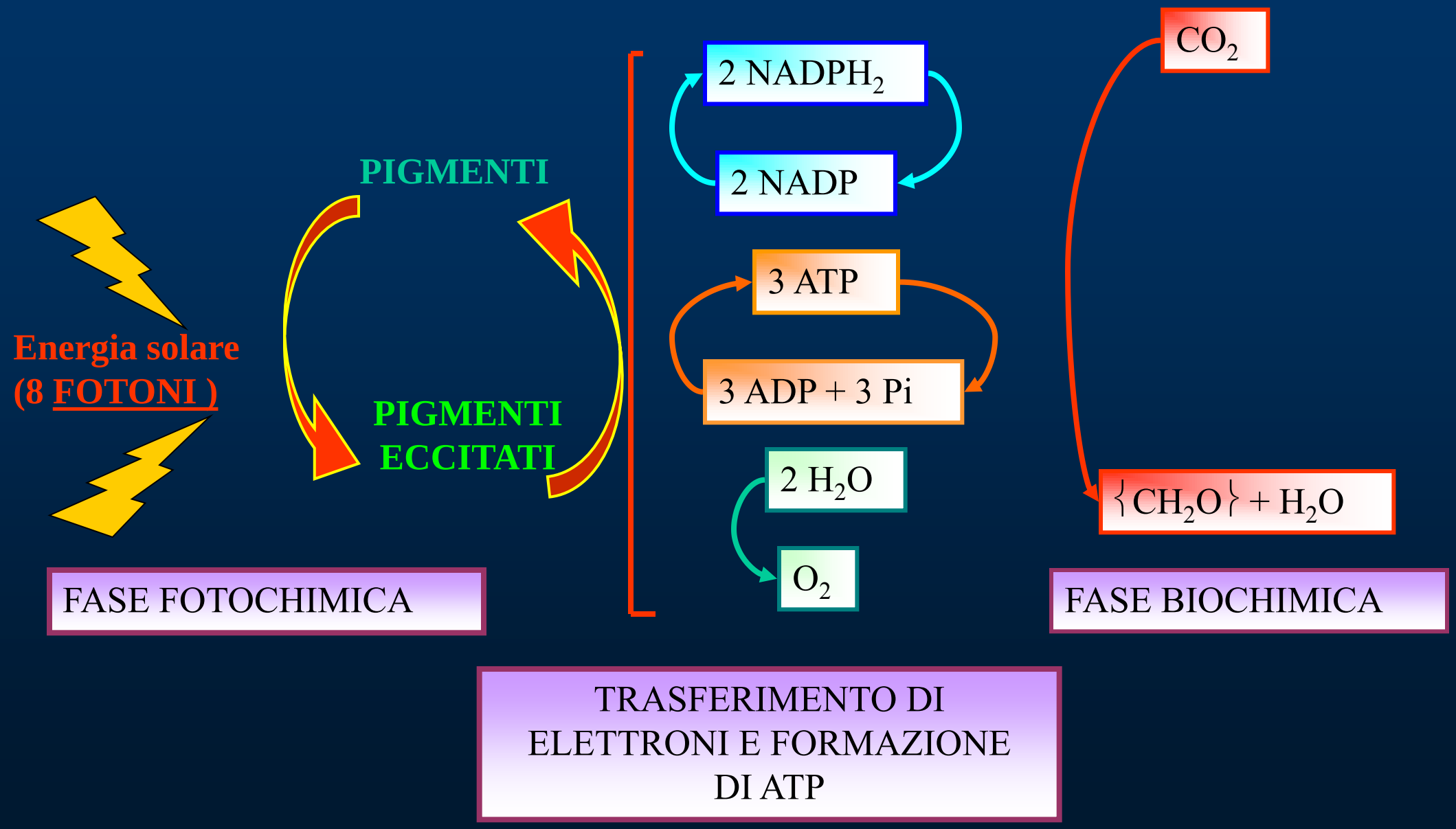
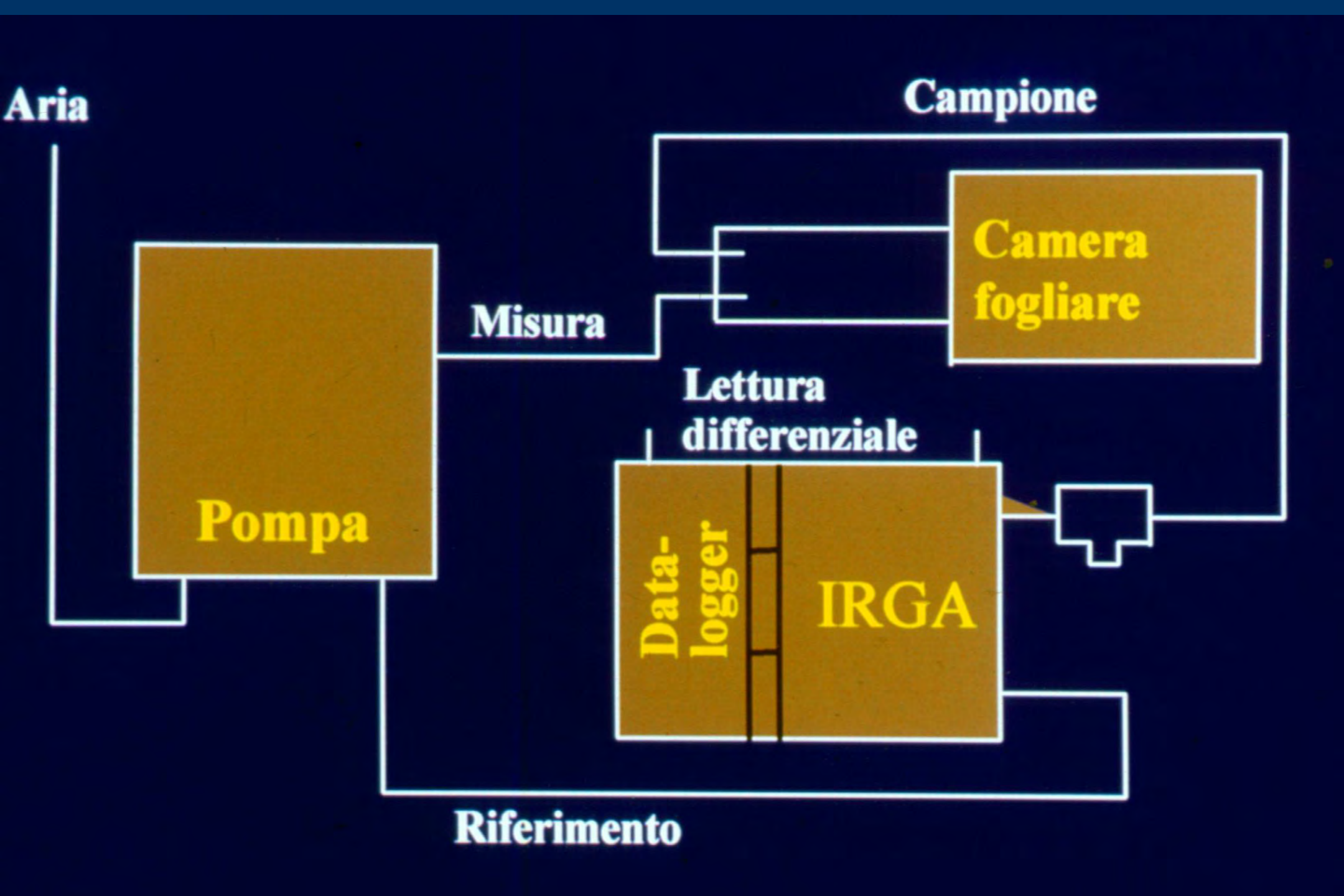
Fotosintesi



Grapevine photosynthesis vs. environmental, physiological and cultural factors

- **Phenological stage measurements are made**
- **Environmental conditions during readings**
- **Equipment available**
- **Units**

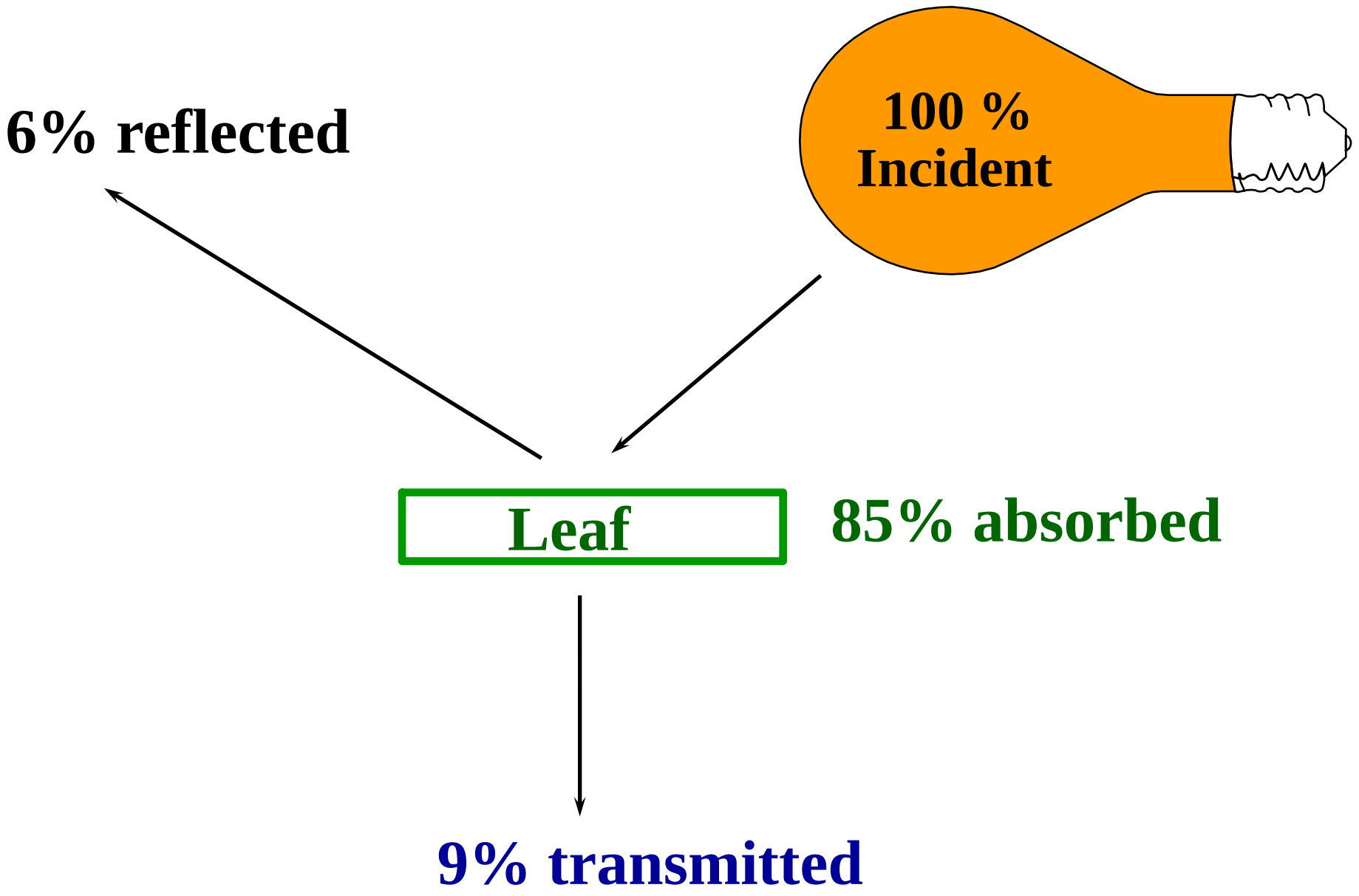
(1 µmol CO_2 m^{-2} s^{-1} = 0.63 CO_2 mg dm^{-2} h^{-1})

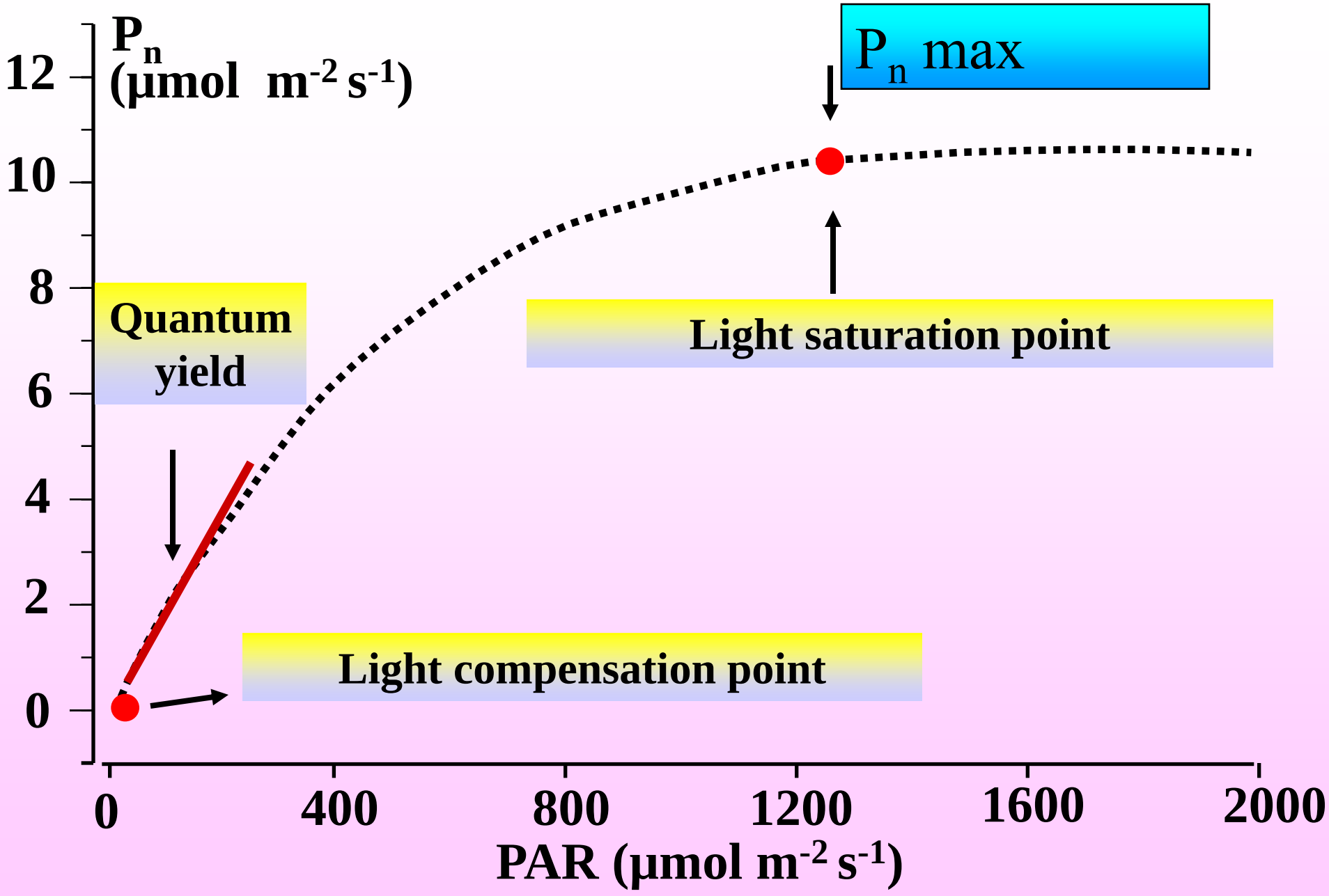

Aria
Campione
Camera fogliare
Misura
Lettura differenziale
Pompa
Data-logger
IRGA
Riferimento

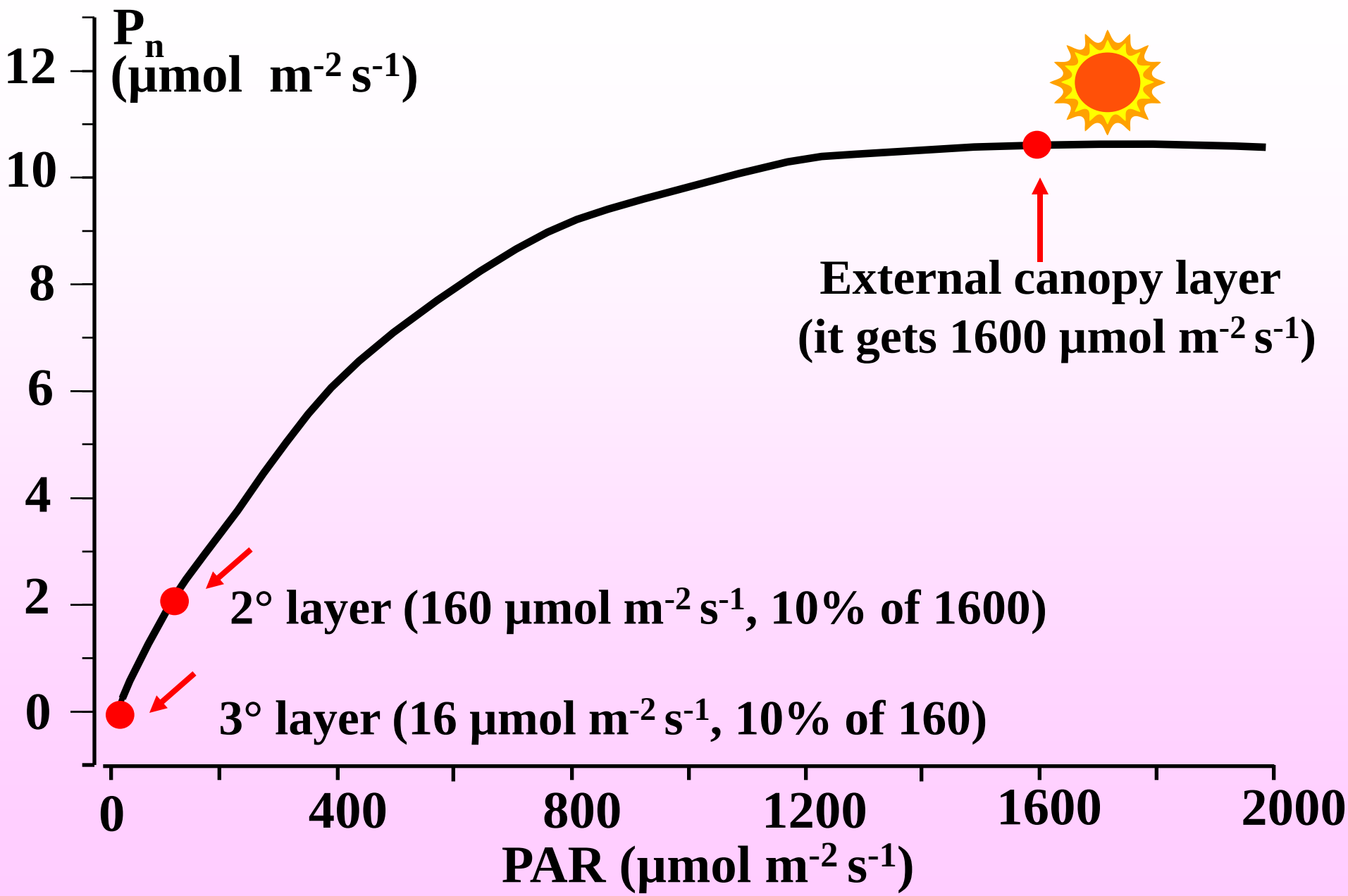

UNIVERSITA'
CATTOLICA

Radiation

- Light response curve
- Light environment during leaf development
- Light environment after leaf development


6% reflected
100 %
Incident
Leaf
85% absorbed
9% transmitted


P_n max
P_n (µmol m^{-2} s^{-1})
12
10
8
6
4
2
0
Quantum yield
Light saturation point
Light compensation point
0
400
800
1200
1600
2000
PAR (µmol m^{-2} s^{-1})


P_n (µmol m^{-2} s^{-1})
12
10
8
6
4
2
0
External canopy layer
(it gets 1600 µmol m^{-2} s^{-1})
2° layer (160 µmol m^{-2} s^{-1}, 10% of 1600)
3° layer (16 µmol m^{-2} s^{-1}, 10% of 160)
0
400
800
1200
1600
2000
PAR (µmol m^{-2} s^{-1})

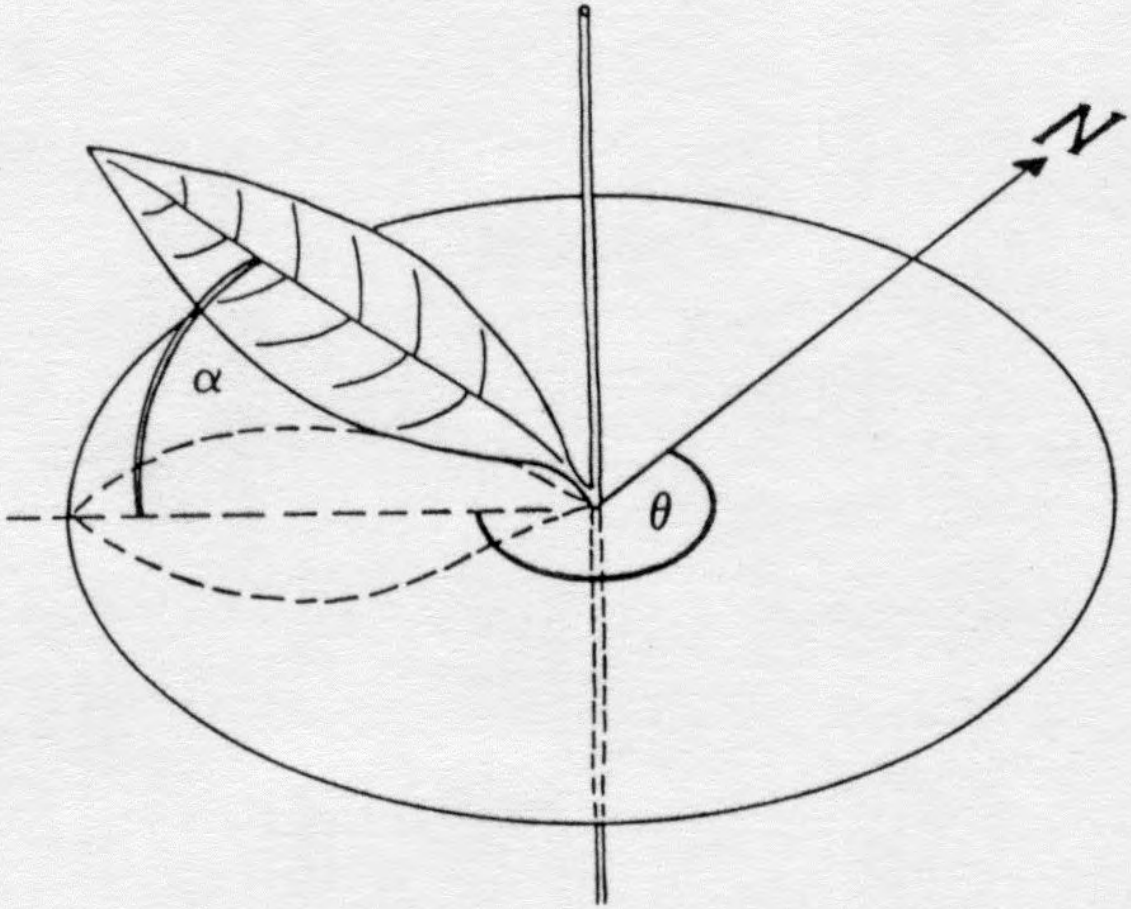


Fig.4.4. Leaf inclination (α) is the angle formed between the long axis of the leaf (or leaf segment) and the horizontal. Leaf orientation (θ) is the angle formed clockwise from due North by the horizontal projection of the leaf.

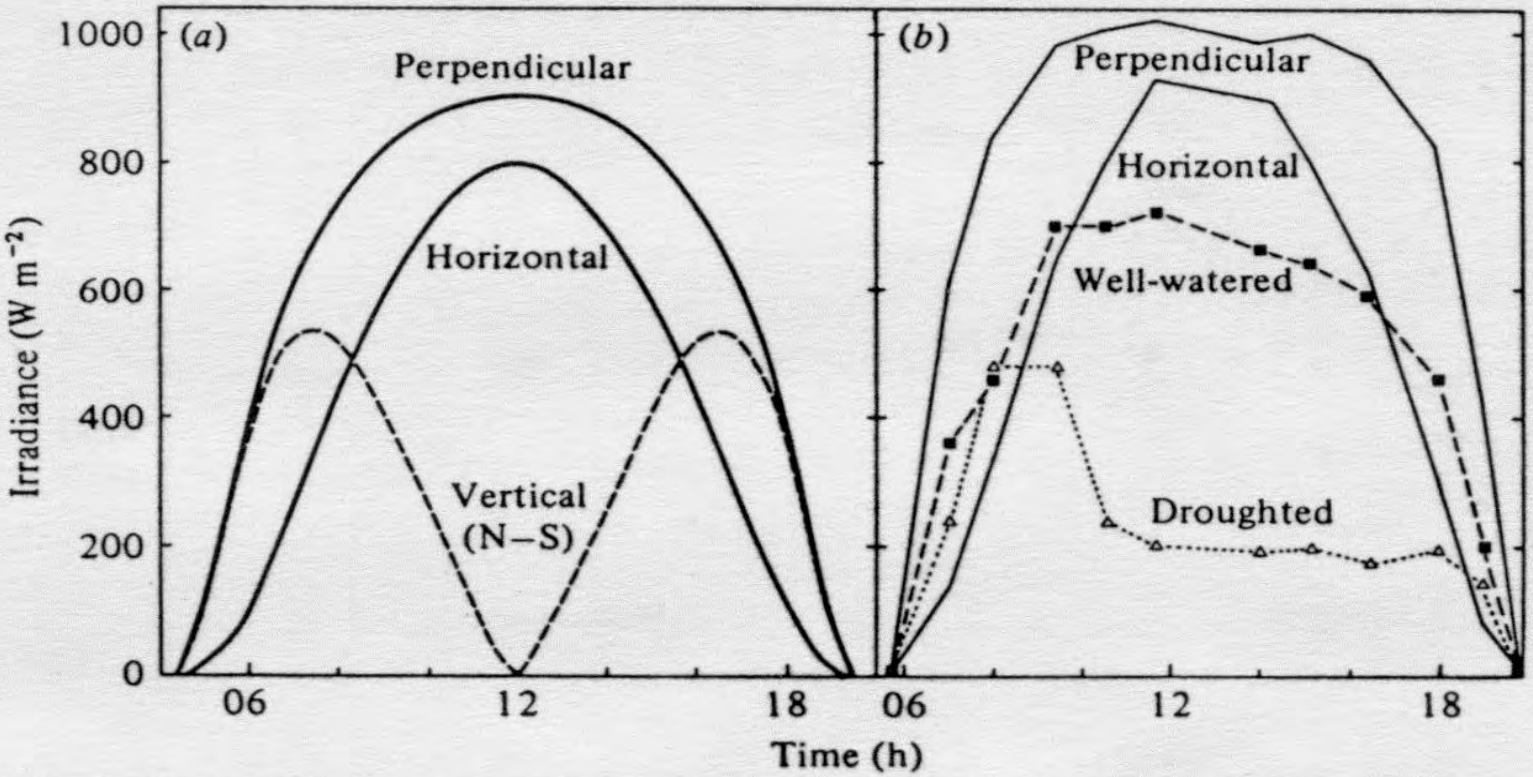


Fig. 2.19. (*a*) Diurnal variation in direct beam irradiance on a clear day ($\tau = 0.7$) in early June at 50°N latitude for a horizontal leaf, a leaf normal to the beam (perpendicular) and a vertical leaf oriented north–south. (*b*) Actual measurements for irradiance received by the upper surface of leaflets of water-stressed (.....△.....) and well-watered (- -■- -) *Vigna* plants at Davis, California (after Shackel & Hall 1979).

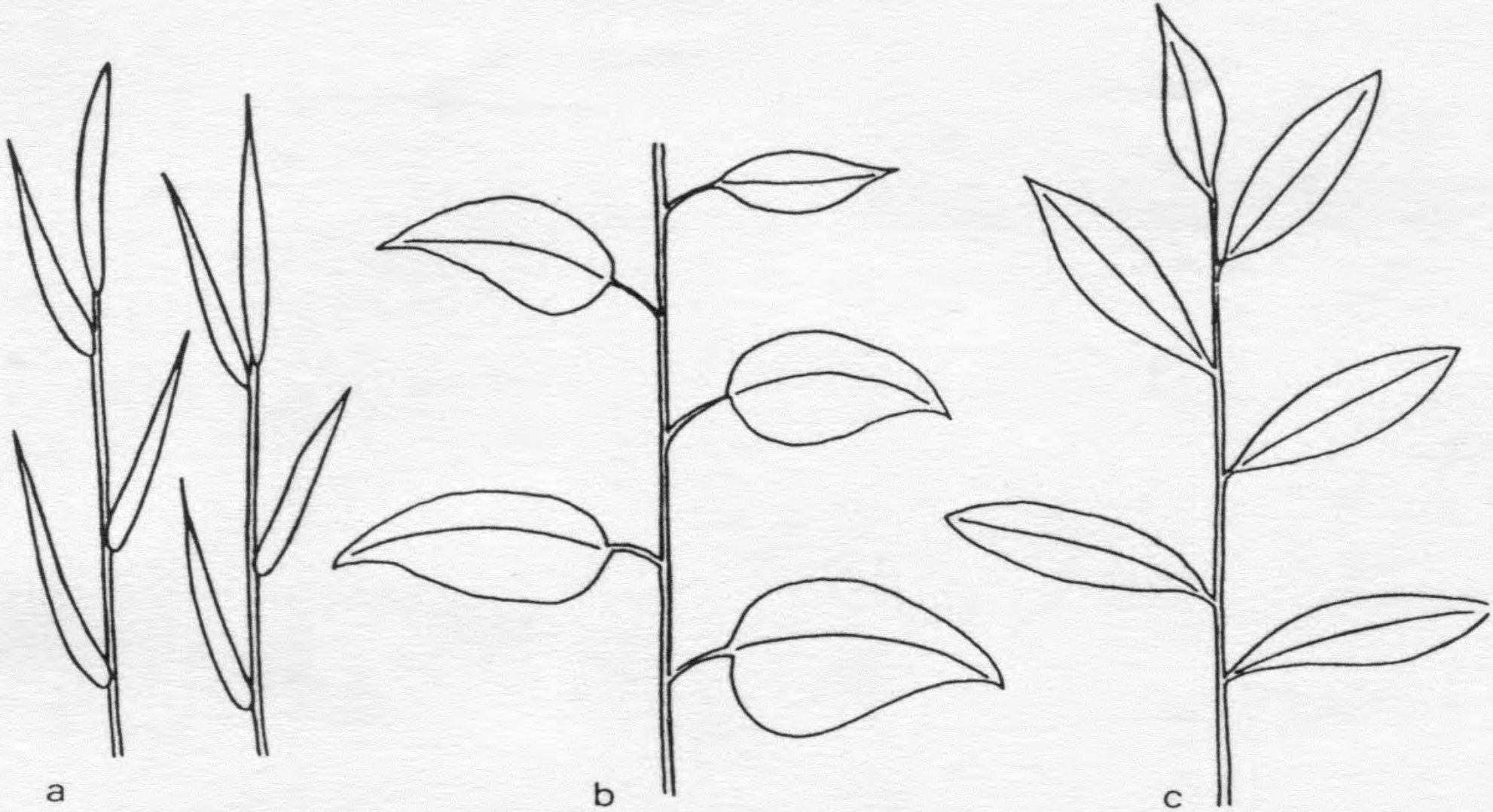
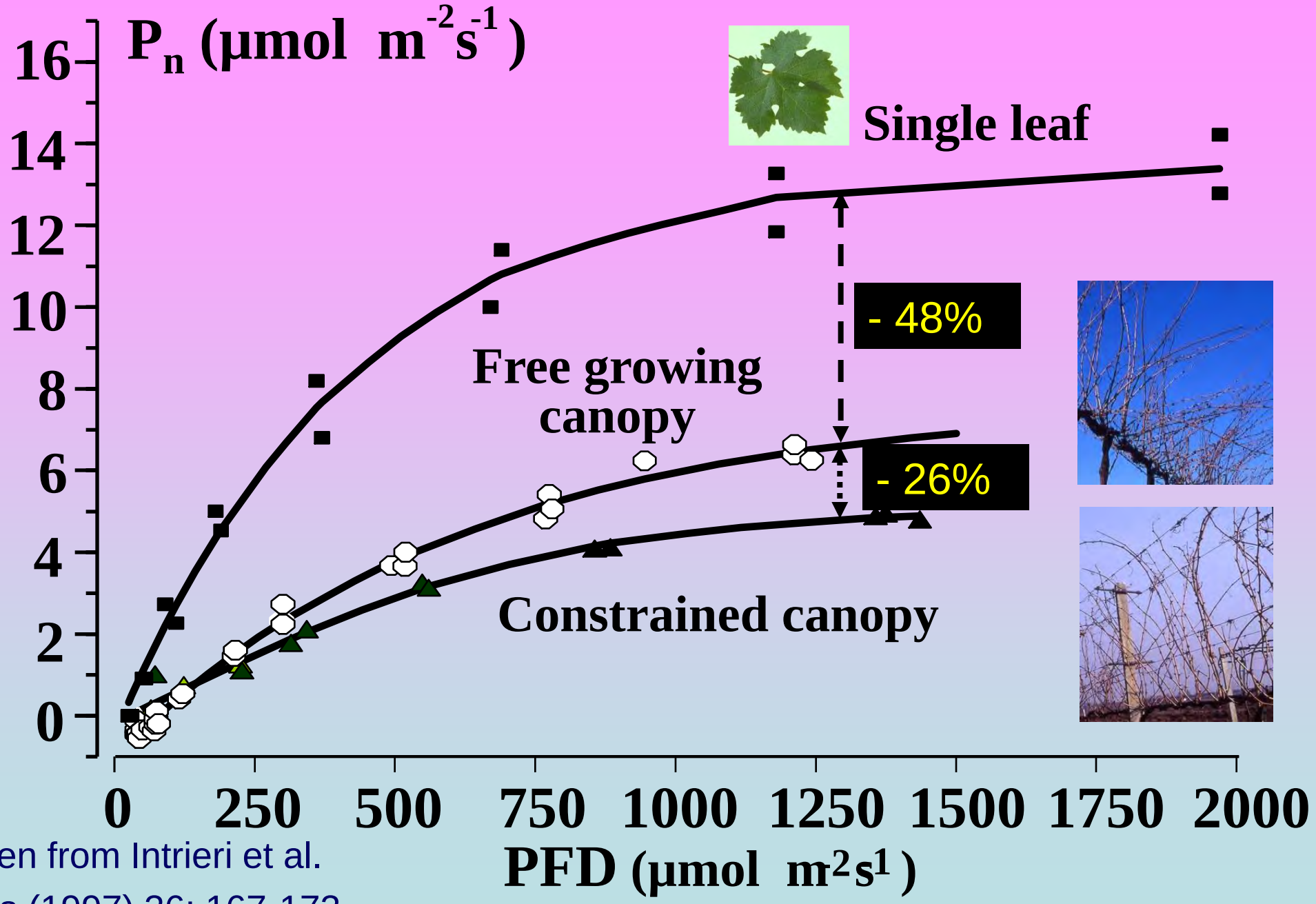


Fig.4.2. Canopies with various leaf inclinations: a) vertical leaves of grasses (erectophile); b) horizontal leaves, as occurs for beans (planophile); and c) leaves varying from vertical near the top of the canopy to horizontal near the base, as occur for sugar beet.

Comparison of single leaf and whole-canopy assimilation (A) rates.

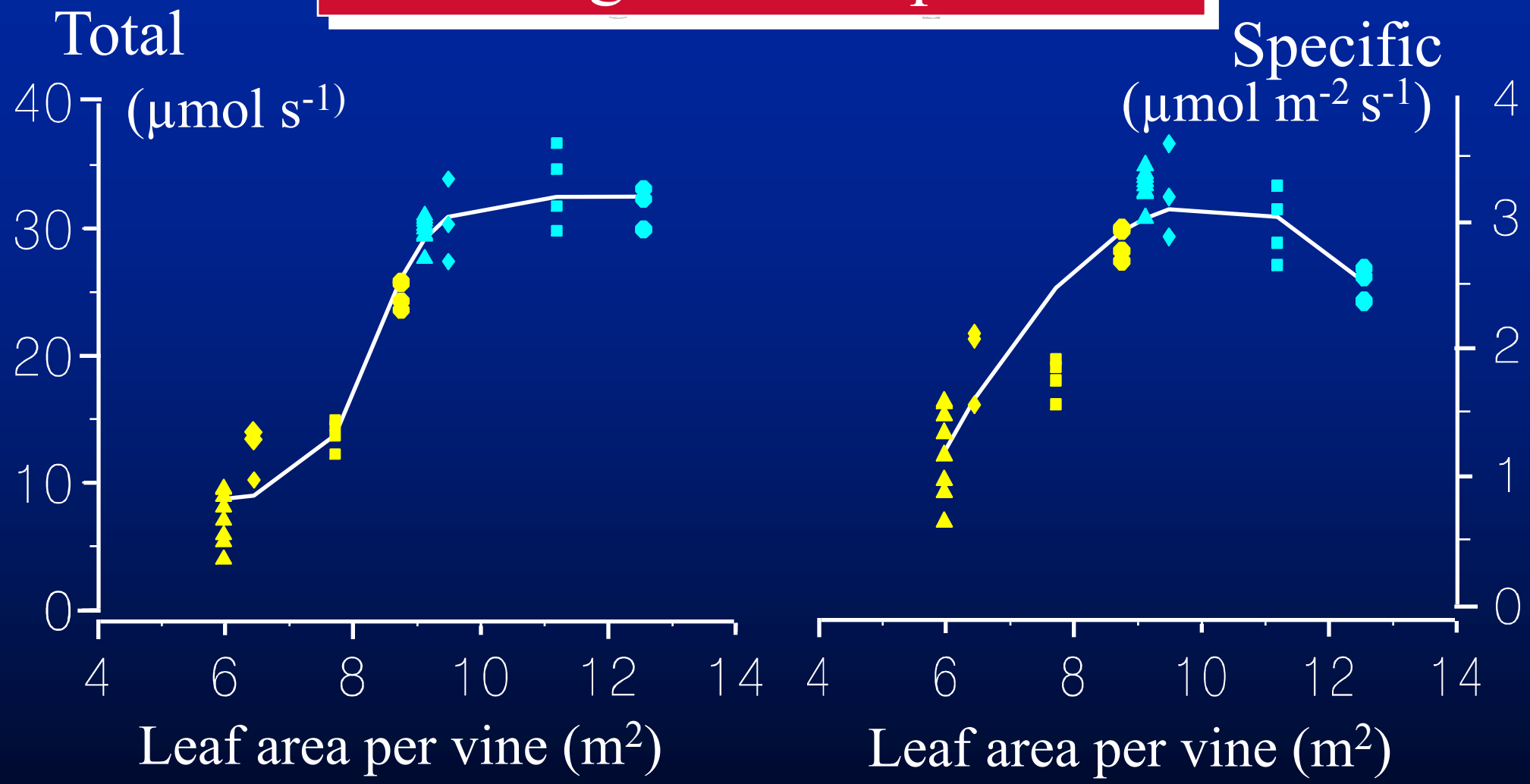
	LA (m^2)	A_l ($\mu mol\ m^{-2}\ s^{-1}$) Morn.	A_l ($\mu mol\ m^{-2}\ s^{-1}$) Aft.	A_c ($\mu mol\ m^{-2}\ s^{-1}$) Morn.	A_c ($\mu mol\ m^{-2}\ s^{-1}$) Aft.
Vine 1	1.26	**9.3 ± 1.3**	**8.7 ± 0.8**	**4.5 ± 0.1**	**4.0 ± 0.1**
Vine 2	1.34	**8.3 ± 0.7**	**8.0 ± 0.7**	**4.1 ± 0.1**	**3.8 ± 0.1**

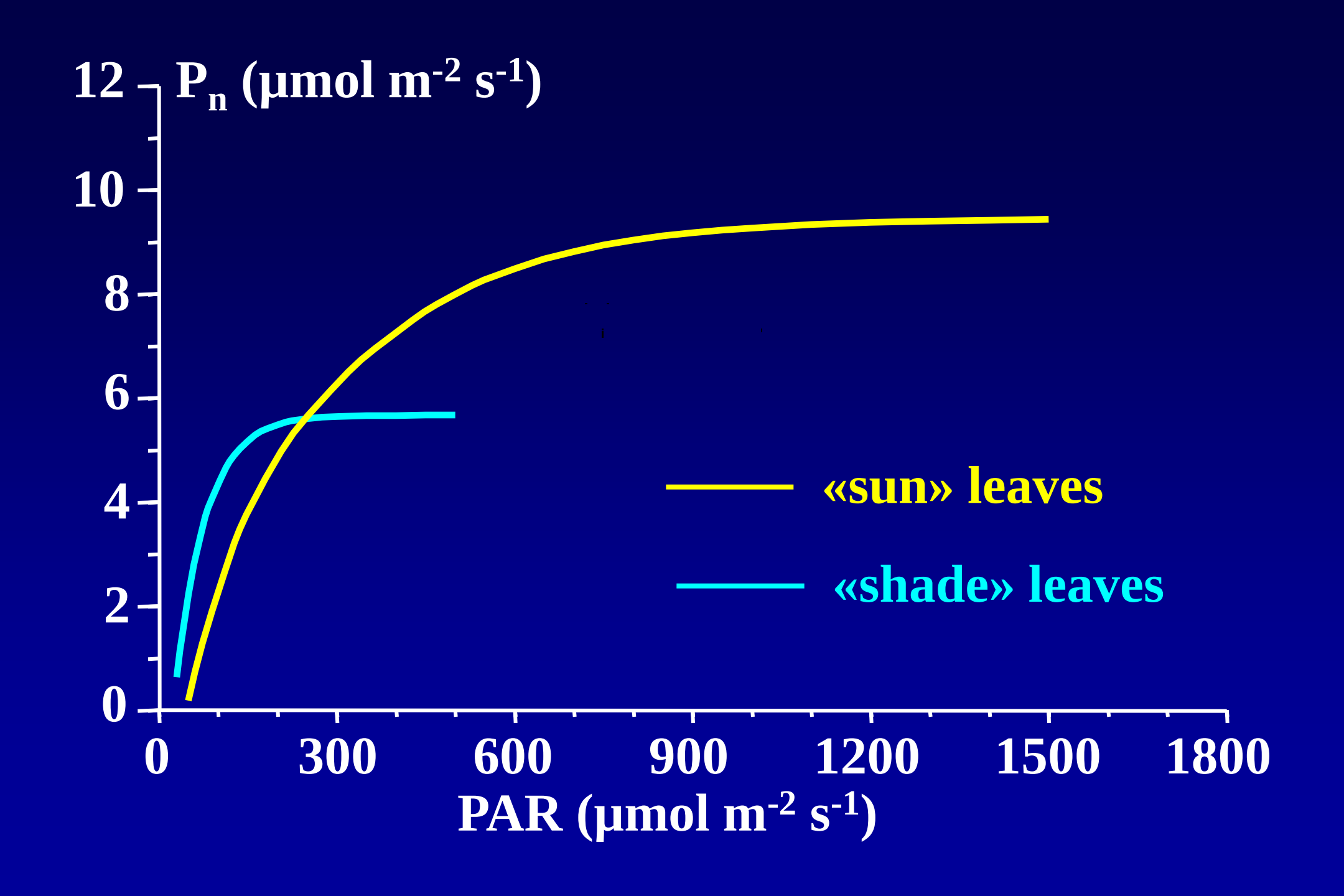


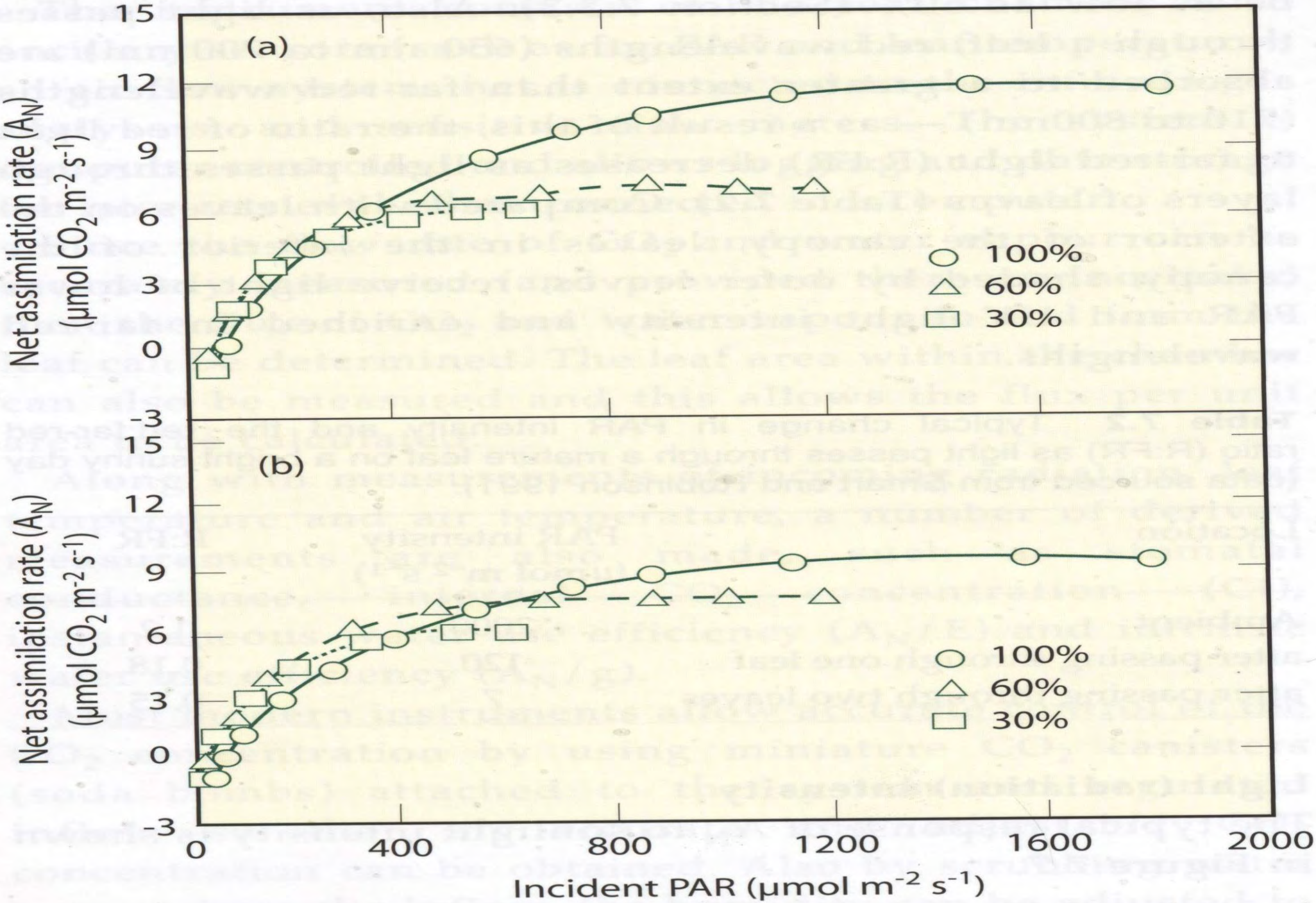
Taken from Intrieri et al.

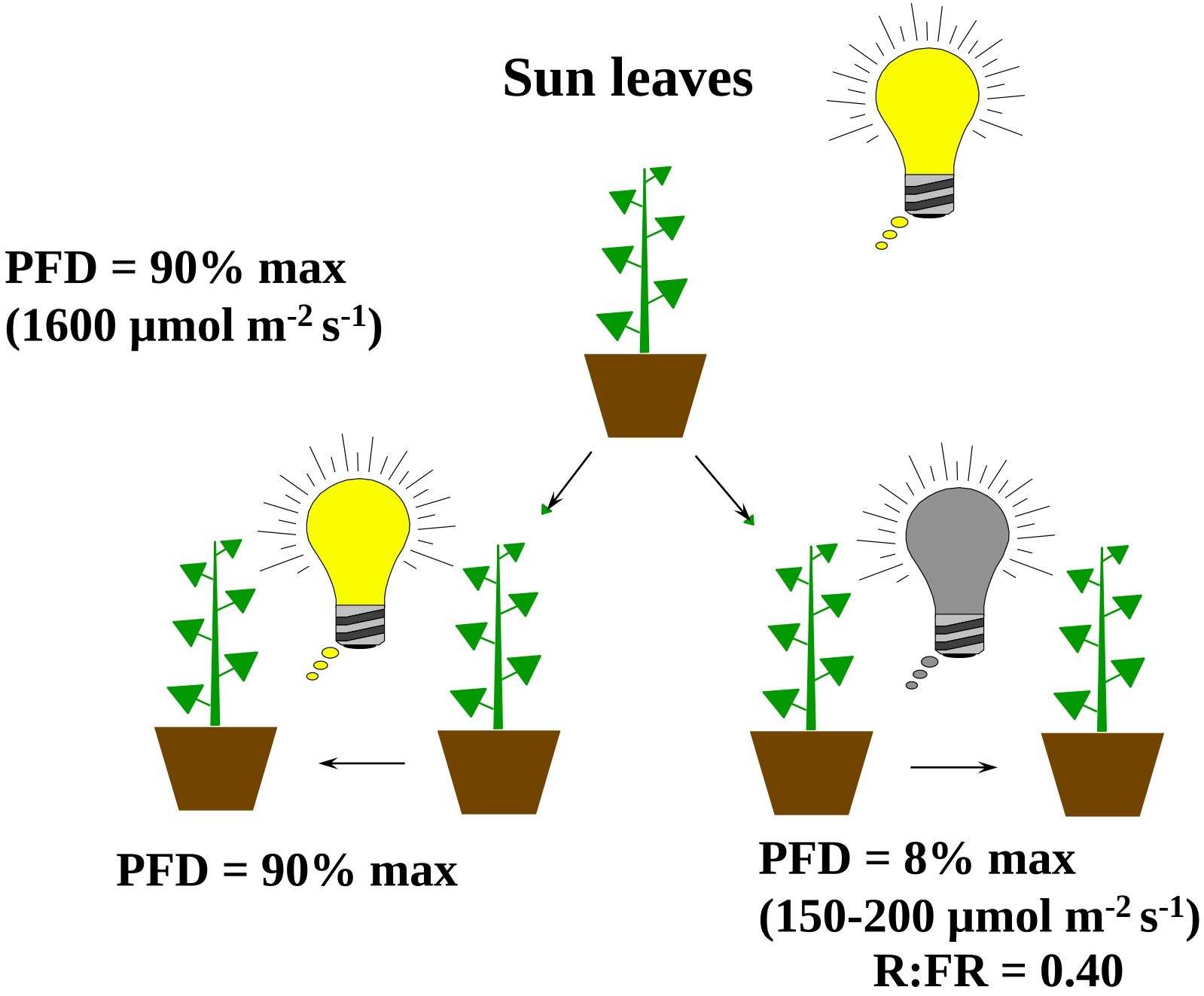
Vitis (1997) 36: 167-173

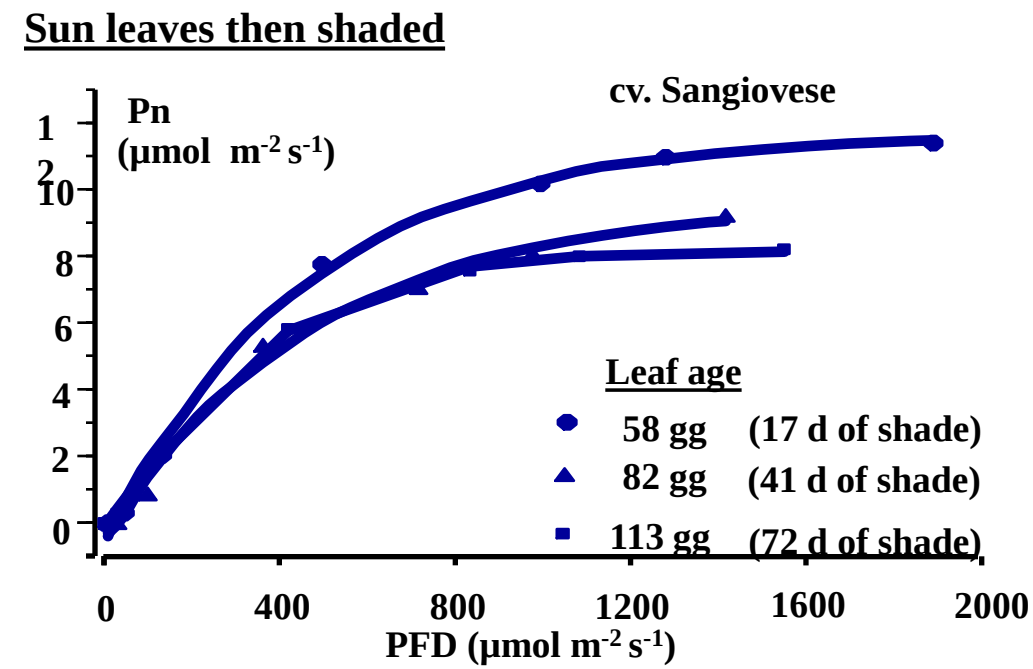
Another good example…..

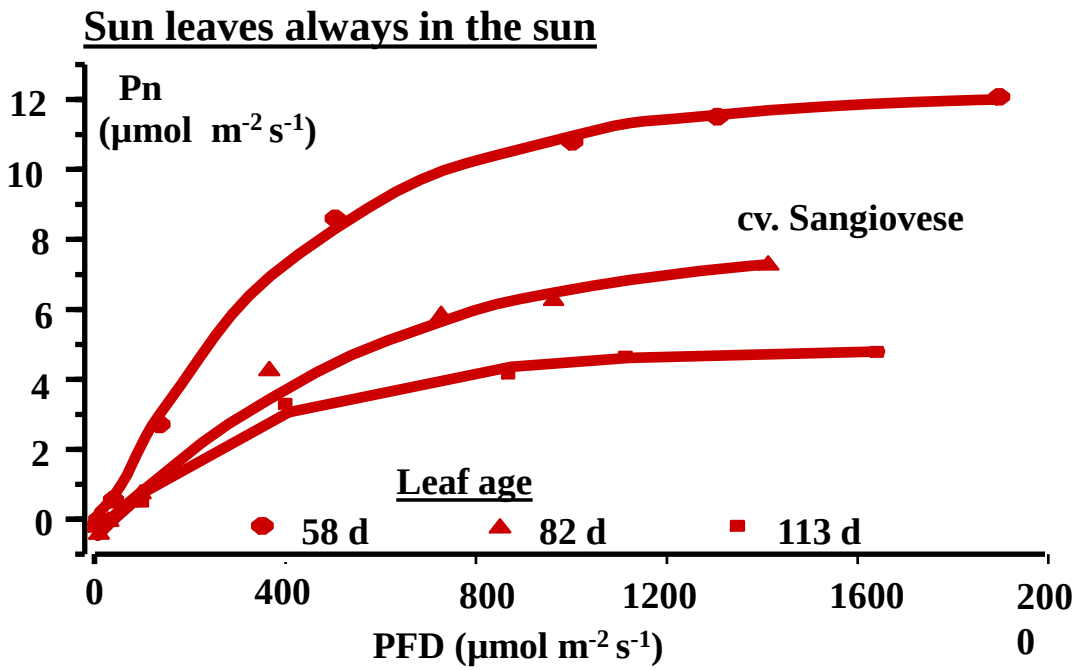



P_n (µmol m^{-2} s^{-1})
12
10
8
6
4
2
0
0
300
600
900
1200
1500
1800
PAR (µmol m^{-2} s^{-1})
«sun» leaves
«shade» leaves


(a)
(b)
Net assimilation rate (A_N) (µmol CO_2 m^{-2} s^{-1})
Incident PAR (µmol m^{-2} s^{-1})
100%
60%
30%
15
12
9
6
3
0
-3
0
400
800
1200
1600
2000


Sun leaves
PFD = 90% max
(1600 µmol m-2 s-1)
PFD = 90% max
PFD = 8% max
(150-200 µmol m-2 s-1)
R:FR = 0.40

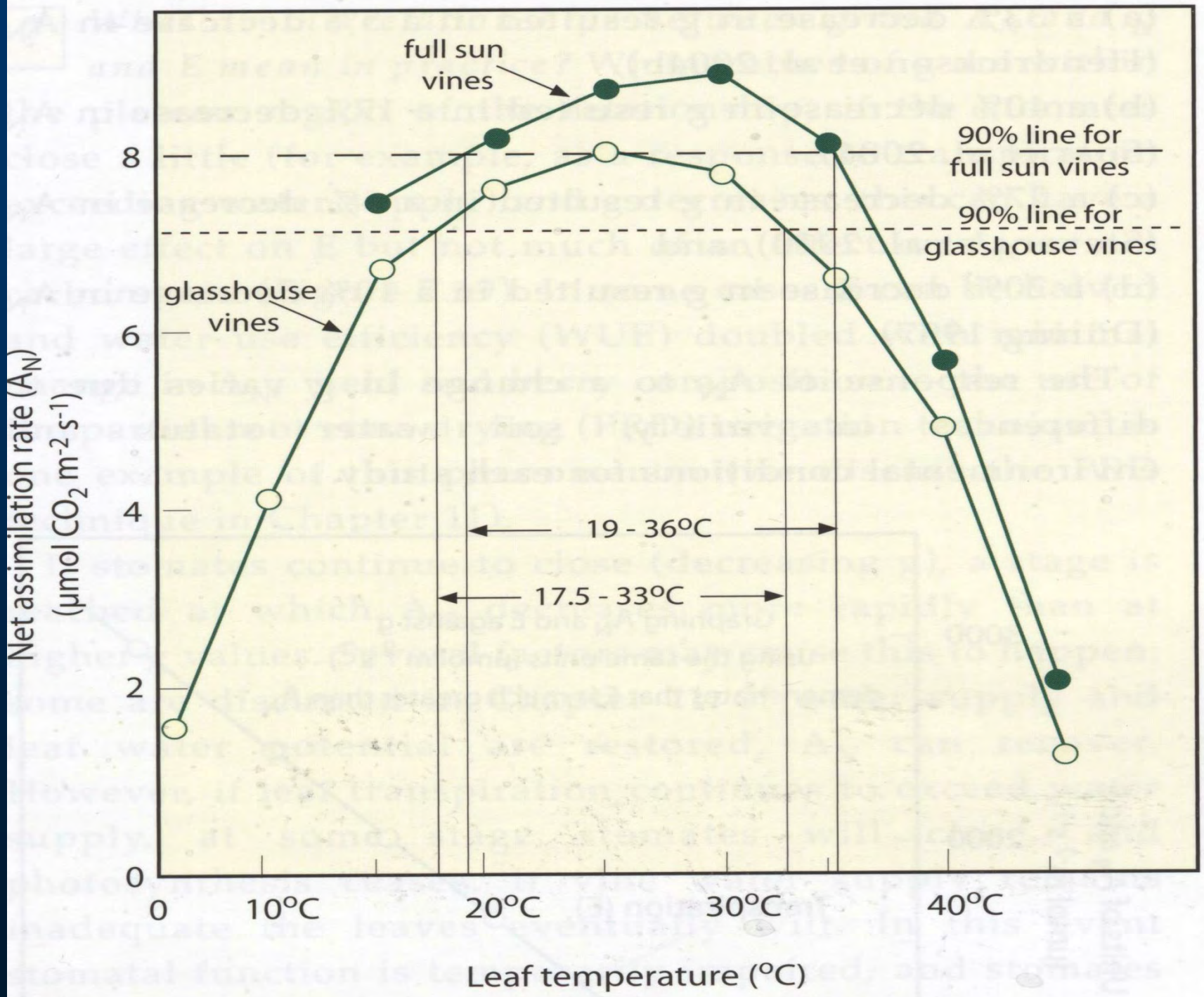




Da Silvestroni et al., 1993

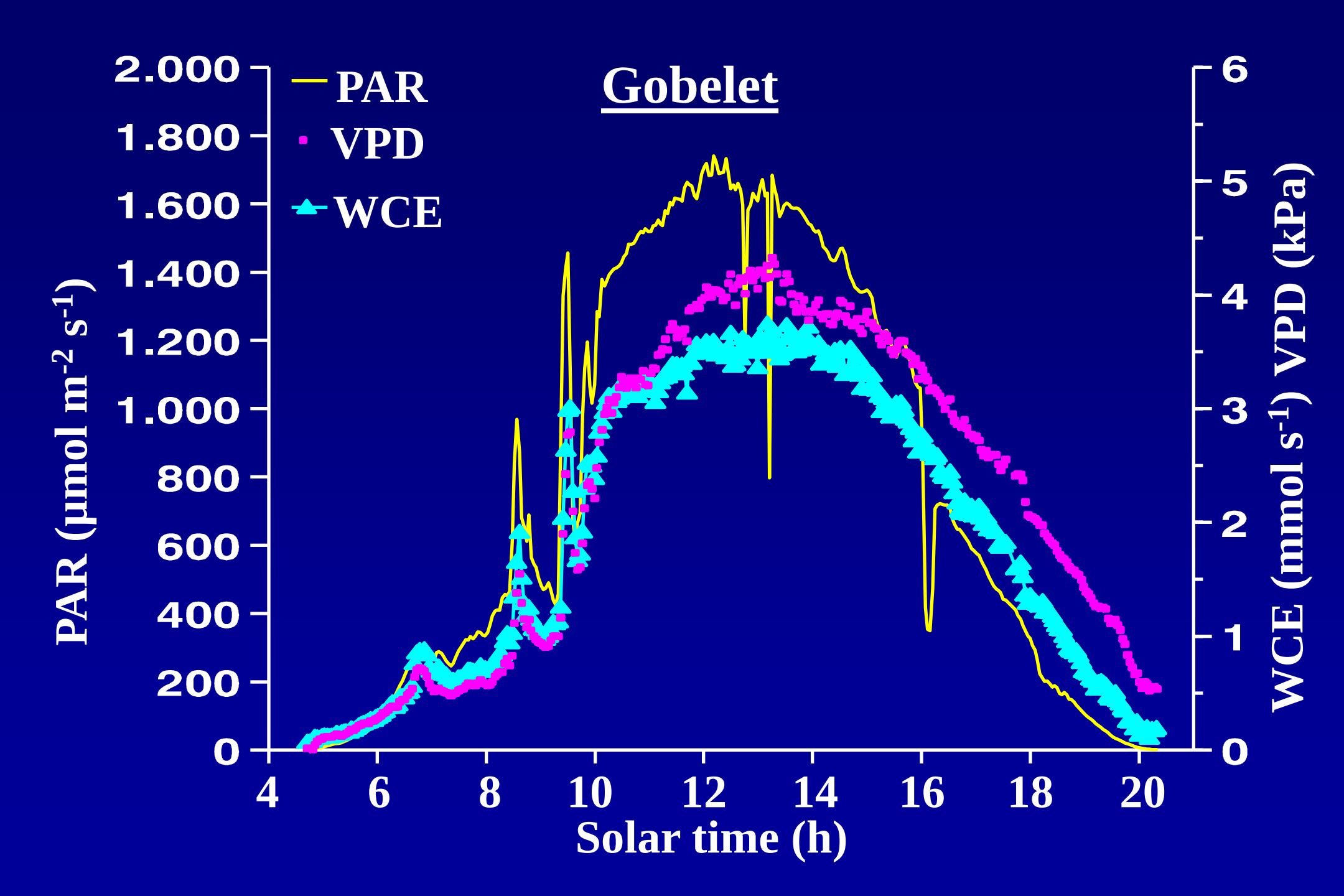
Temperature

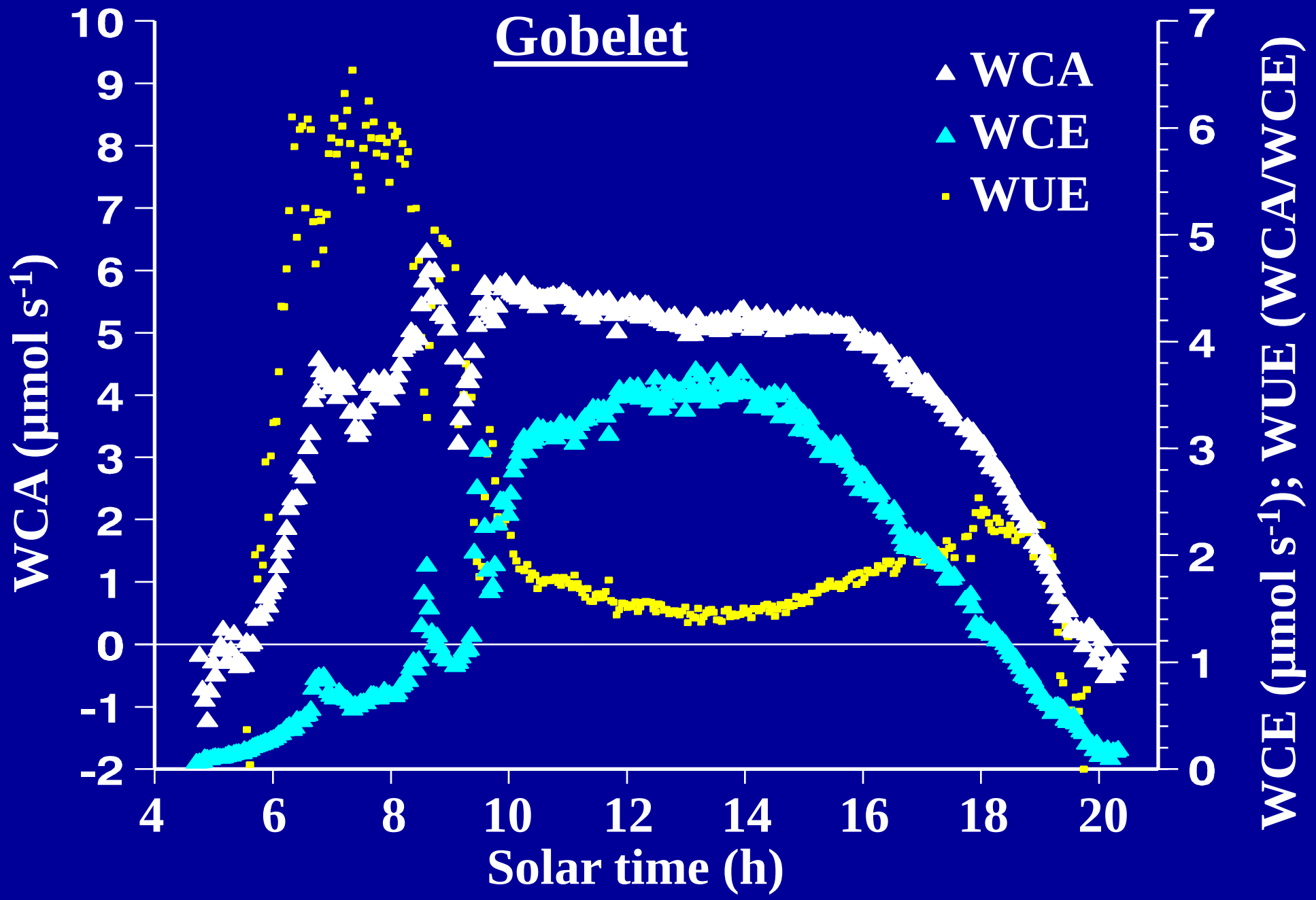
- Long term effects
- Short term effects

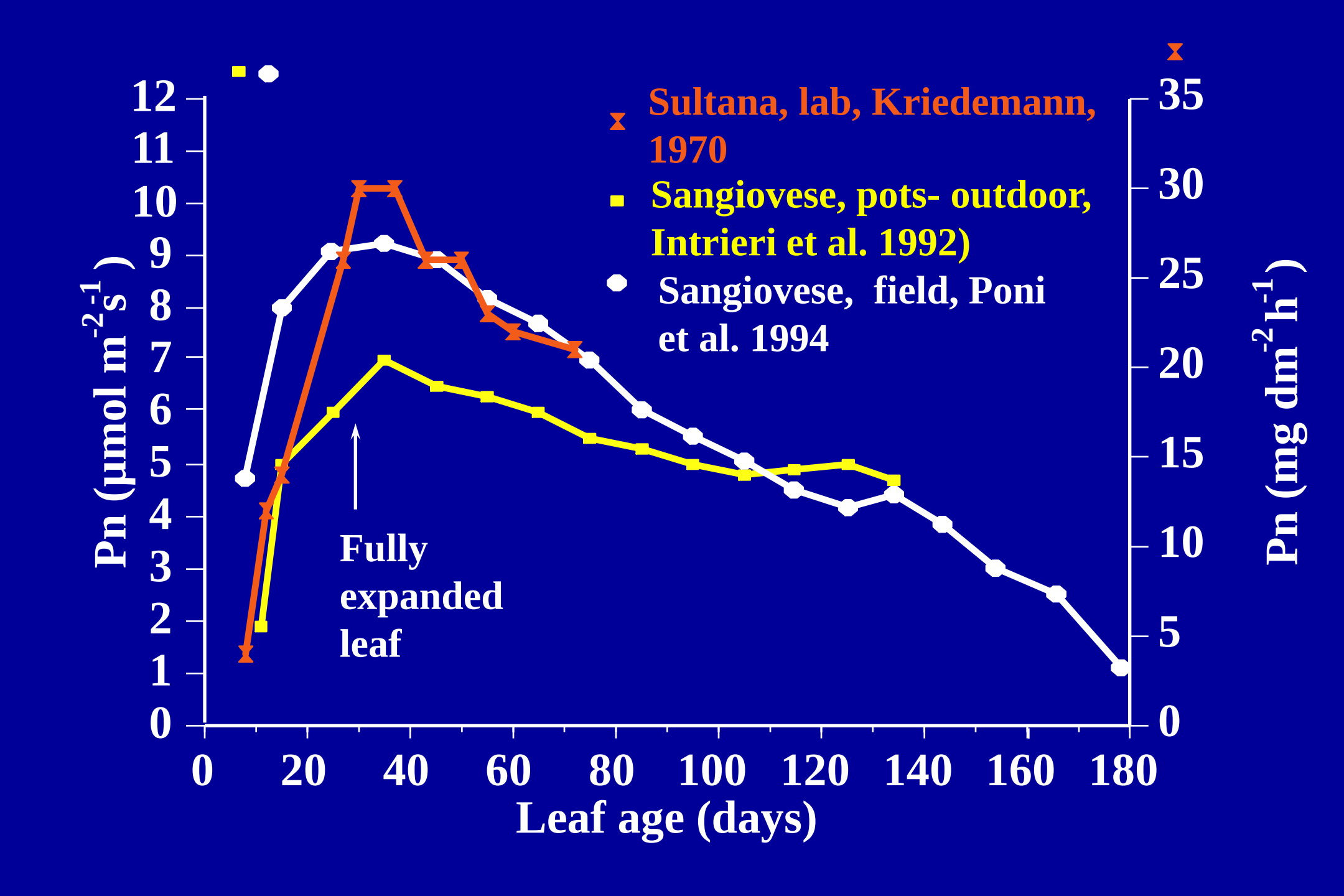

full sun vines
90% line for full sun vines
90% line for glasshouse vines
glasshouse vines
19 - 36°C
17.5 - 33°C
Net assimilation rate (A_N) (µmol CO_2 m^{-2} s^{-1})
0
2
4
6
8
0
10°C
20°C
30°C
40°C
Leaf temperature (°C)

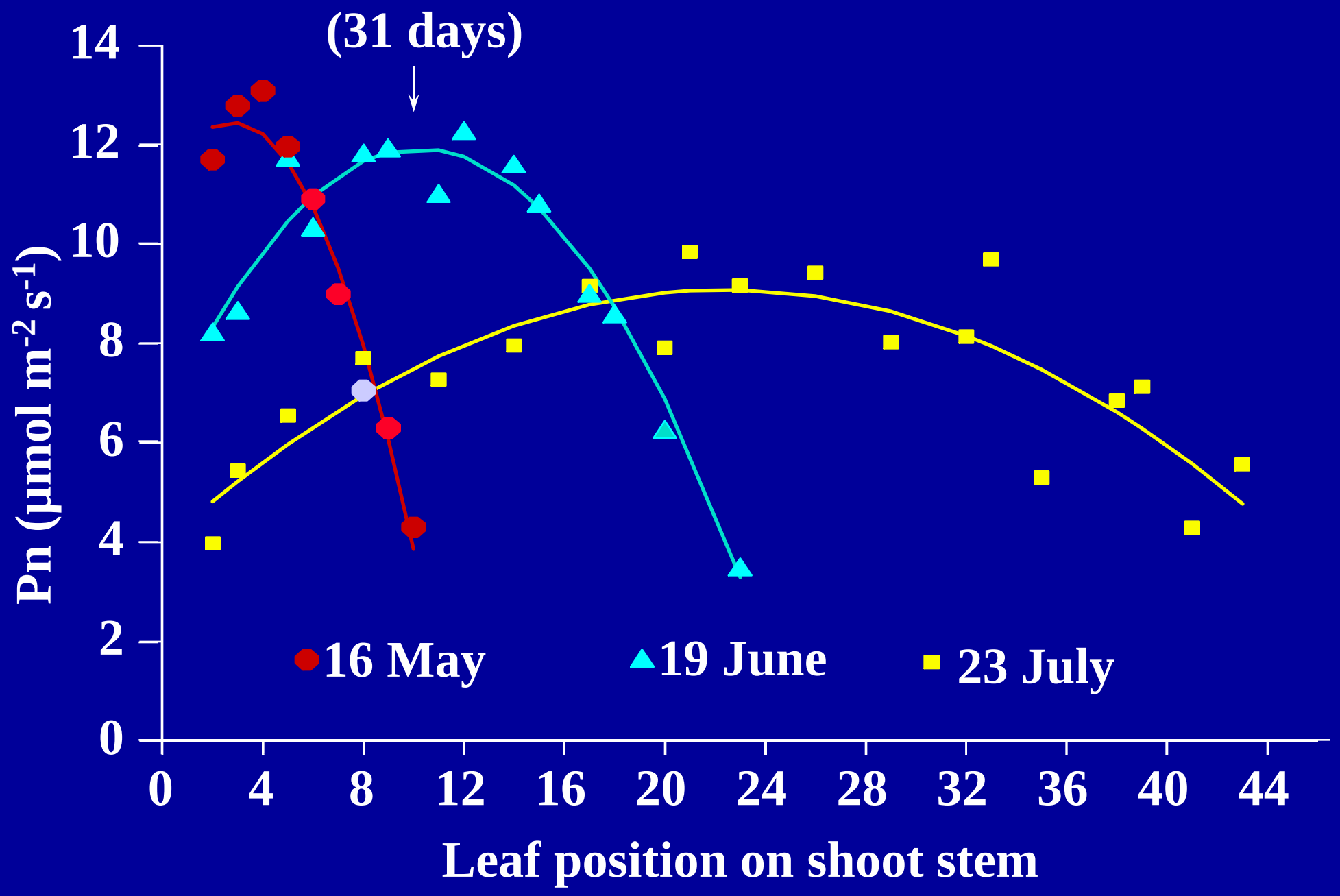
P_n and other factors

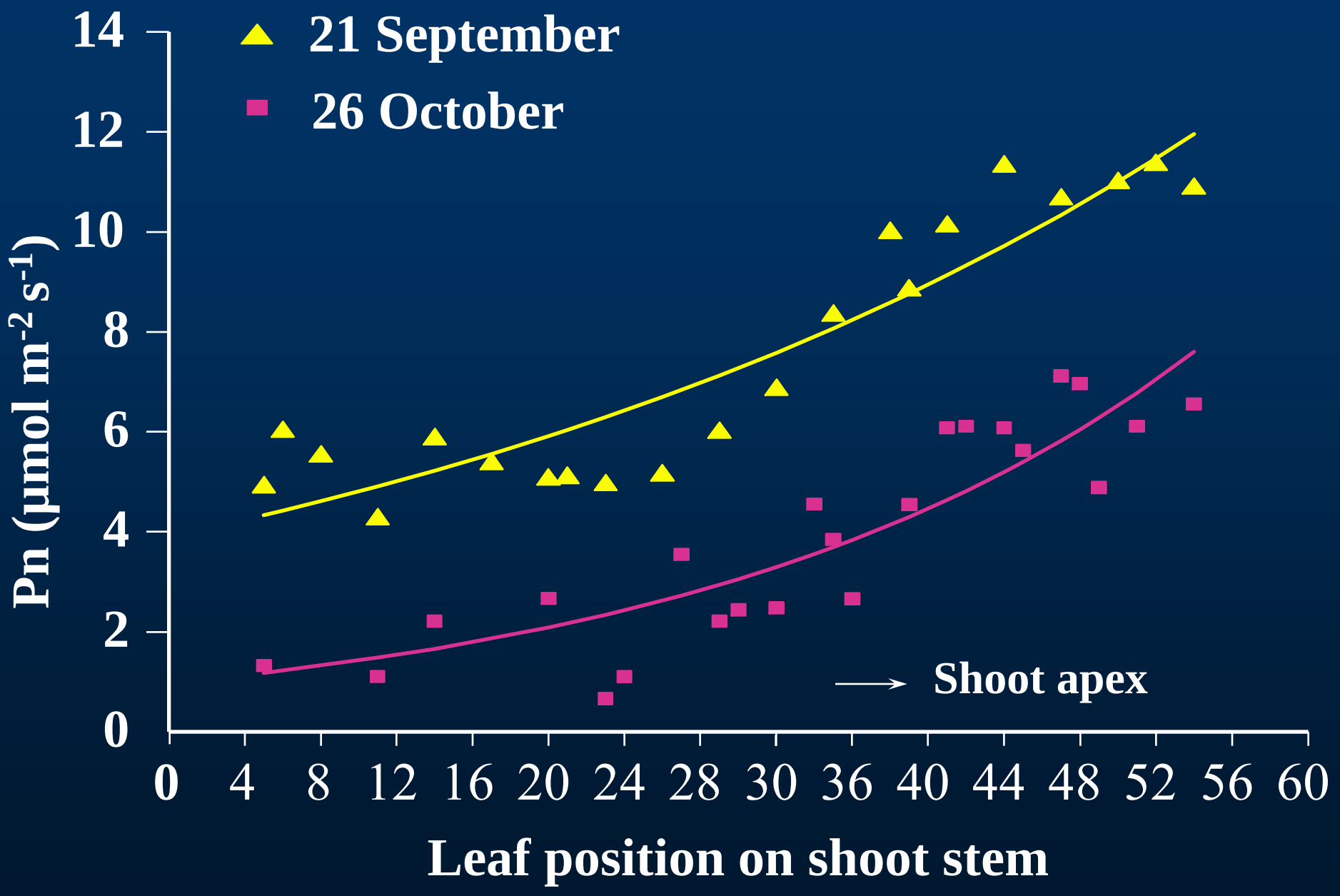
- Diurnal variation
- Seasonal variation
- Leaf age
- Compensation mechanisms
- Source and sink balance

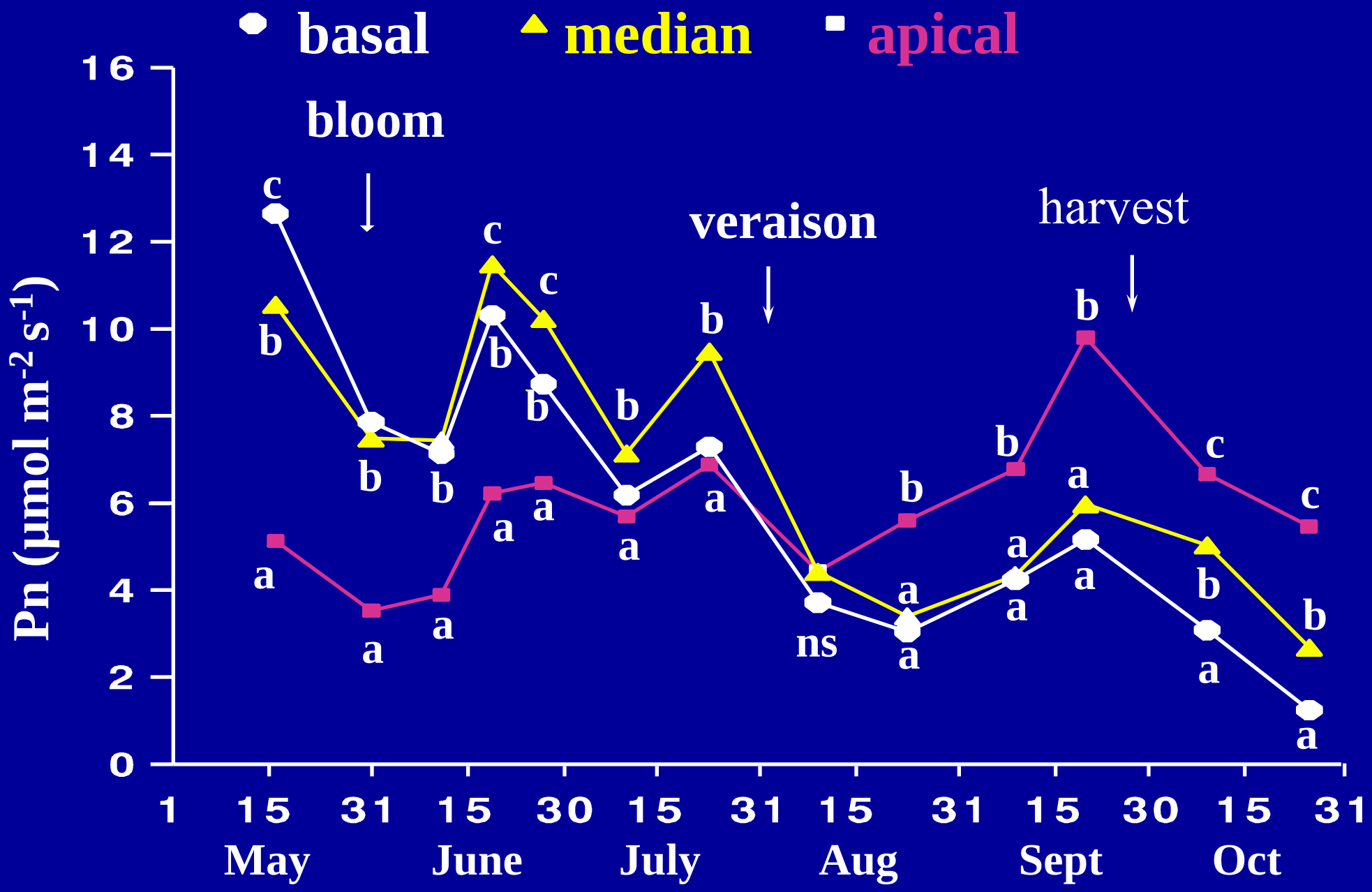

Gobelet
PAR
VPD
WCE
PAR (µmol m-2 s-1)
WCE (mmol s-1) VPD (kPa)
Solar time (h)
2.000
1.800
1.600
1.400
1.200
1.000
800
600
400
200
0
6
5
4
3
2
1
0
4
6
8
10
12
14
16
18
20

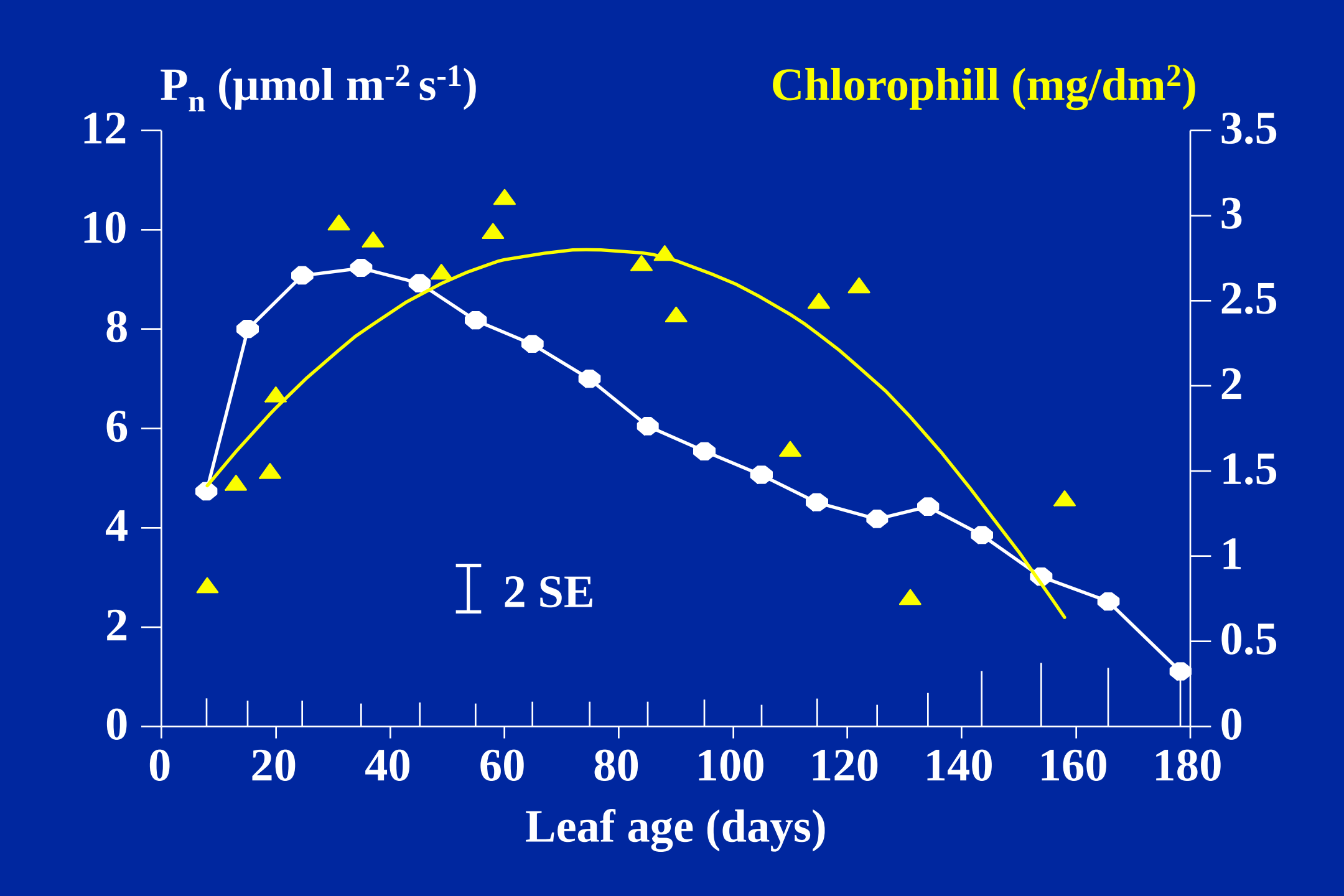

Gobelet
WCA
WCE
WUE
WCA (µmol s-1)
WCE (µmol s-1); WUE (WCA/WCE)
Solar time (h)
10
9
8
7
6
5
4
3
2
1
0
-1
-2
7
6
5
4
3
2
1
0
4
6
8
10
12
14
16
18
20

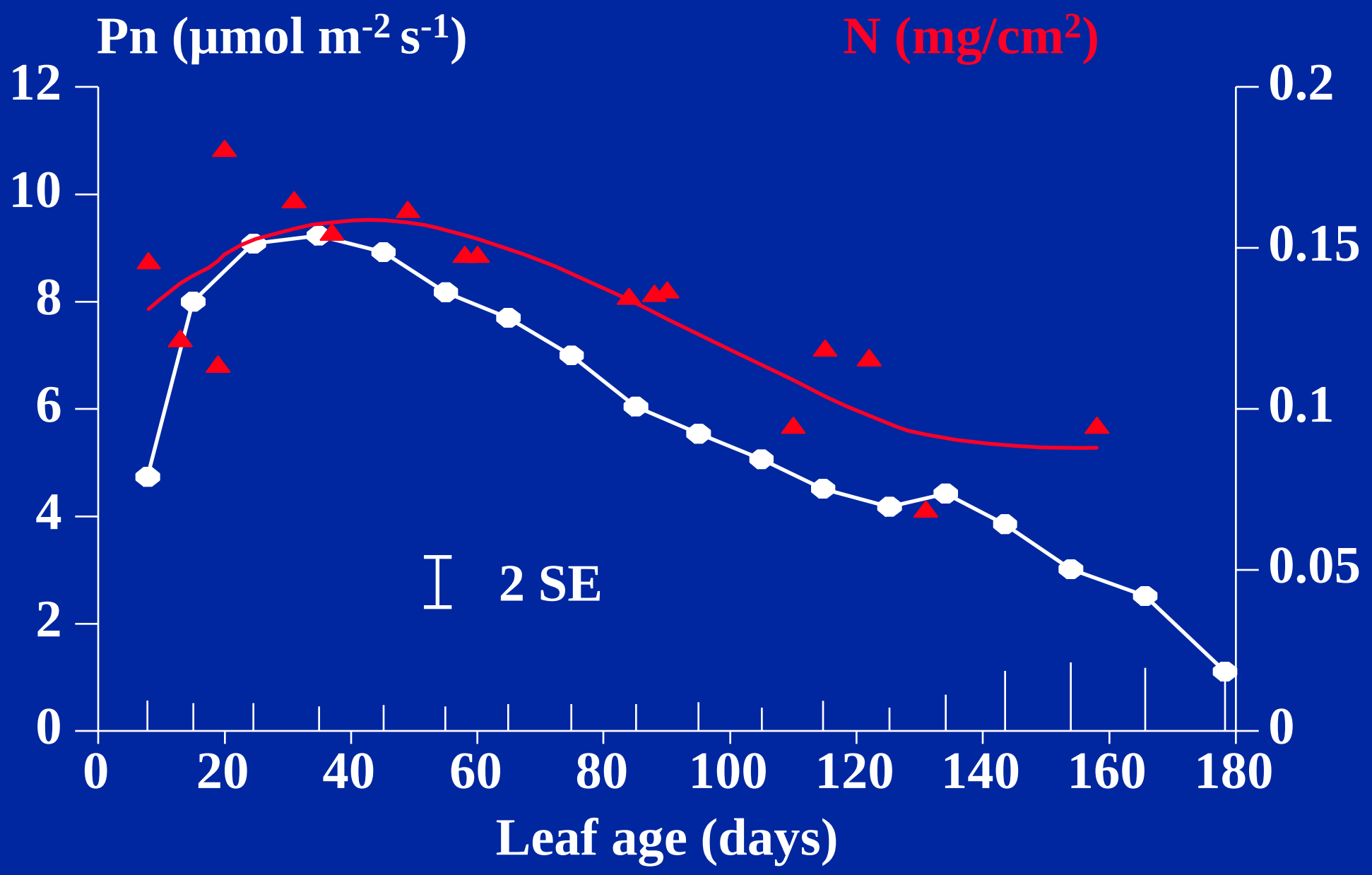

Sultana, lab, Kriedemann, 1970
Sangiovese, pots- outdoor, Intrieri et al. 1992)
Sangiovese, field, Poni et al. 1994
Fully expanded leaf
Pn (µmol m-2 s-1)
Pn (mg dm-2 h-1)
Leaf age (days)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
5
10
15
20
25
30
35
0
20
40
60
80
100
120
140
160
180


(31 days)
14
12
10
8
6
4
2
0
Pn (µmol m-2 s-1)
16 May
19 June
23 July
0
4
8
12
16
20
24
28
32
36
40
44
Leaf position on shoot stem


21 September
26 October
Pn (µmol m-2 s-1)
14
12
10
8
6
4
2
0
Shoot apex
0 4 8 12 16 20 24 28 30 36 40 44 48 52 56 60
Leaf position on shoot stem


basal
median
apical
bloom
veraison
harvest
Pn (µmol m-2 s-1)
16
14
12
10
8
6
4
2
0
1
15
31
15
30
15
31
15
31
15
30
15
31
May
June
July
Aug
Sept
Oct
ns


P_n (µmol m^{-2} s^{-1})
Chlorophill (mg/dm^2)
12
10
8
6
4
2
0
3.5
3
2.5
2
1.5
1
0.5
0
2 SE
0
20
40
60
80
100
120
140
160
180
Leaf age (days)


Pn (µmol m-2 s-1)
N (mg/cm2)
12
10
8
6
4
2
0
0.2
0.15
0.1
0.05
0
2 SE
0
20
40
60
80
100
120
140
160
180
Leaf age (days)