

Does the Azimuth Direction of Observation of Trees influence Chlorophyll Content and Spectral Reflectance?

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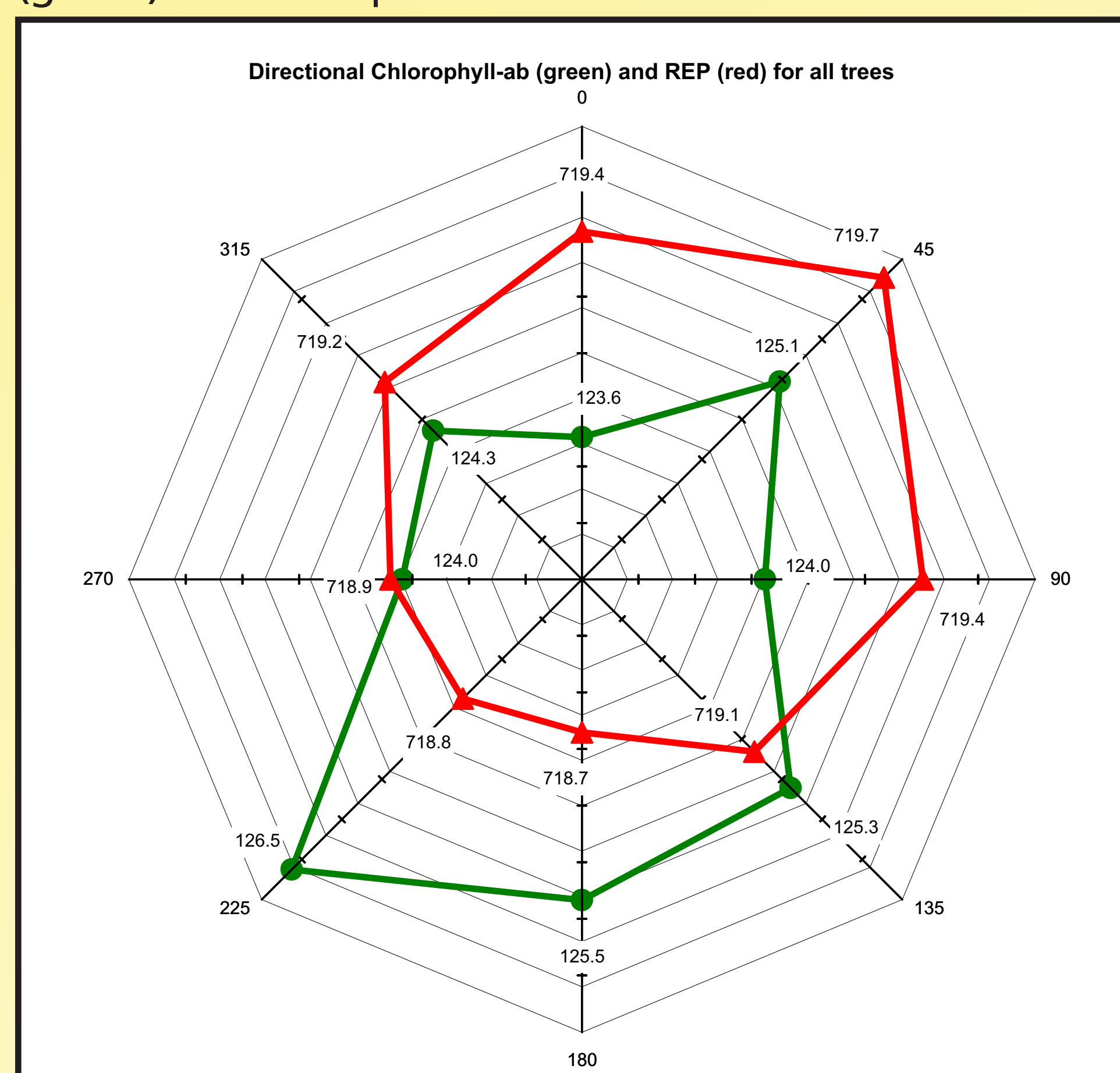
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Hyperspectral Images are widely used for quantitative mapping of vegetation parameters such as Leaf Area Index, aboveground biomass, canopy structure and canopy moisture content. Based on statistical relations between field observation and hyperspectral measurements, predictive models are built to map the vegetation parameters for larger areas. The effect of azimuth angle of observation of the trees however is unknown and never investigated. The objective of this study is to determine the effect of observation azimuth directions on leaf reflectance and chlorophyll contents of *Quercus ilex* trees. It was anticipated that the south oriented parts of trees may yield higher chlorophyll contents and different reflectance properties.



▲ Detached Holm Oak tree (*Quercus ilex*).

Red Edge Position (red) and Chlorophyll content (green) of all sampled trees in 8 directions. ▼



Spectral measurements (leafclip) and Chlorophyll (SPAD) of leaves. ▼

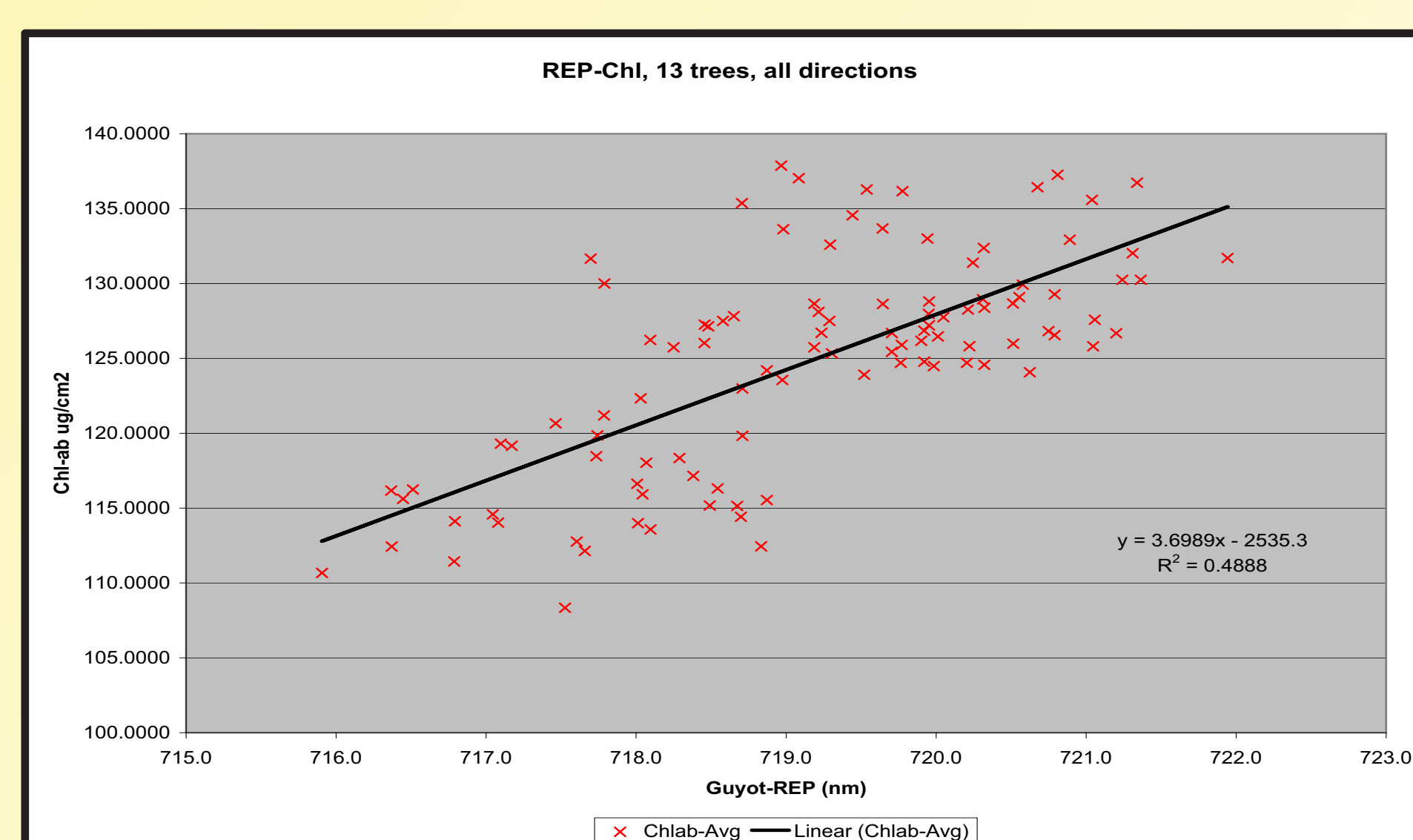


Methods

Spectral reflectance (ASD FieldSpec with leaf clip) and Chlorophyll-ab (SPAD) content were measured around 13 individual free-standing *Quercus ilex* trees in 8 azimuth directions in steps of 45°. Per direction 20 SPAD measurements and 6 spectra of different leaves were collected. SPAD measurements were converted to chlorophyll concentrations using relations described by Ribas et al. (2005). Directional dependence of reflectance and chlorophyll was investigated and the relation between chlorophyll content of leaves and leaf spectral properties such as red edge position, Carters stress indices and NDVI.

► Average 8-directional relations (13 trees) for chlorophyll-ab content (upper) and the REP: Red Edge Position (centre), right axes show standard deviations.

The relation between average (n=2080) leaf chlorophyll concentration and the Red Edge Position ▼



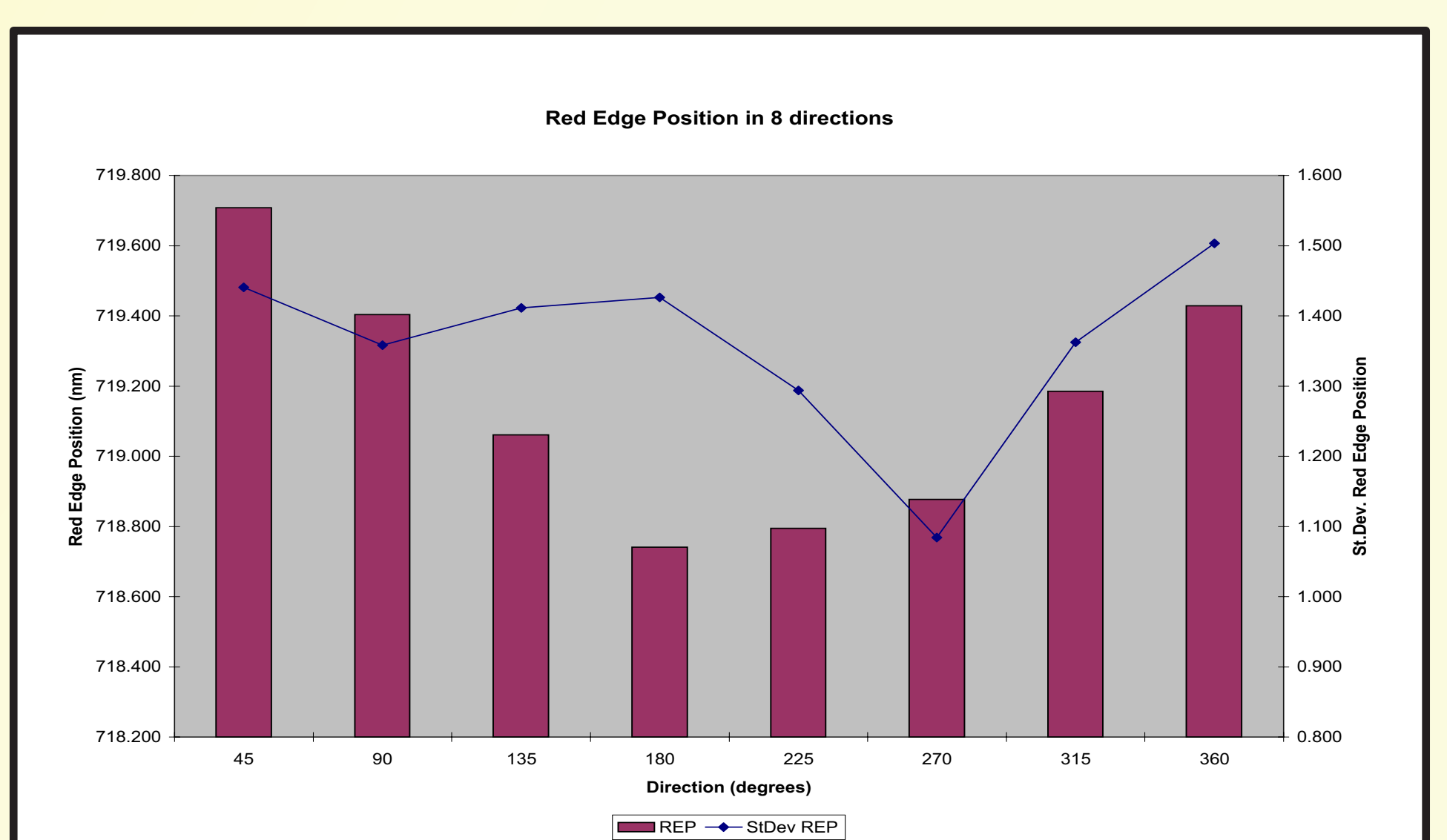
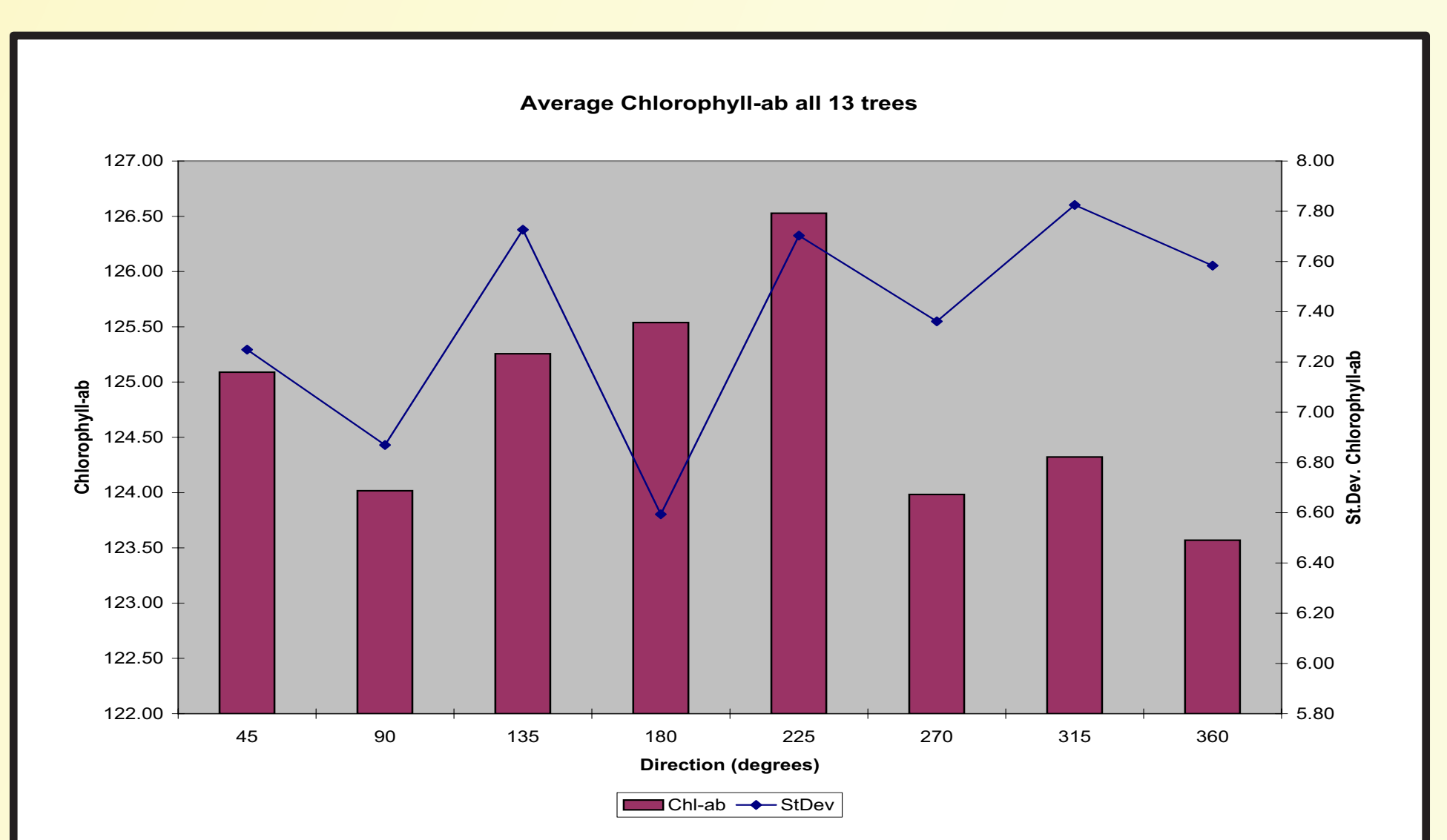
Results & Conclusions

Azimuth direction plays a small but noteworthy role in hyperspectral observations and chlorophyll measurements of *Quercus ilex* properties. Chlorophyll concentration is about 3 $\mu\text{g}/\text{cm}^2$ higher at 270° than at 360°. The Red Edge Position shows also a small directional dependency of 1.5 to 2 nm. REP is smallest for south-oriented leaves while surprisingly chlorophyll concentrations are highest for south-oriented leaves. The Red edge Position gives an indication for the chlorophyll contents for the *Quercus ilex* leaves in the Payne study area with the presented regression function with a r^2 of 0.49

Study Area



The Payne area is located 60 km west of Montpellier (France) and is covered by Mediterranean oak forest dominated by *Quercus ilex* and *Quercus pubescens*, and 'Garrigue' shrub lands. The area is characterised by a complex of geological and lithological substrates resulting in a wide range of soil and moisture conditions and hence, growing conditions. The area is an experimental study site for airborne imaging spectroscopy (DAIS7915, HyMap) since 1997.



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