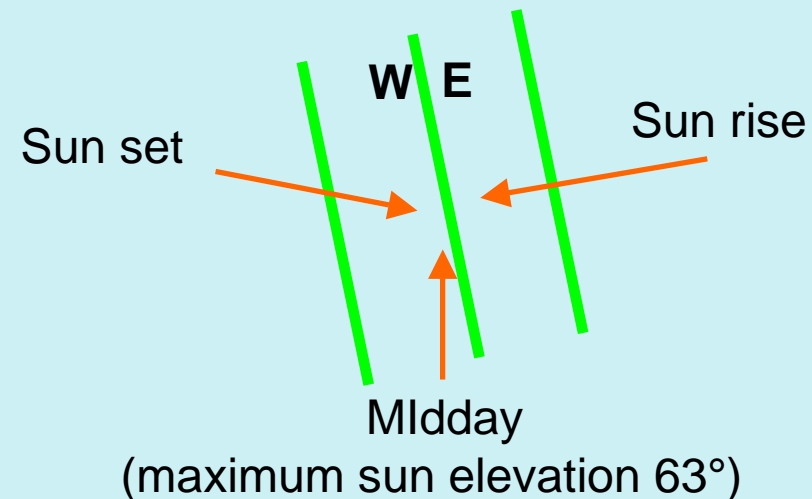
Rows oriented South-West/North-East
(azimuth of 60° respect to north)



SITE B

5 August 2005 (Poggio Casciano's vineyard)

Rows oriented North-West/South-East
(azimuth of 165° respect to north)



Instruments and methodology



Instruments:

- Double monochromator Spectroradiometer
- PAR radiometer

Methodology:

Radiation measurements were performed, at three different levels, every 50 minutes on both sides of grapevine walls:

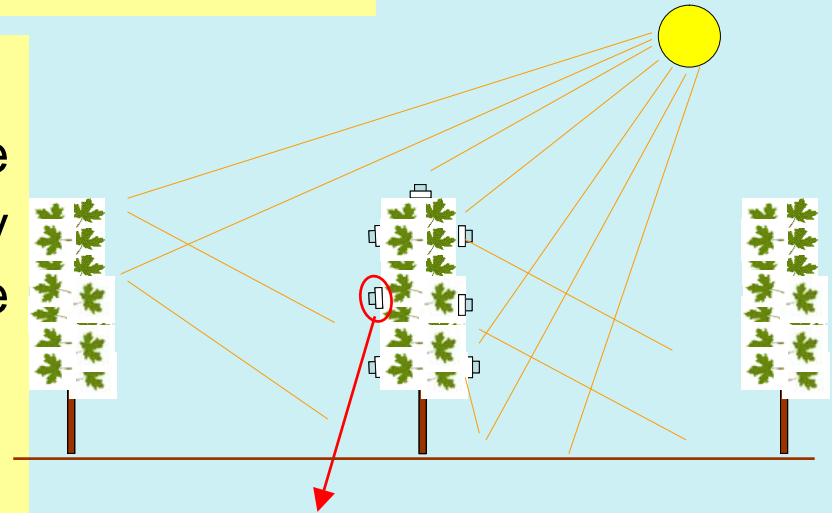
0.85 m

1.35 m

1.85 m

A measurement was performed at the top of vegetation

- No cosine correction were performed because in particular for vertical surfaces it would involve too many assumptions



Characterization of measurement days

The measurements were performed in two different clear sky days with some different characteristics:

Parameter	Site A (15 July)	Site B (5 August)
Ozone column thickness (DU)	302	307
Maximum air temperature (°C)	33	31
Minimum air temperature (°C)	22	21
Average relative humidity (%)	45	43
Barometric pressure (hPa)	1012	1017
Maximum sun elevation (°)	67.8	63.2
Minimum sun azimuth (°)	70.8	74.1
Maximum sun azimuth (°)	282.5	278.9

Atmospheric and sun parameters

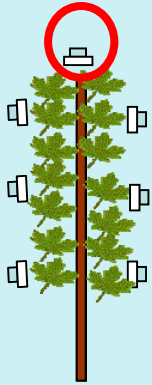
Spectral Band	Site A 15 July	Site B 5 August
PAR (400–700)	14 (%)	16 (%)
UV (280–400)	42 (%)	36 (%)
UV-A (3120–400)	41 (%)	34 (%)
UV-B (280–320)	55 (%)	48 (%)

Percentage of diffuse radiation on global radiation for UV and PAR on horizontal surfaces for the central part of the day

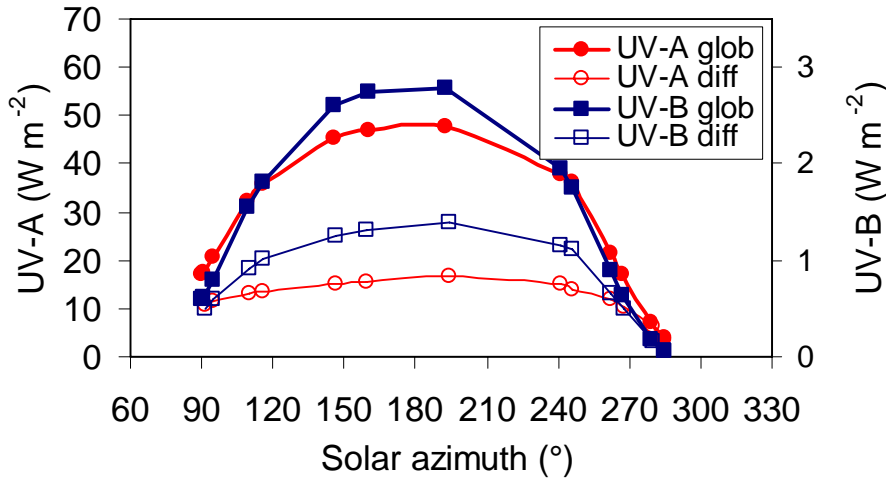
Although these differences some radiation behavior inside vineyards can be detected

UV radiation on a horizontal surface

15 July
SITE A



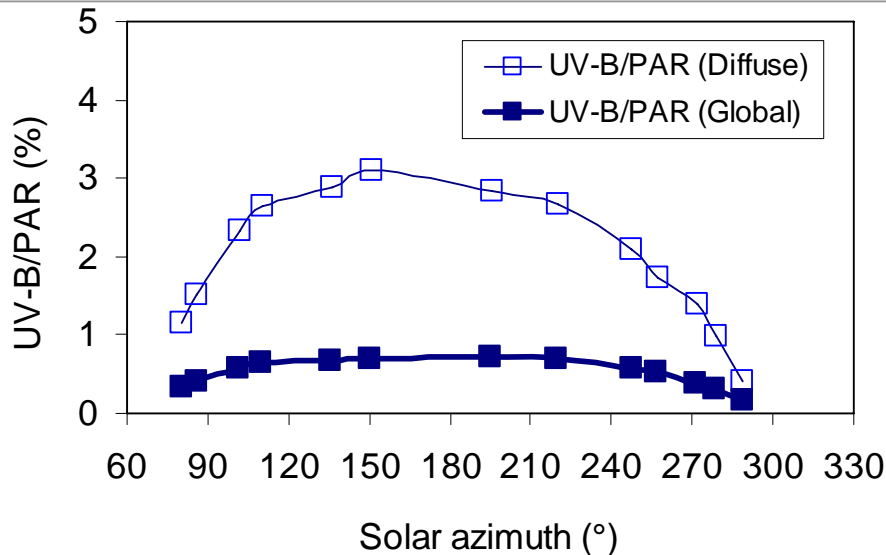
UV-B and UV-A on horizontal surface



➤ UV-B and UV-A radiation have the typical diurnal trend.

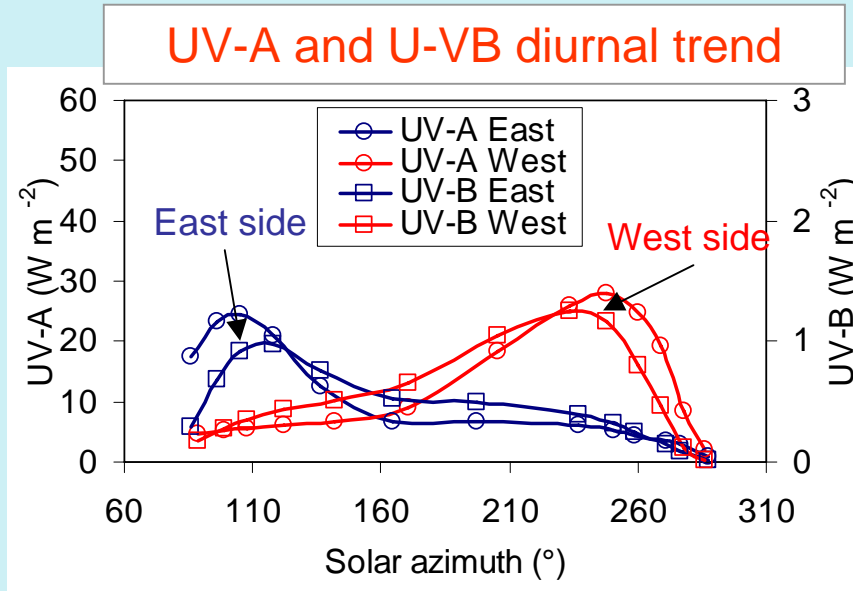
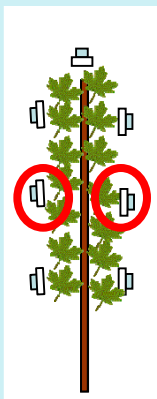
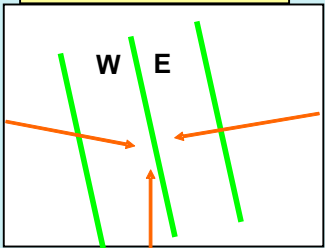
➤ UV-B/PAR ratio was significantly higher in diffuse than in full radiation

UV-B/PAR ratio in Global and Diffuse light condition

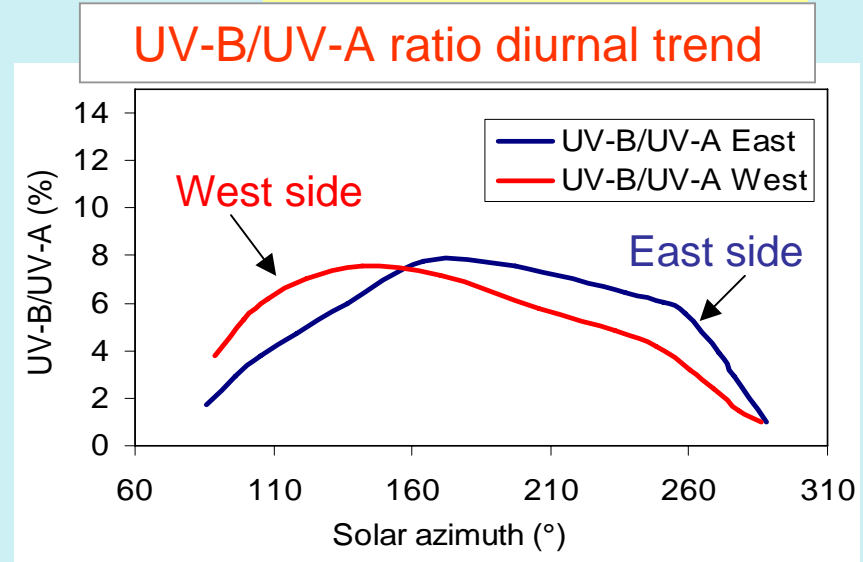
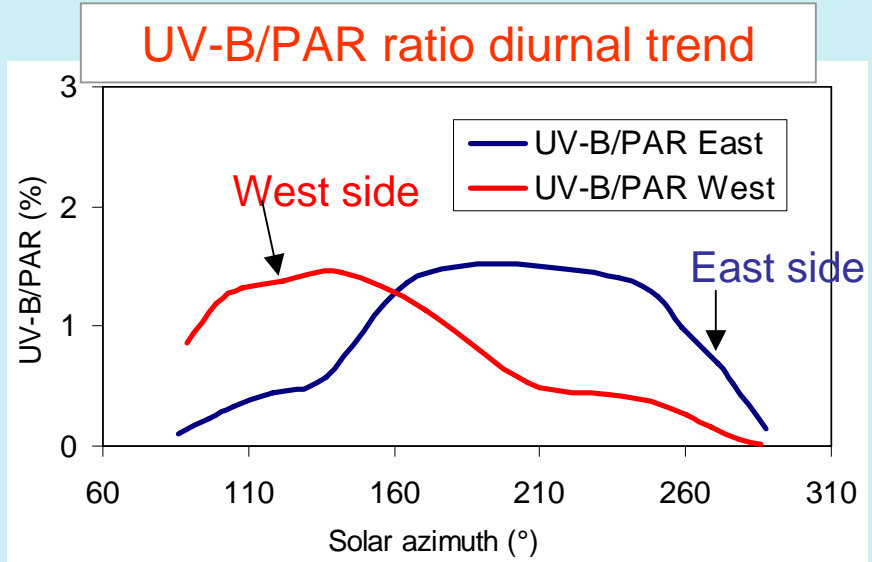


Comparison between UV radiation incident on opposite sides of the grapevine walls

5 August
SITE B

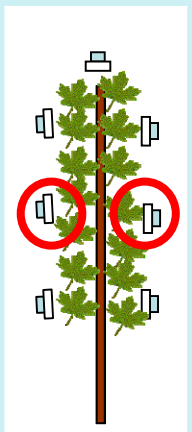
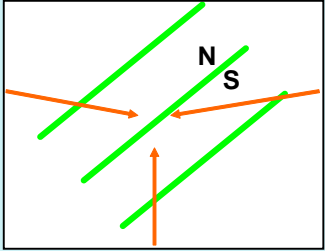


In the shaded portion of the grapevine walls the **UV-B/PAR** ratio is higher respect than in full sun. Also UV-B/UV-A ratio is higher, but with lower relative differences.

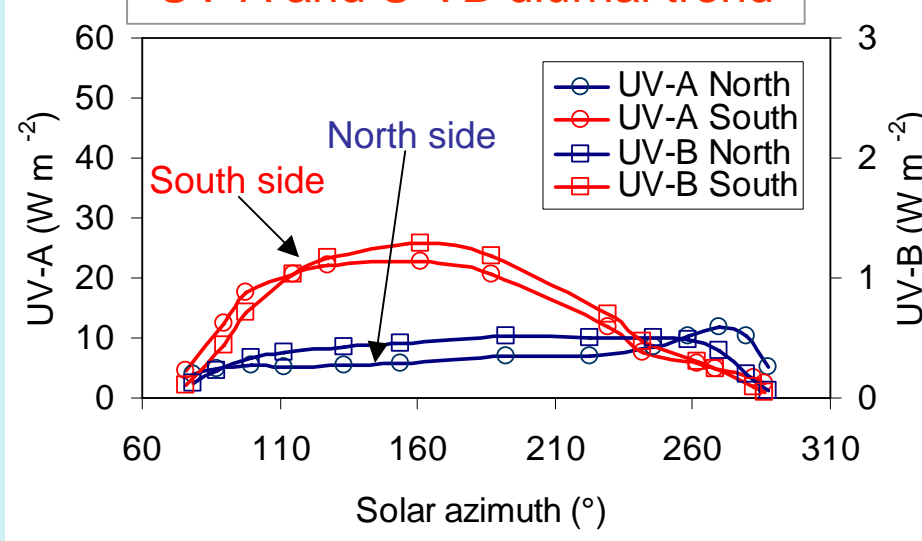


Comparison between UV radiation incident on opposite sides of the grapevine walls

15 July
SITE A

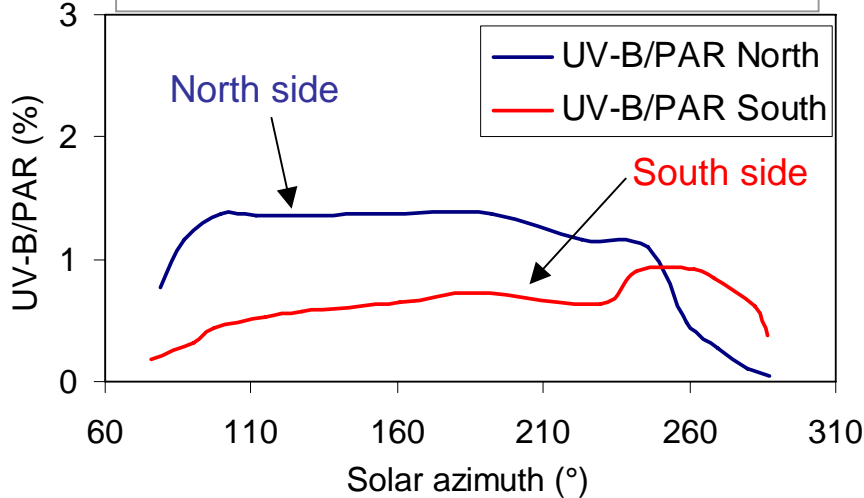


UV-A and U-VB diurnal trend

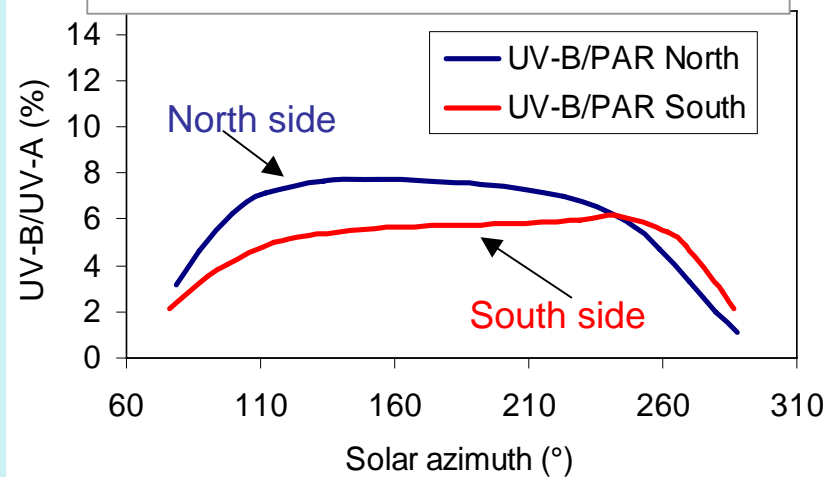


Even in this situation the **UV-B/PAR** and **UV-B/UV-A** ratio are higher in the shaded portion of plant

UV-B/PAR ratio diurnal trend

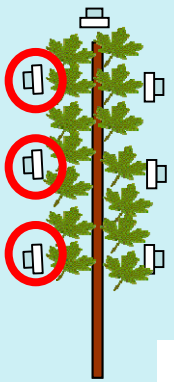
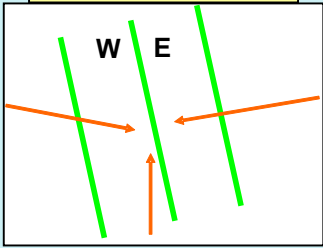


UV-B/UV-A ratio diurnal trend

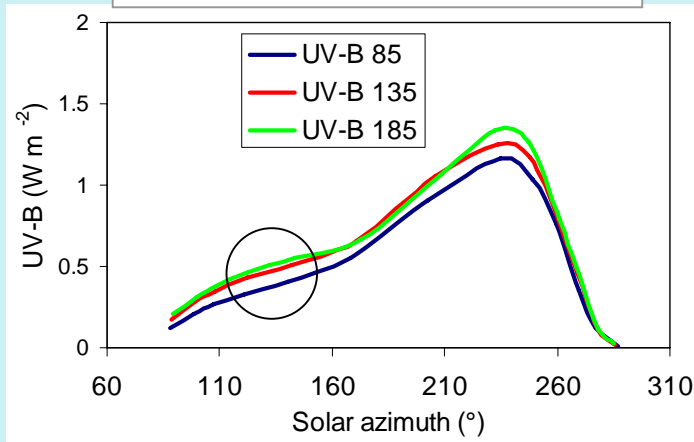


Incident radiation at different levels

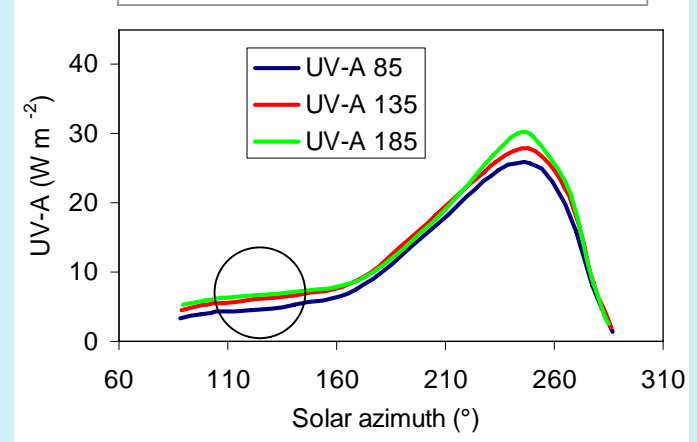
5 August
SITE B



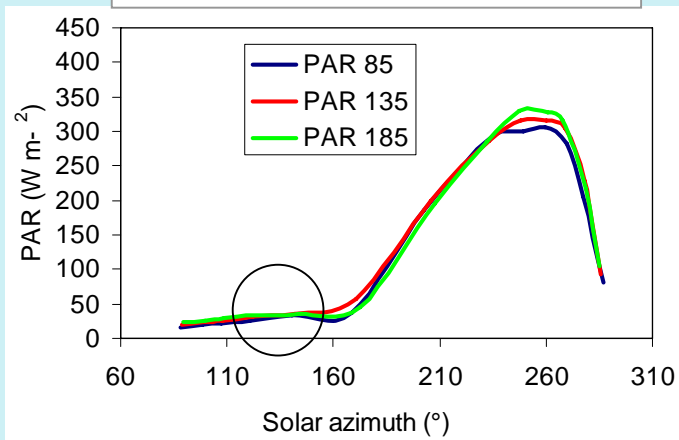
UV-B diurnal trend



UV-A diurnal trend



PAR diurnal trend



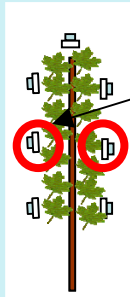
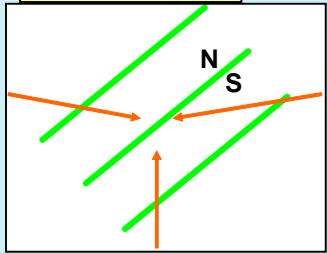
➤ higher plant portions received slightly higher radiation levels and these differences were larger in the case of UV respect to PAR

➤ This was probably due to the effect of different sky line viewed by sensors positioned at different levels and by higher diffusive capacity of UV radiation respect to PAR (mainly UV-B)

➤ UV diurnal trend curve resulted to have different shape respect to the PAR one

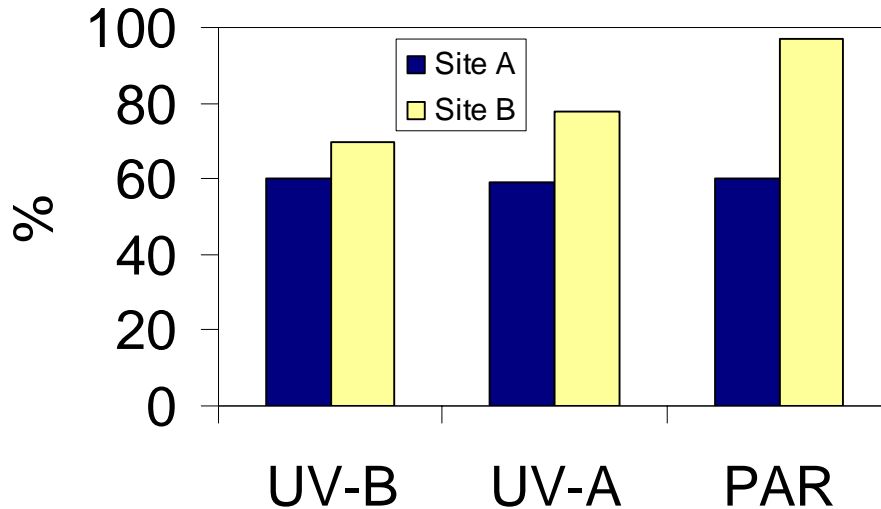
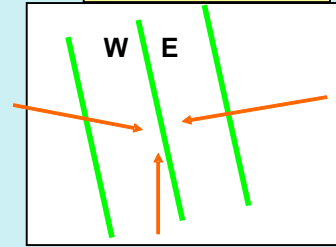
Comparison between daily intercepted radiation on differently oriented rows

15 July
SITE A



For site A and B we have calculated the daily intercepted radiation cumulated on both sides of the row (1.35 m above ground level)

5 August
SITE B



Daily UV-B, UV-A and PAR radiation cumulated on the row were expressed as percentage of that incident over horizontal surface

Intercepted PAR was more sensitive than UV to vineyards characteristics (mainly to differences in geometry).

Site B intercepted a higher amount of solar radiation respect to site A in all the wavebands considered.

Conclusions

- On a vertical “green” surface the UV/PAR ratio changes during the day according to the relative position (elevation and azimuth) of the Sun.
- Row orientation (azimuth) affects daily cumulated irradiance: PAR is much more affected than UV, and UV-A more than UV-B.

Conclusions

- Despite some limitations and uncertainties this preliminary study can contribute to improve our knowledge of the UV-visible radiative regime in non-horizontal surfaces of complex geometry systems.
- Future plans: to compare these field data with the outputs of radiative models now becoming available simulating the UV irradiance on vertical surfaces in a complex geometrical system.

**Thank you for
your attention**

