

Water relations in grapes

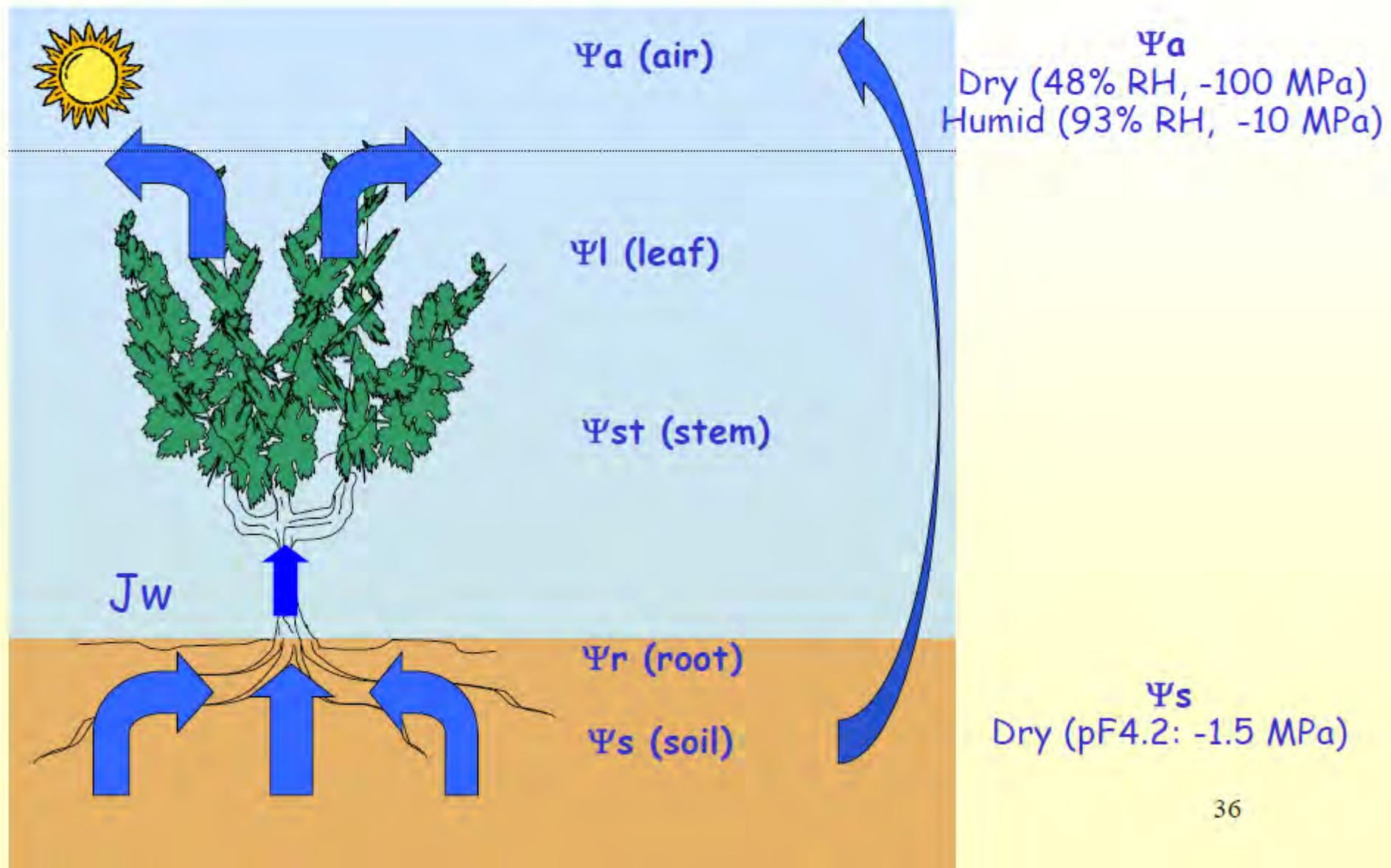
- **Water potential and its components**
- **Water uptake and transport along the soil-root-canopy continuum**
- **Transpiration and controlling factors**
- **Stomata movements**
- **Drought adaptation mechanisms**

$$\psi_w = \psi_t + \psi_\pi + \psi_g + \psi_m$$

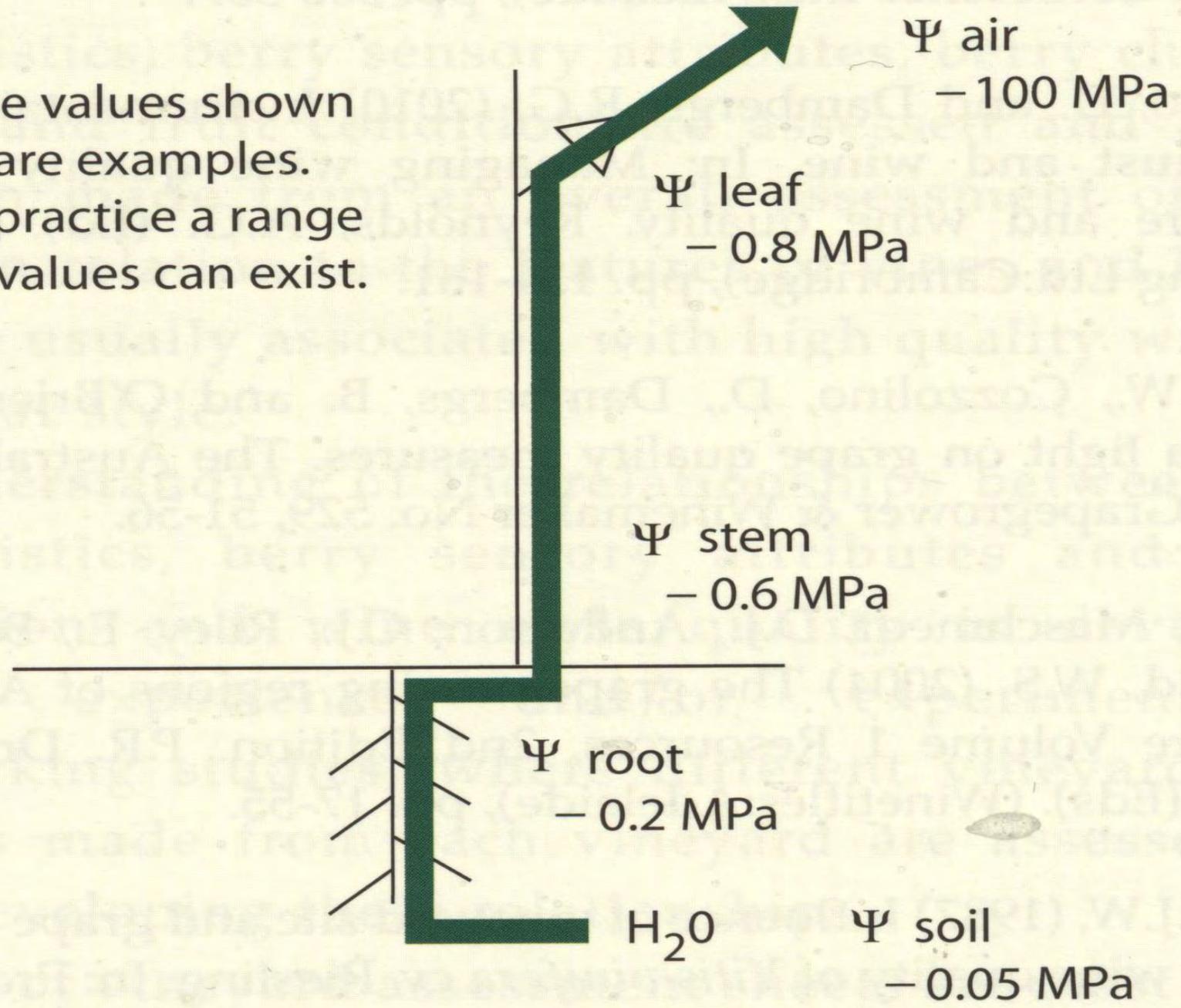
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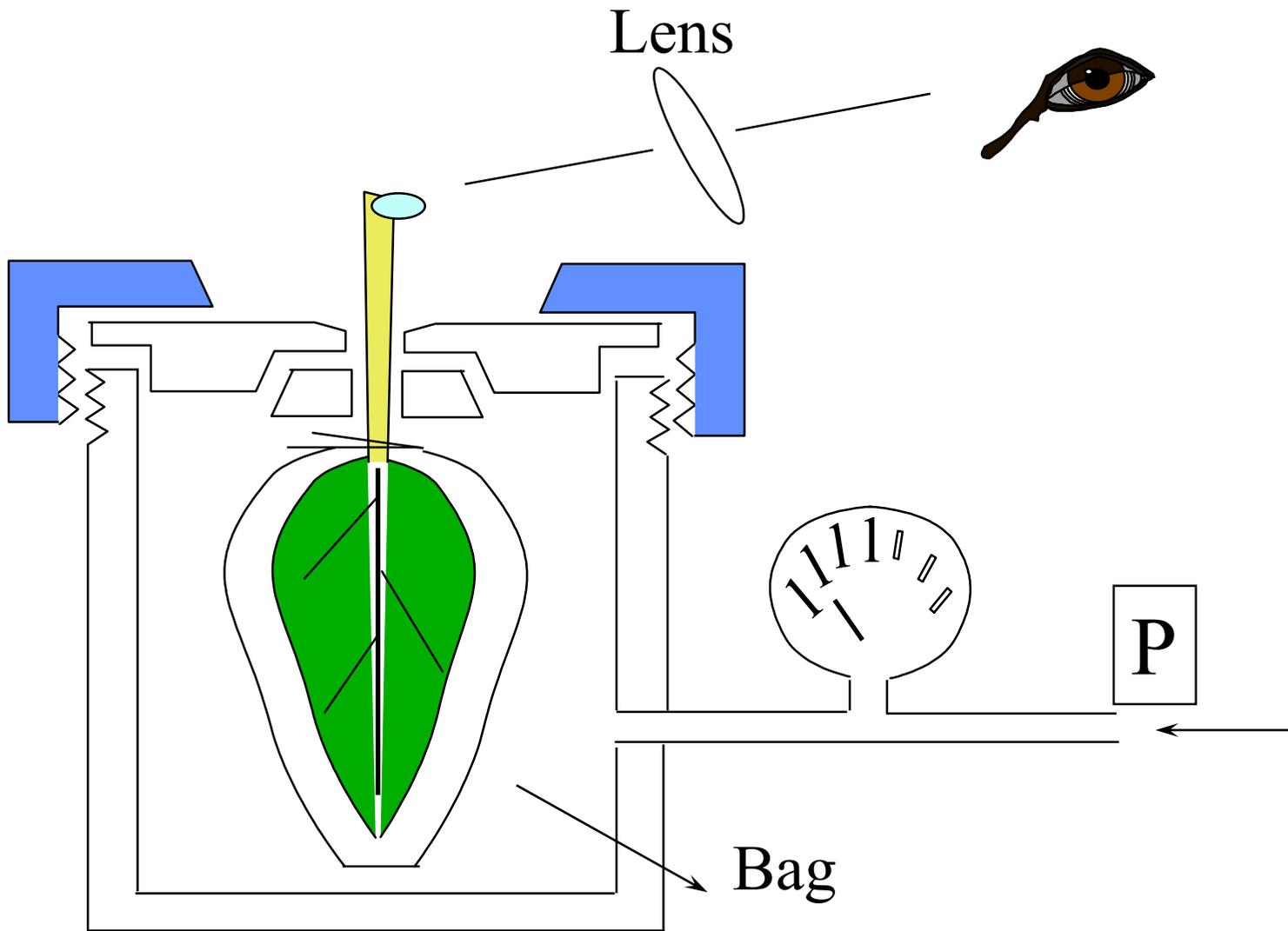
1 MPa = 10 bars

Water moves along the SPAC toward the lowest water potential

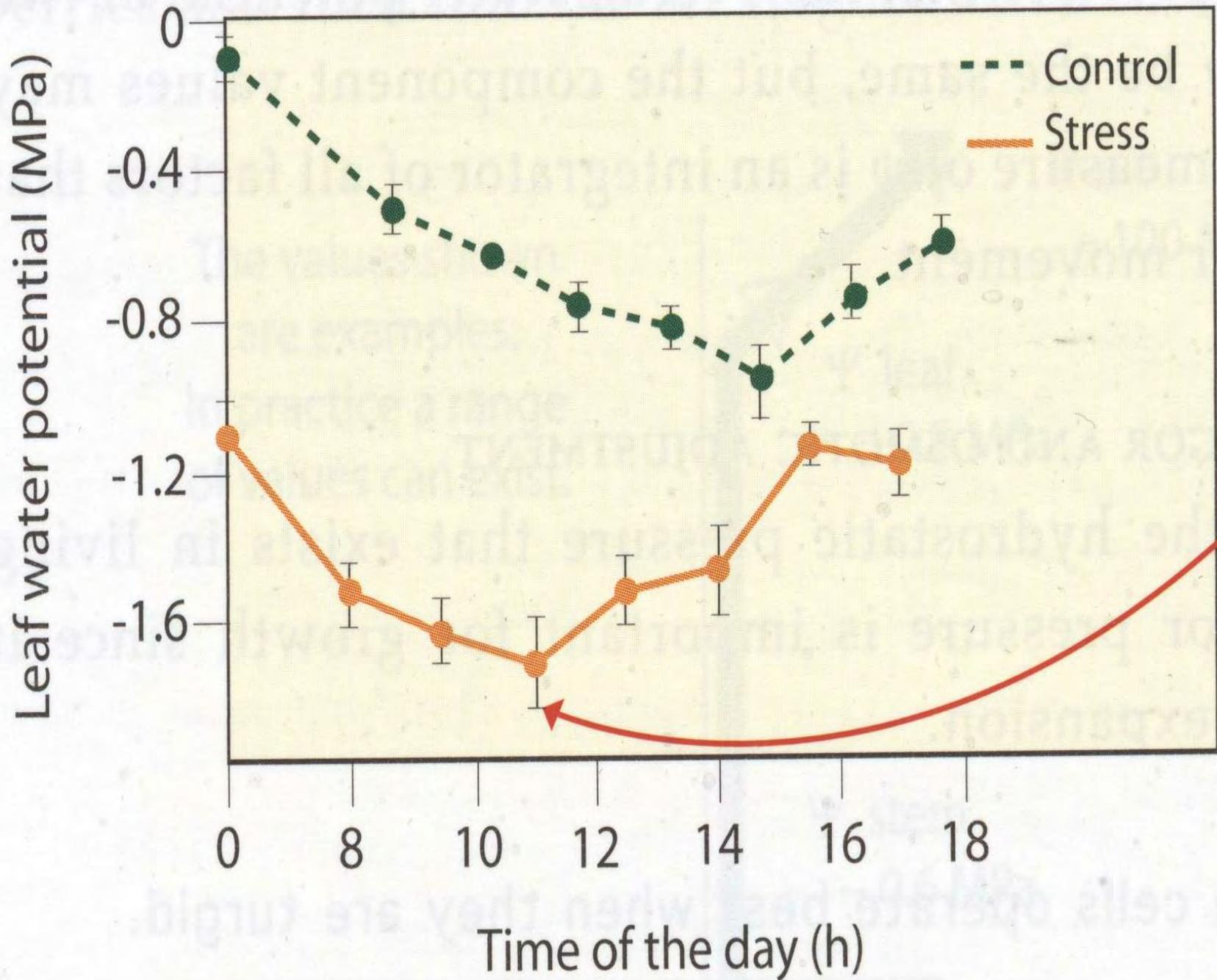


The values shown are examples. In practice a range of values can exist.









Water stressed vines reached a lower value earlier in the day and have more negative water potentials

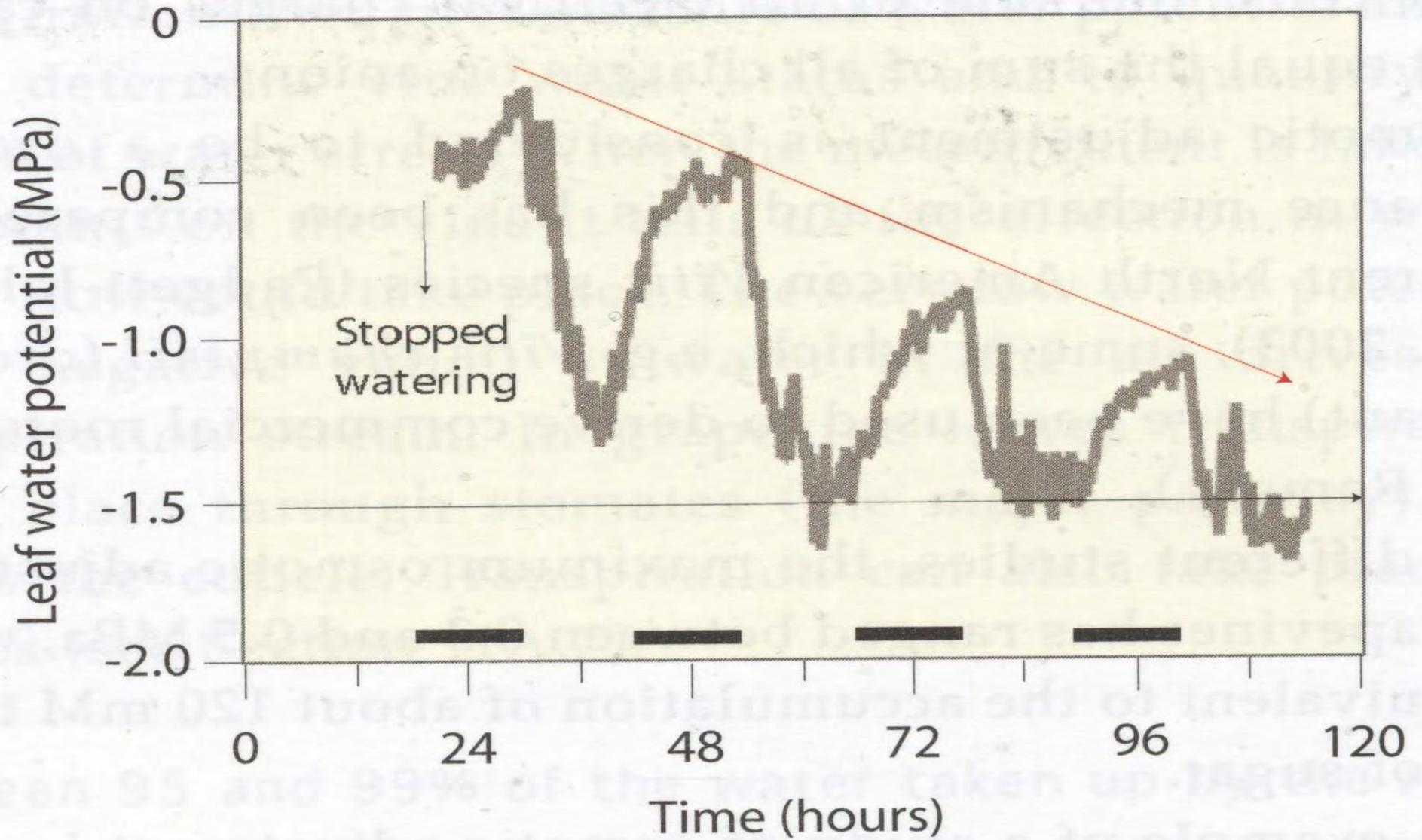
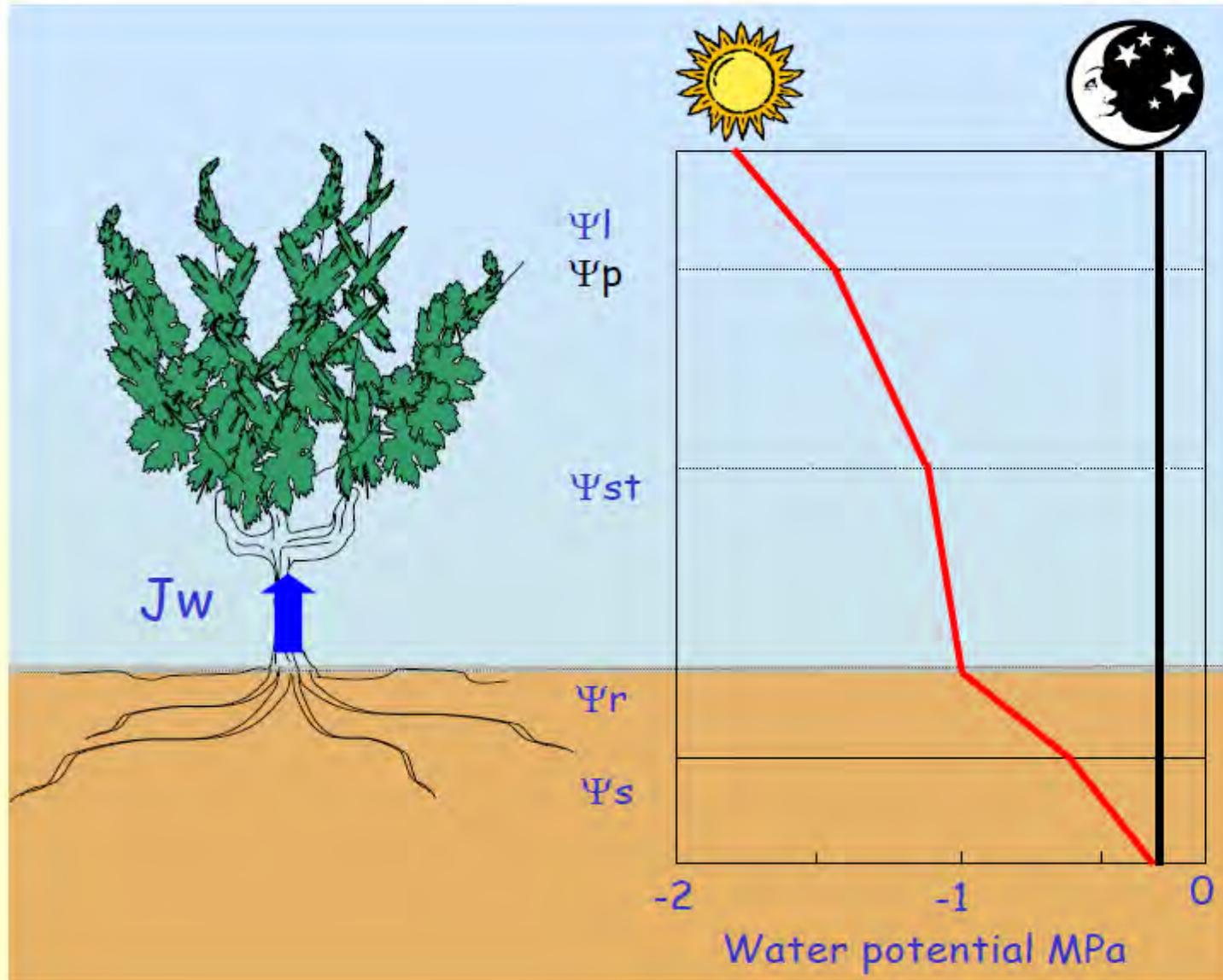


Figure 11.5 The change in leaf water potential (measured by a psychrometer) when water supply was restricted to the roots of potted Chardonnay vines (figure provided by S.D. Tyerman).

Predawn leaf water potential (Ψ_p) can be assimilated to soil water potential



Predawn:
 $\Psi_l = \Psi_s = \Psi_p$

| PLWP (Ψ_{plwp}, Mpa) | Vine water status |
|--|--------------------------|
| 0 to -0.3  | absent to mild |
| -0.3 to -0.6  | moderate to progressive |
| < -0.6/-0.8  | hydric stress |

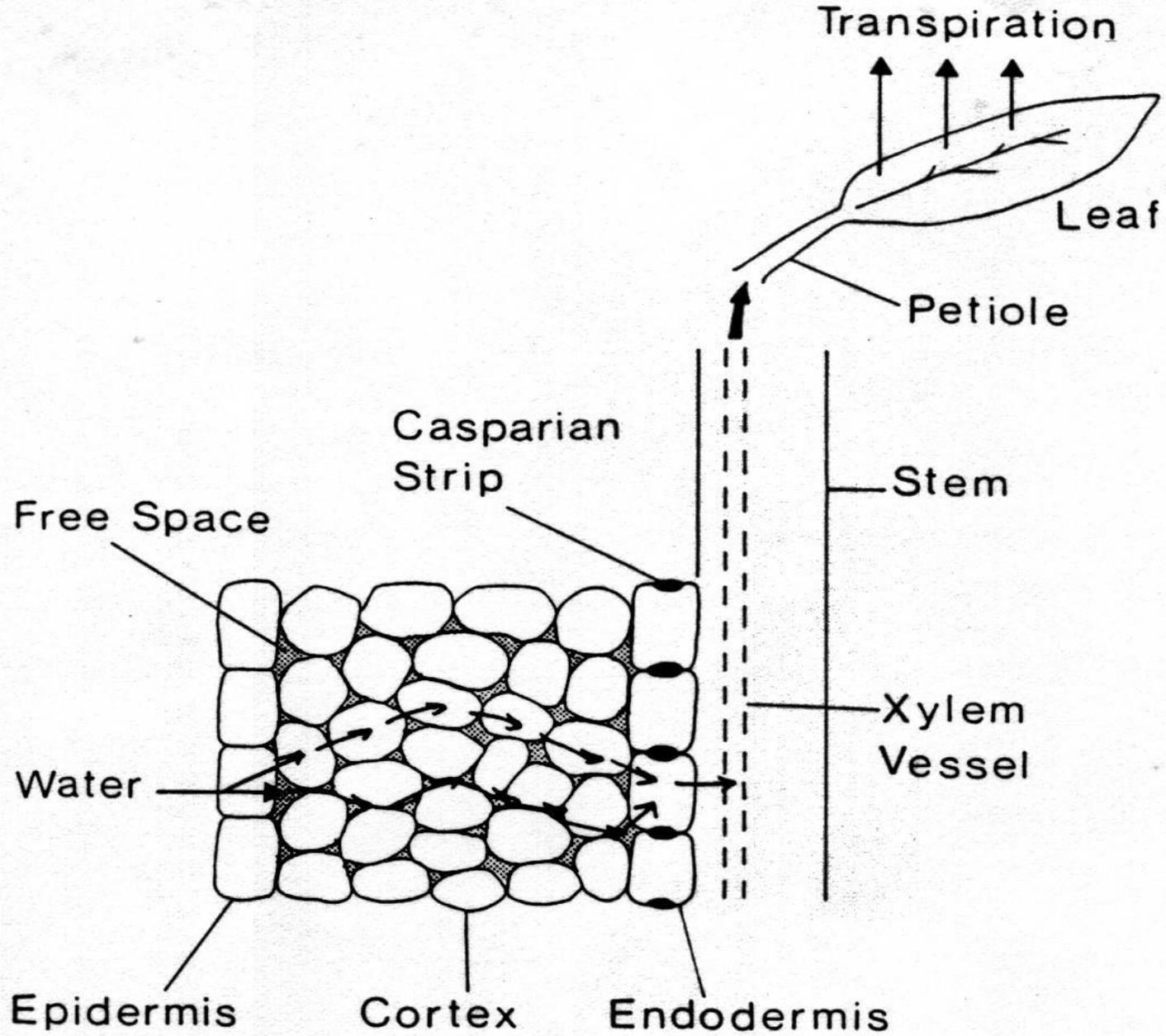
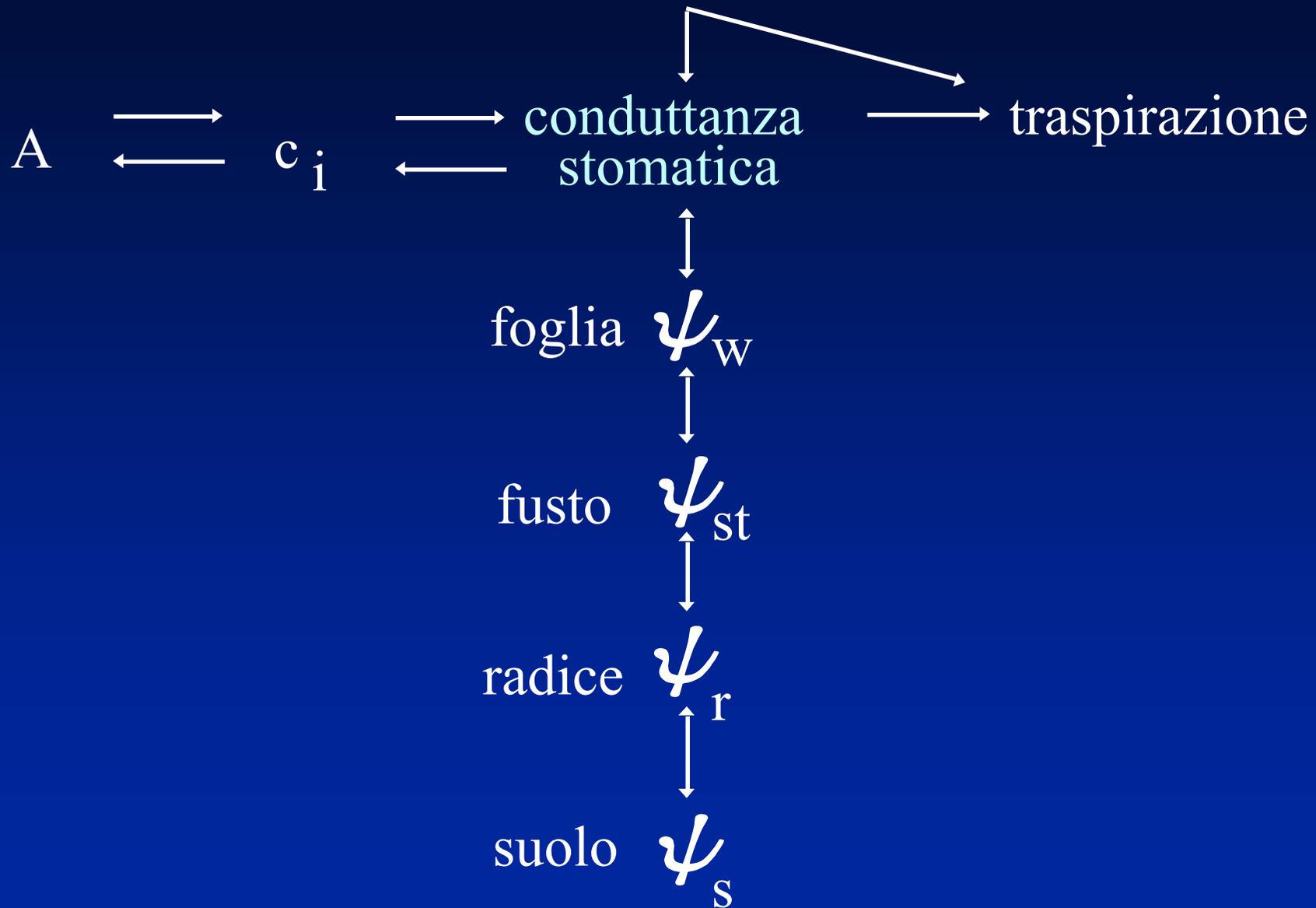


Fig. 4.4 Water pathways in the higher plant.

VPD (RH e T)



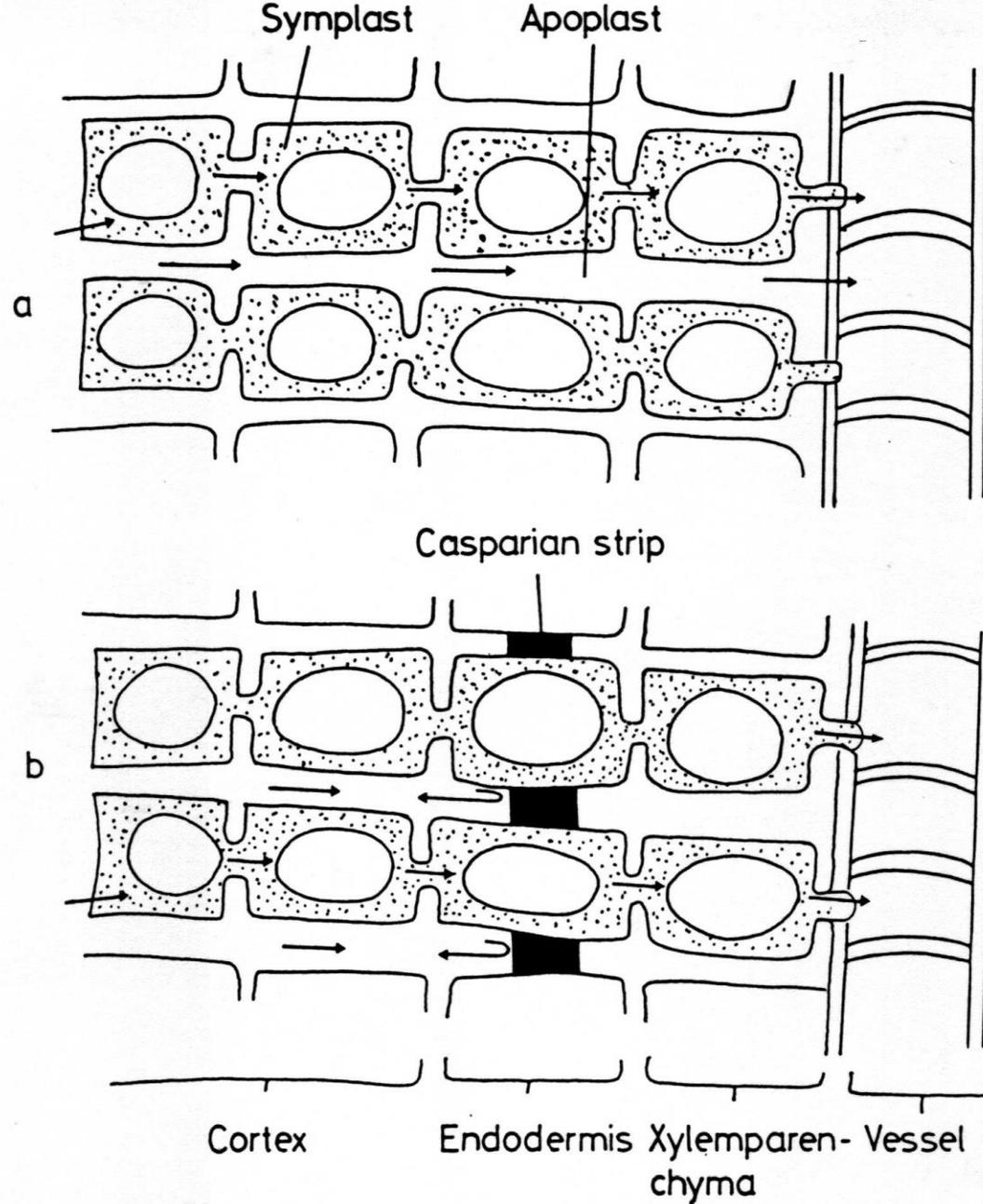


Fig. 4.6 Centripetal transport of water through the root towards the vessel

a) Young unsuberized root allowing apoplastic and symplastic transport.

b) Suberized root with Casparian strip allowing only symplastic transport.

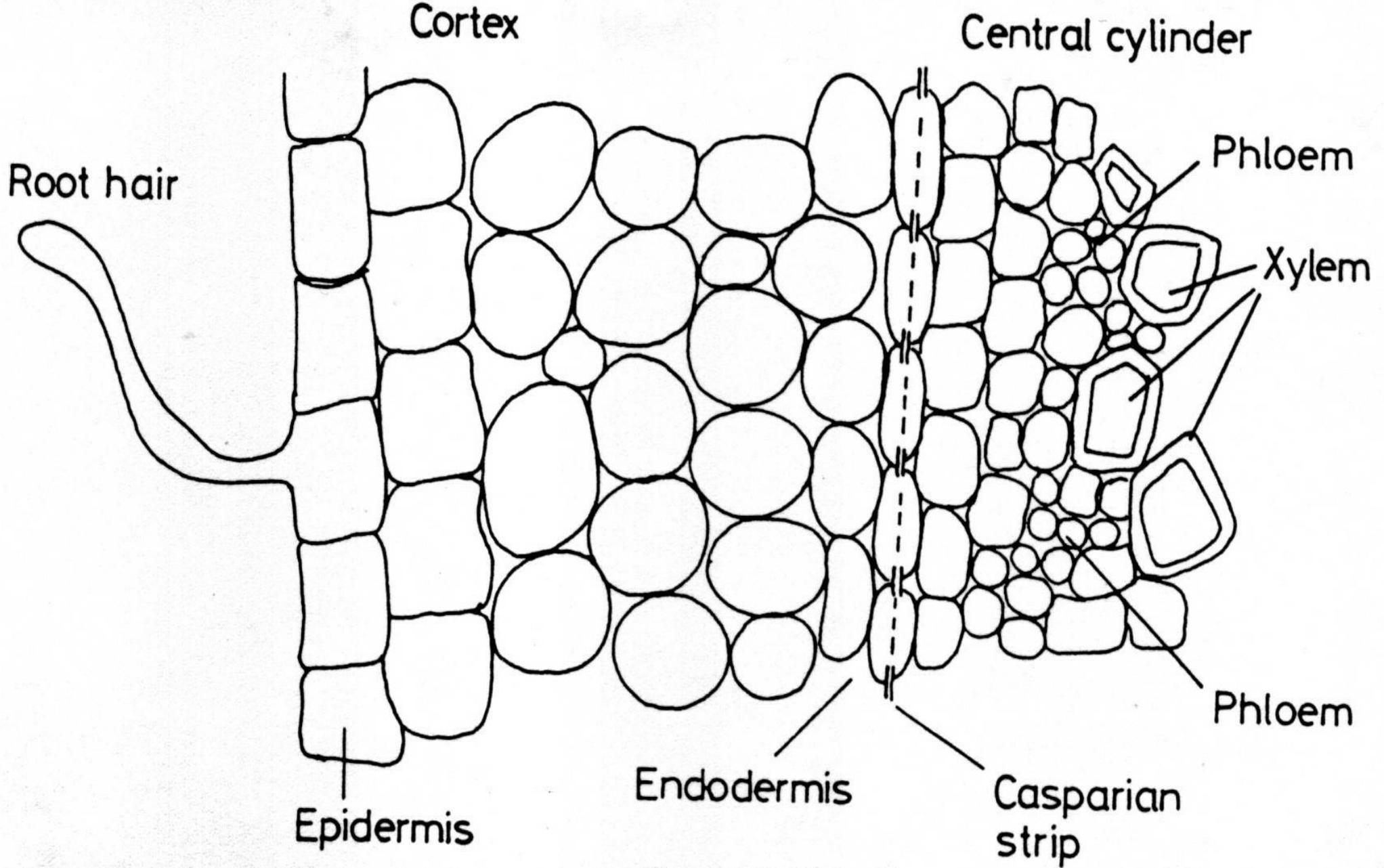


Fig. 4.5 Transverse section of a young root.

Transpiration rate depends on climatic demand



Net radiation, Φ_n

Vapor pressure deficit, VPD

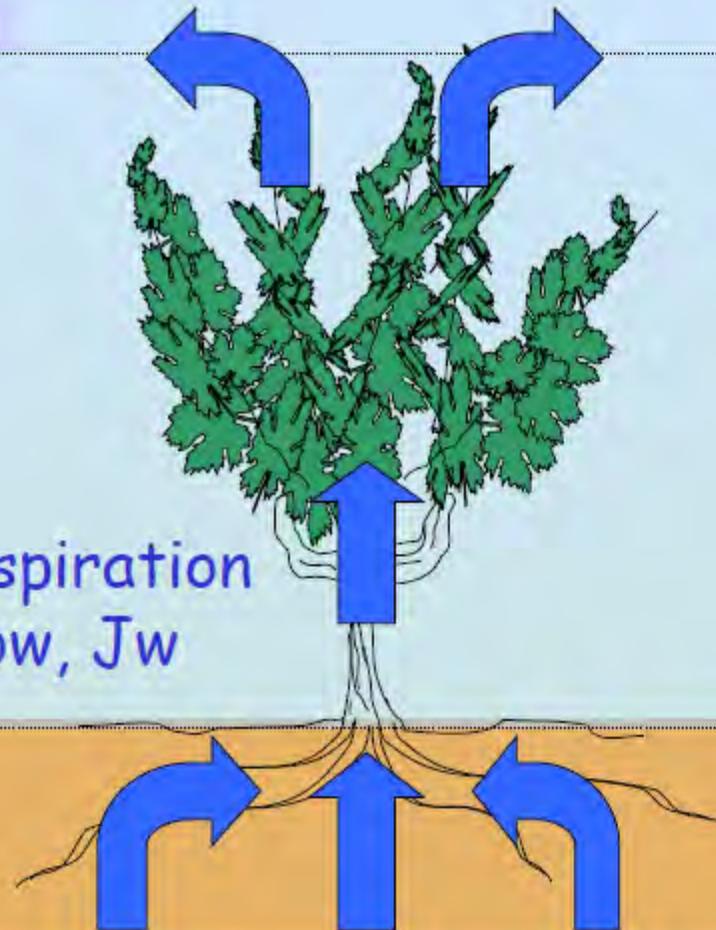
Climatic demand, E_{clim}

ATMOSPHERE=
DEMAND

PLANT

Transpiration
Flow, J_w

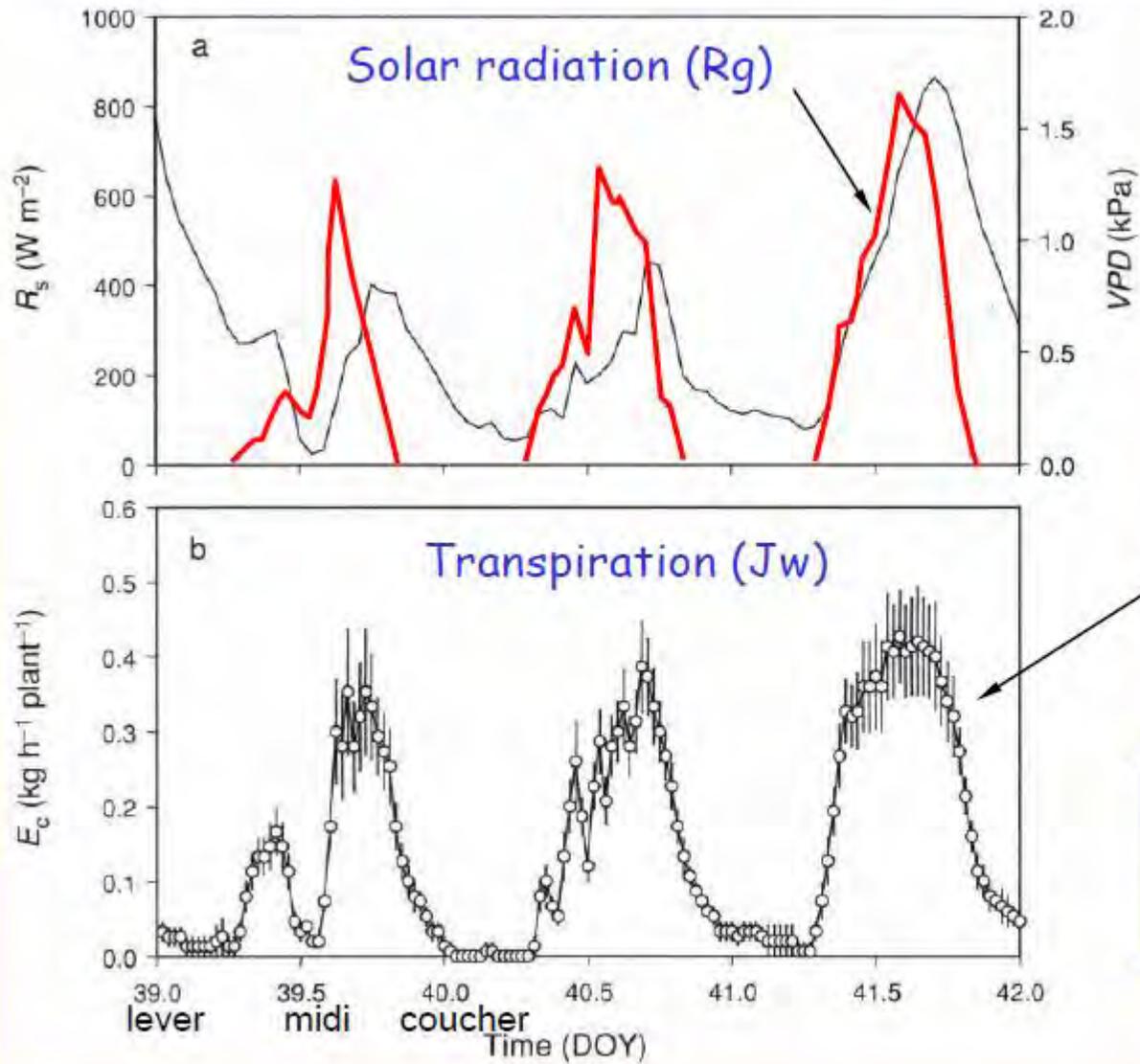
SOIL



Transpiration

- **Environment** (light, temperature, relative humidity, wind, soil moisture)
- **Crop factors** (canopy size and density, leaf distribution, row orientation, soil management)

Transpiration rate depends on climatic demand



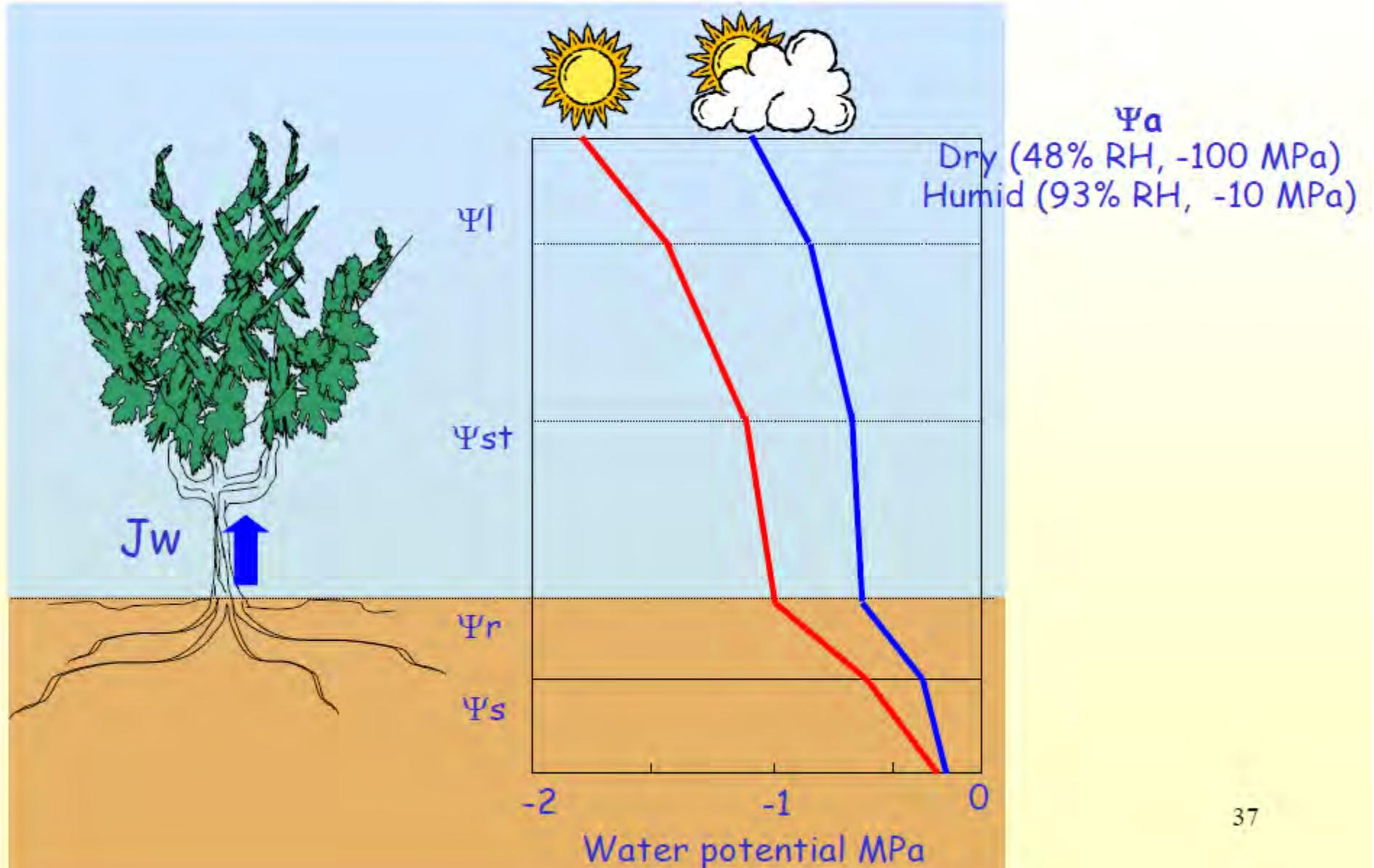
Daily transpiration
= $6 l. plant^{-1}$
= $1 mm. d^{-1}$

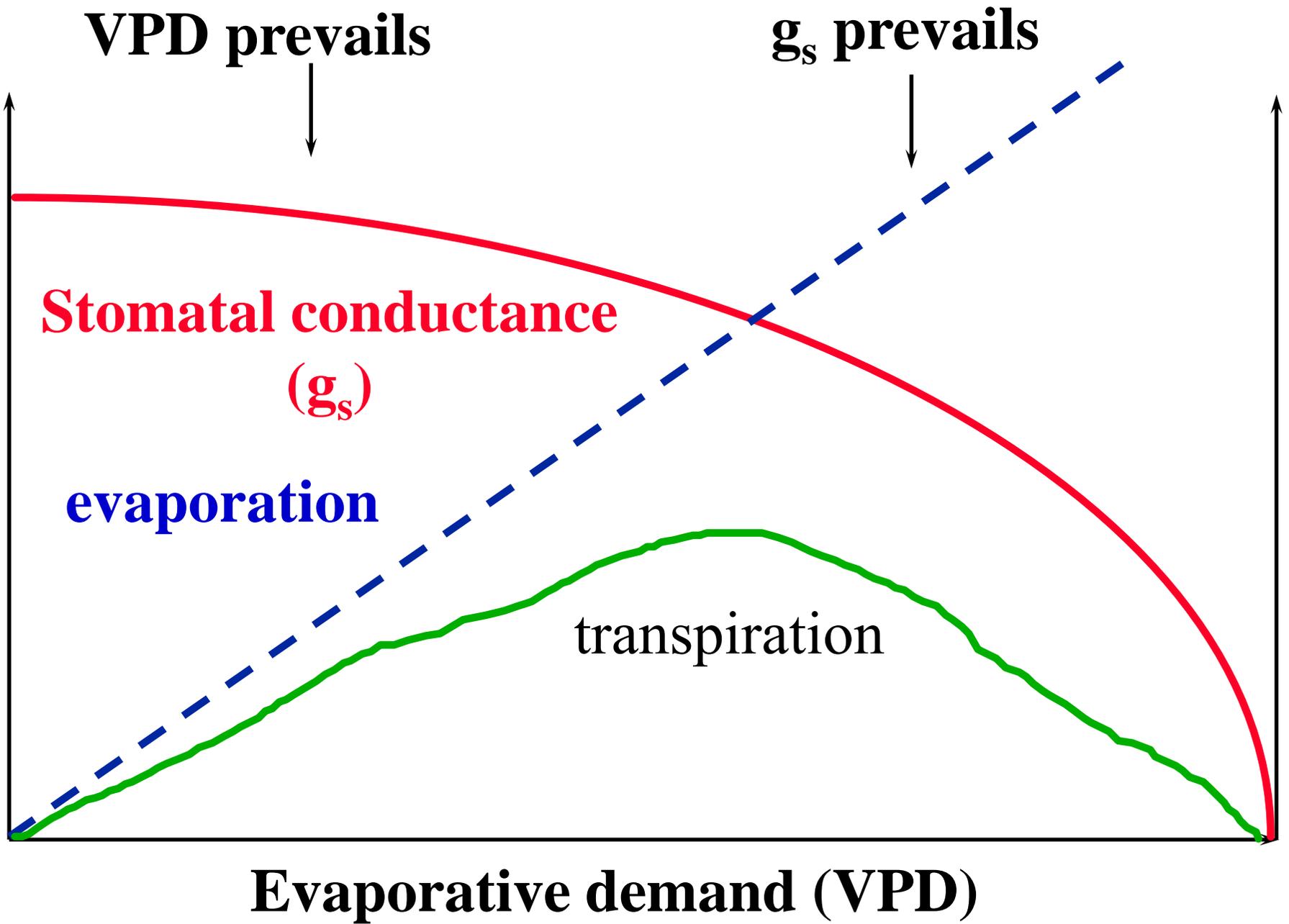
$$E_c = g_{(leaf)} * VPD$$

Sultanine, Australia
density = $1600 plants. ha^{-1}$

(Lu et al 2003)

The water potential gradient along the SPAC is higher when the climatic demand is high













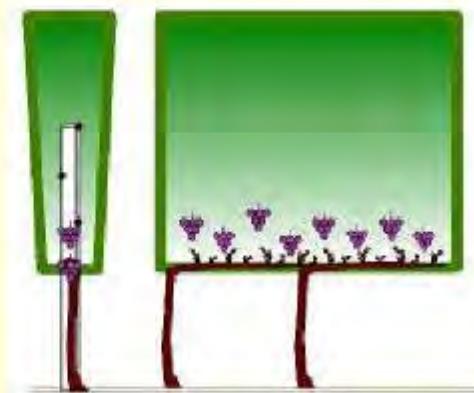
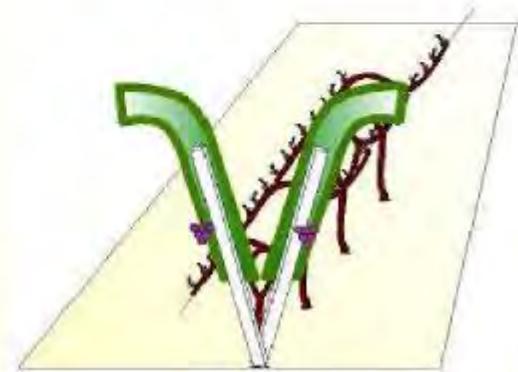
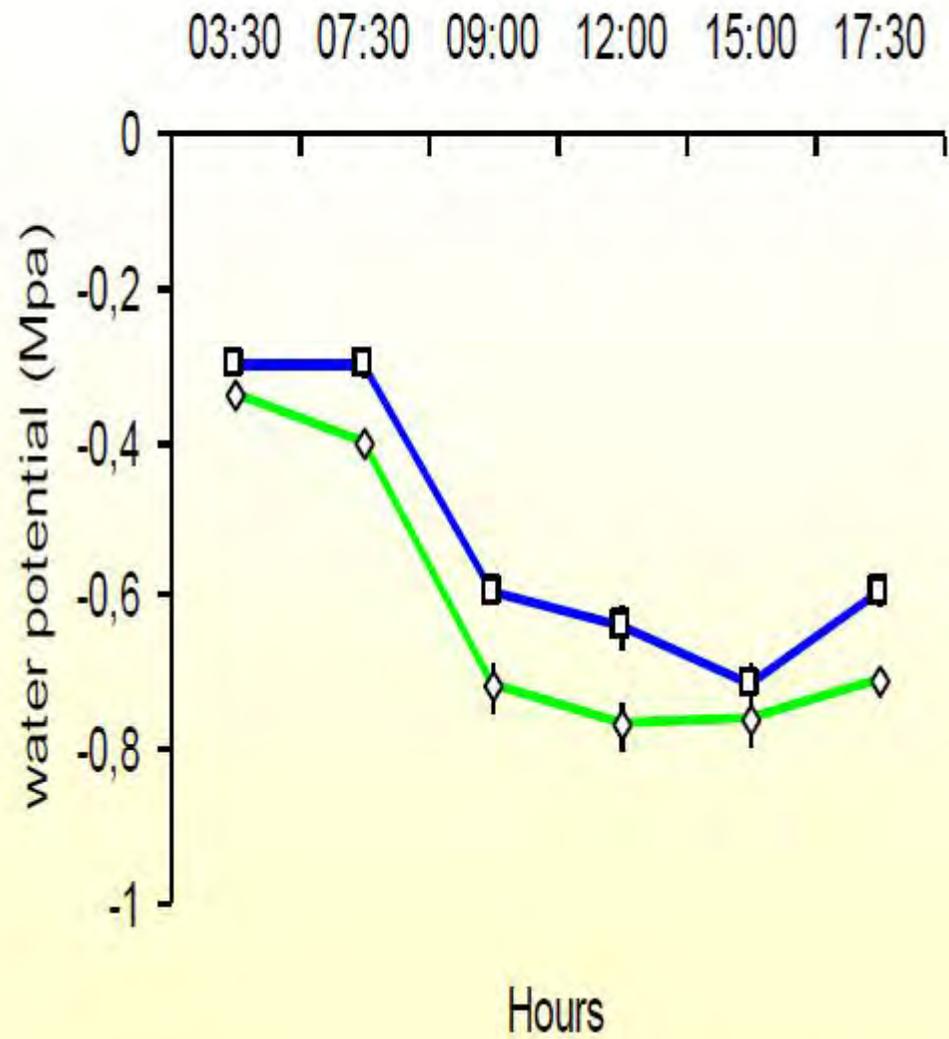


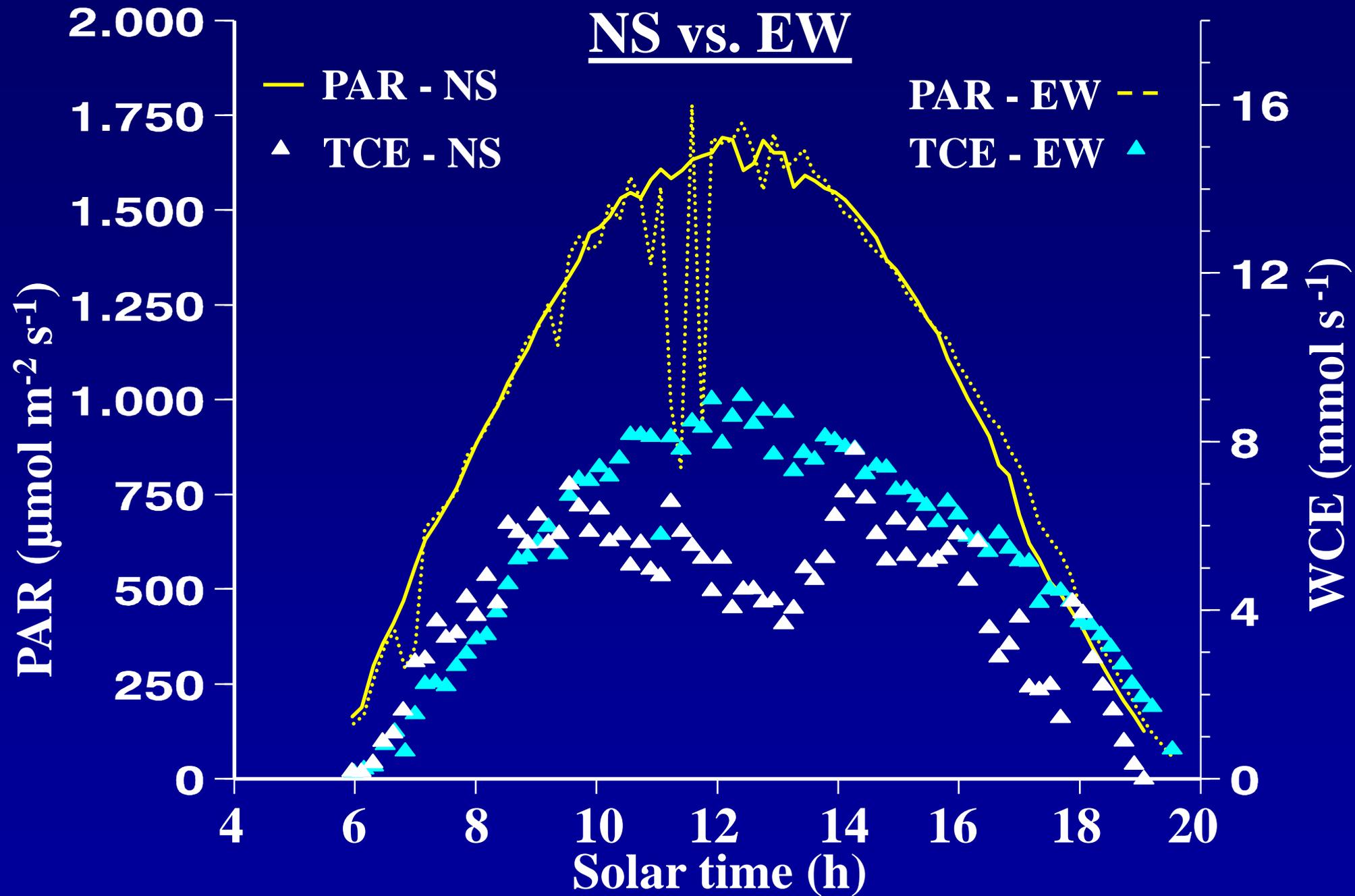
Water use by different trellises and vine spacings in Cabernet S.
(from Williams , 2000)

| Trellis | Spacing (m x m) | Density (viti/ha) | K_c | ET_c (mm) | ET_c (m ³ /ha) | ET_c (L/vine) |
|----------------|--------------------|----------------------|-------|----------------|--------------------------------|--------------------|
| CSP | 1.8 x 1.8 | 2984 | 0.81 | 40.5 | 405 | 136 |
| CSP | 2.7 x 1.8 | 1996 | 0.54 | 27.0 | 270 | 136 |
| Lira | 2.7 x 1.8 | 1996 | 0.83 | 41.5 | 415 | 208 |
| GDC | 3.7 x 1.8 | 1493 | 0.75 | 37.5 | 375 | 251 |
| HD | 1 x 1 | 10000 | 0.91 | 45.5 | 455 | 45.5 |

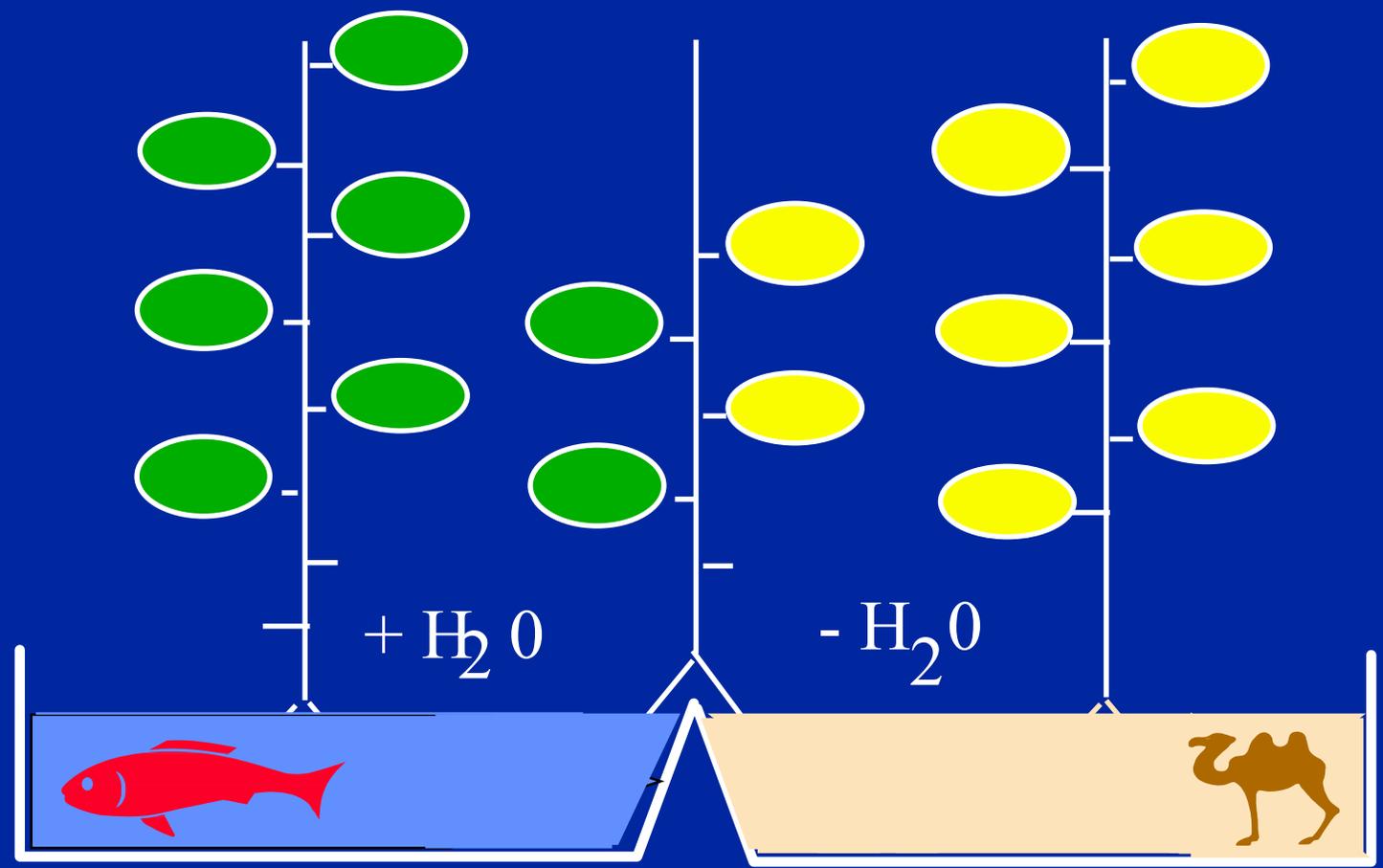
California, one-week water balance.

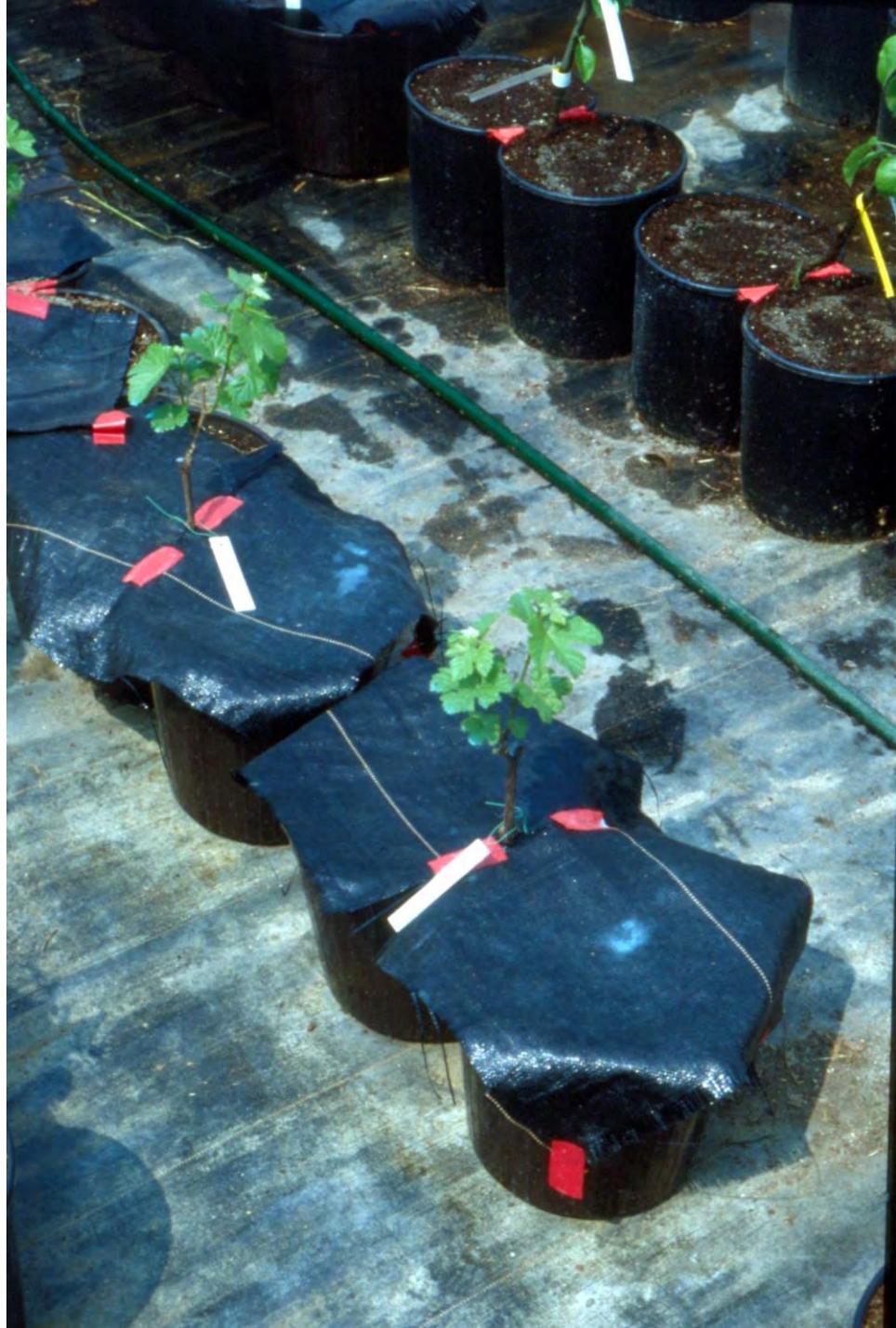
Leaf Water Potential and training system





| | | | |
|--------------------------|-------------|-------------|------------|
| Turgor: | high | high | low |
| g_s: | high | low | low |





Split-root experiment. Data taken 4 days after beginning of stress.

| Water regime | ψ_f (-bar) | A ($\mu\text{mol m s}^{-2-1}$) | g CO_2 ($\mu\text{mol m s}^{-2-1}$) | WUE (A/g) |
|-------------------------|--------------------|-------------------------------------|---|--------------|
| + H₂O | 7.9 | 9.3 | 0.111 | 83.8 |
| ± H₂O | 7.5 | 6.5 | 0.056 | 116.1 |

Da During, 1985

Net assimilation rate (A_N)
($\mu\text{mol m}^{-2} \text{s}^{-1}$)

* Note different scales for A_N and E

In this range of g
a change in g
results in
minimal change
in A_N

Assimilation

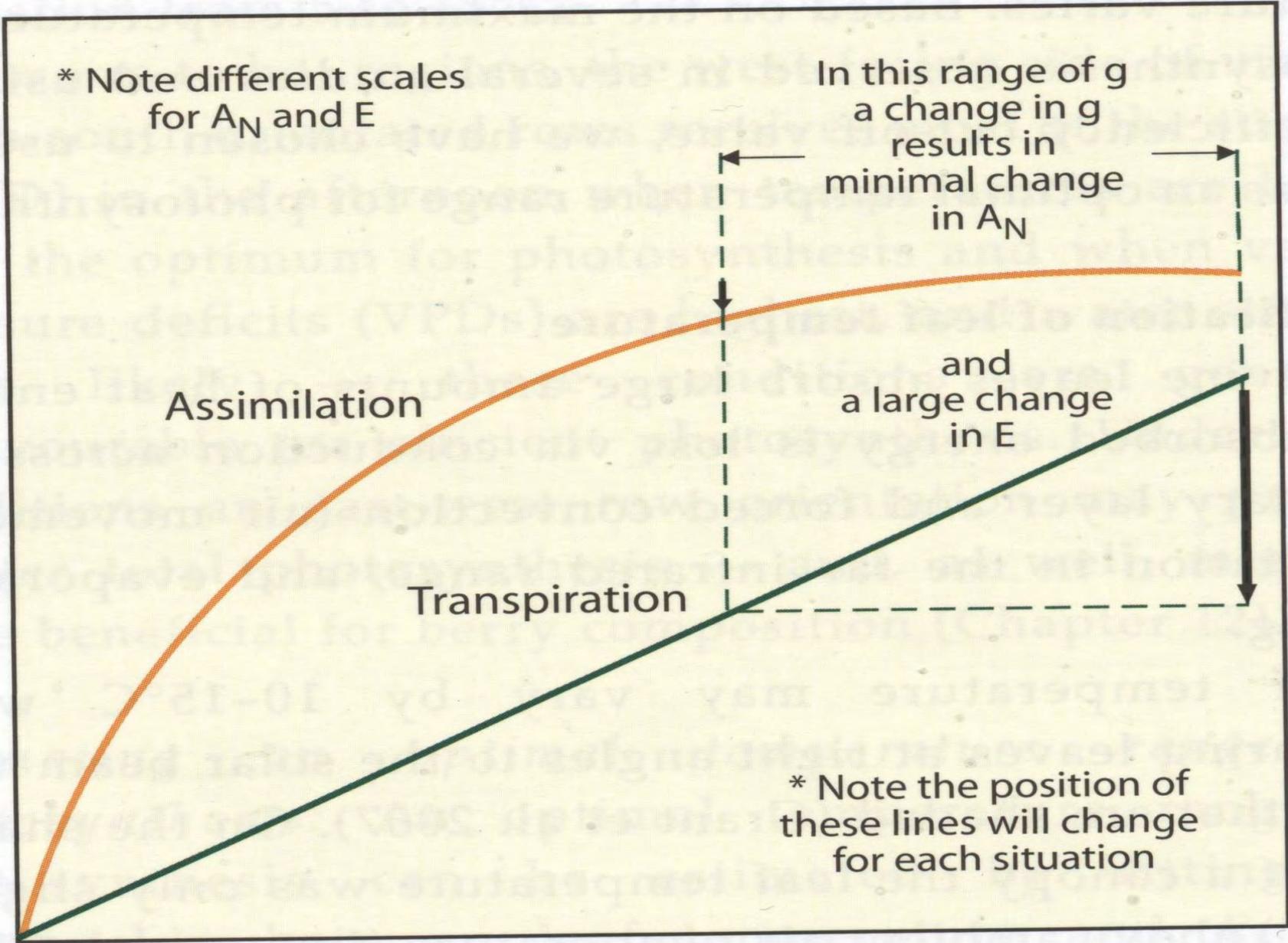
and
a large change
in E

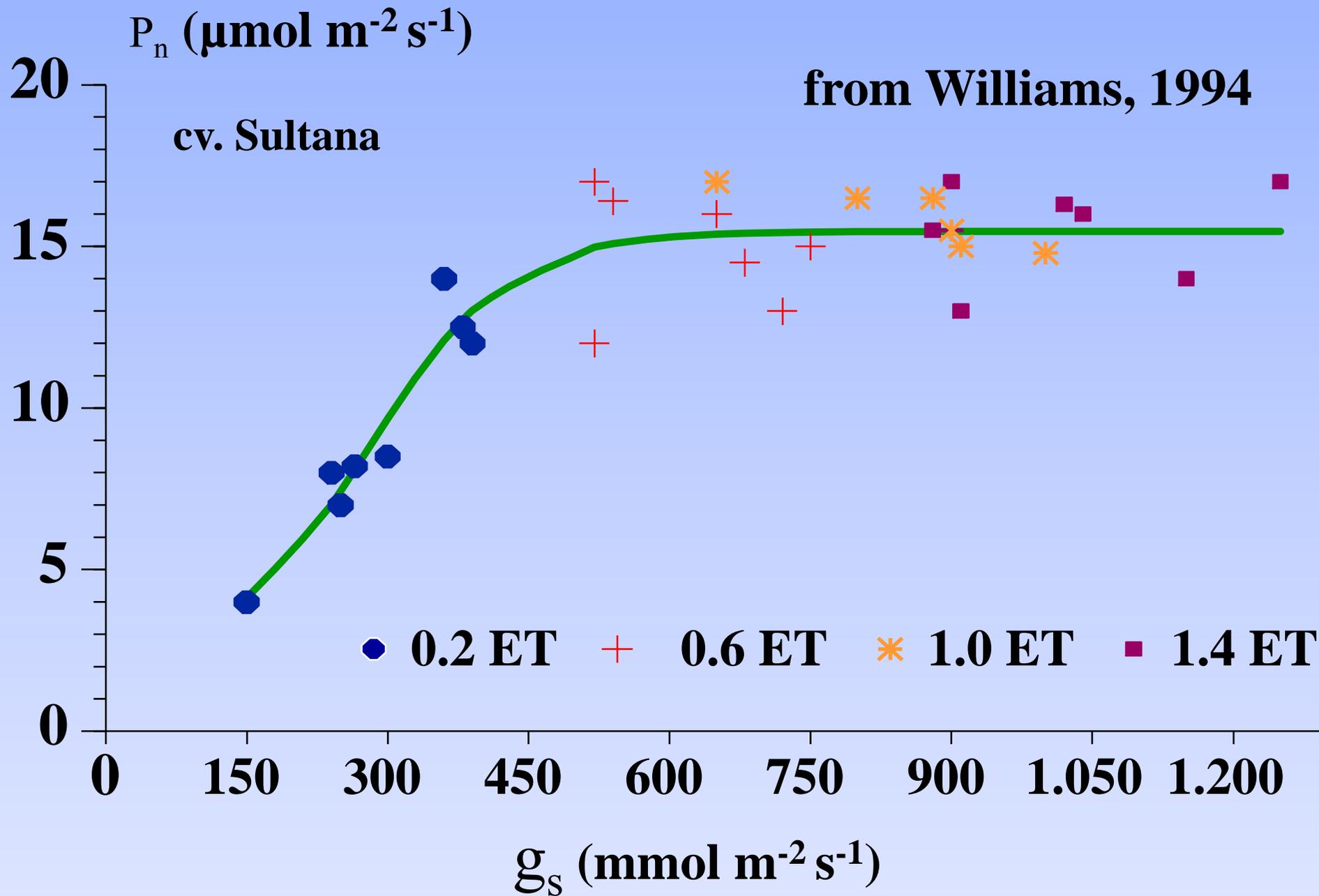
Transpiration

Transpiration (E)
($\text{mmol m}^{-2} \text{s}^{-1}$)

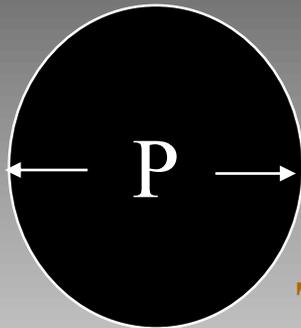
* Note the position of
these lines will change
for each situation

Stomatal conductance (g) \longrightarrow

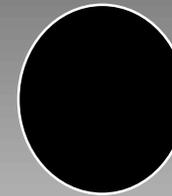




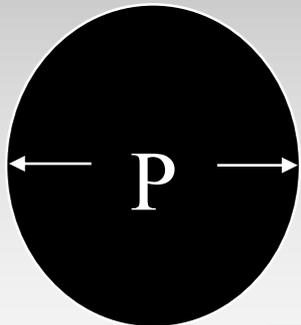
Elasticity of cellular walls



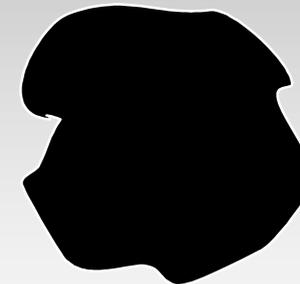
Elastic



Turgor maintained even with high turgor reduction



Rigid



Turgor may be lost even with small reductions in volume.

Sangiovese and water availability



cv. SANGIOVESE

Visual assessment... which cultivar is doing better?



cv. MONTEPULCIANO

