Measurement of drought stress

The Chemical Potential of Water Represents the Free-Energy Status of Water = The ability to do work

Three Major Factors Contribute to Cell Water Potential

$$\Psi_w = \Psi_s + \Psi_p + \Psi_g$$

Solute, Pressure, Gravity.

Water potential:
- determines the direction of water movement
- describes the water status of the plant
Measurements of water status of plants

An Increase in Guard Cell Turgor Pressure Opens the Stomata

Stomata open:
- good water supply
- light (blue light receptors)
- low CO₂ concentration within the leaf
- high RH outside
- diurnal rhythm

Stomata close:
- drought
- dark
- high CO₂ concentration within the leaf
- low RH outside
- diurnal rhythm
- abscisic acid (ABA)
### Measurement of water deficit

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#### Scholander bomb ($\Psi_w \sim \text{MPa}$)

![Scholander bomb diagram]

- **(A)** Water column in xylem before excision
- **(B)** Water column after excision
- **(C)** Water column when pressure balance ($P$) is reached
Measurement of water deficit in indirect modes:

- Infra-red imaging: increase of leaf temperature
- Chlorophyll fluorescence: decrease in photosynthetic capacity
- IRGA: decrease in transpiration and photosynthesis

Connection between water and temperature balance
Infra-red thermometer  Thermoscanner

Infra-red image of *Vitis vinifera*
Chlorophyll fluorescence: decrease in photosynthetic capacity
Spectroscopy
The study of the interaction between matter and radiated energy.

Spectroscopical determination of concentration of substances
Lambert-Beer law:

\[ A = \varepsilon \cdot c \cdot l = \lg \left( \frac{I_0}{I} \right) \]
Why do substances absorb electromagnetic radiation?

Vibrational states

- Stretching
  - Symmetric stretch
  - Asymmetric stretch
- Bending
  - Scissoring
  - Rocking
- Torsional vibration
  - Twisting
  - Wagging
Vibrational states of CO$_2$

Streching

Bending

\[ \text{Symmetric stretch} \quad \text{Antisymmetric stretch} \]

\[ \delta_x \quad \delta_y \quad \delta_z \]

\[ \text{Degenerate same energy one band} \]

4260 nm

15000 nm

Vibrational states of H$_2$O

Experiment

TTM3-F

Intensity

Frequency (cm$^{-1}$)
Infrared absorption of H$_2$O and CO$_2$

Open system (differential system)

- Operating multiple chambers is possible
- CO$_2$, H$_2$O, O$_2$... can be regulated