

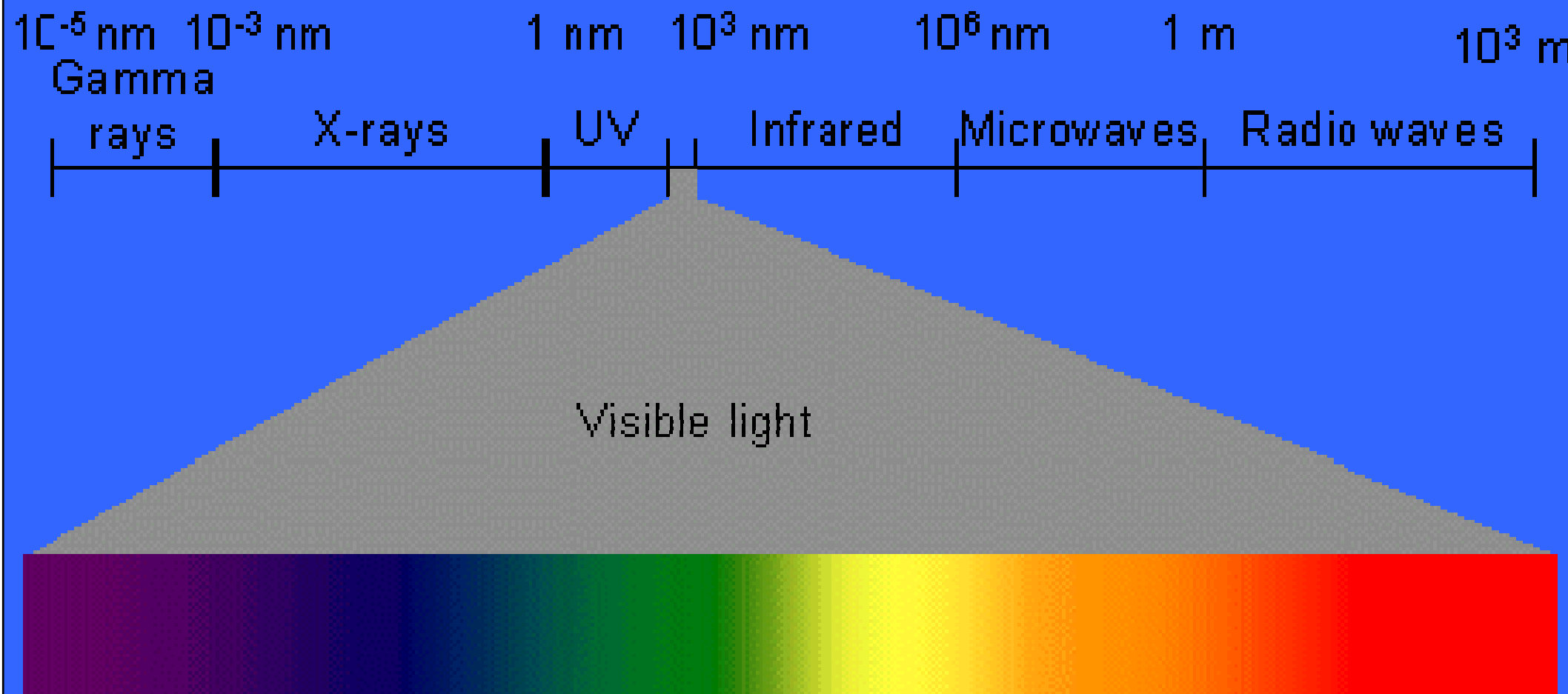
# Produkční biologie Bi8030

podzimní semestr 2011

1. Sluneční záření jako energetický zdroj produkce
2. Struktura vegetačního krytu, intercepce radiace, absorpce, LAI

M. Barták  
OFAR ÚEB PŘF MU Brno

**Viditelné záření  
(světlo) je jen malá  
část spektra záření**



# Sluneční záření

- Solární konstanta =  $1.36 \text{ kW/m}^2$  [ $\text{kJ/m}^2 \cdot \text{s}$ ]

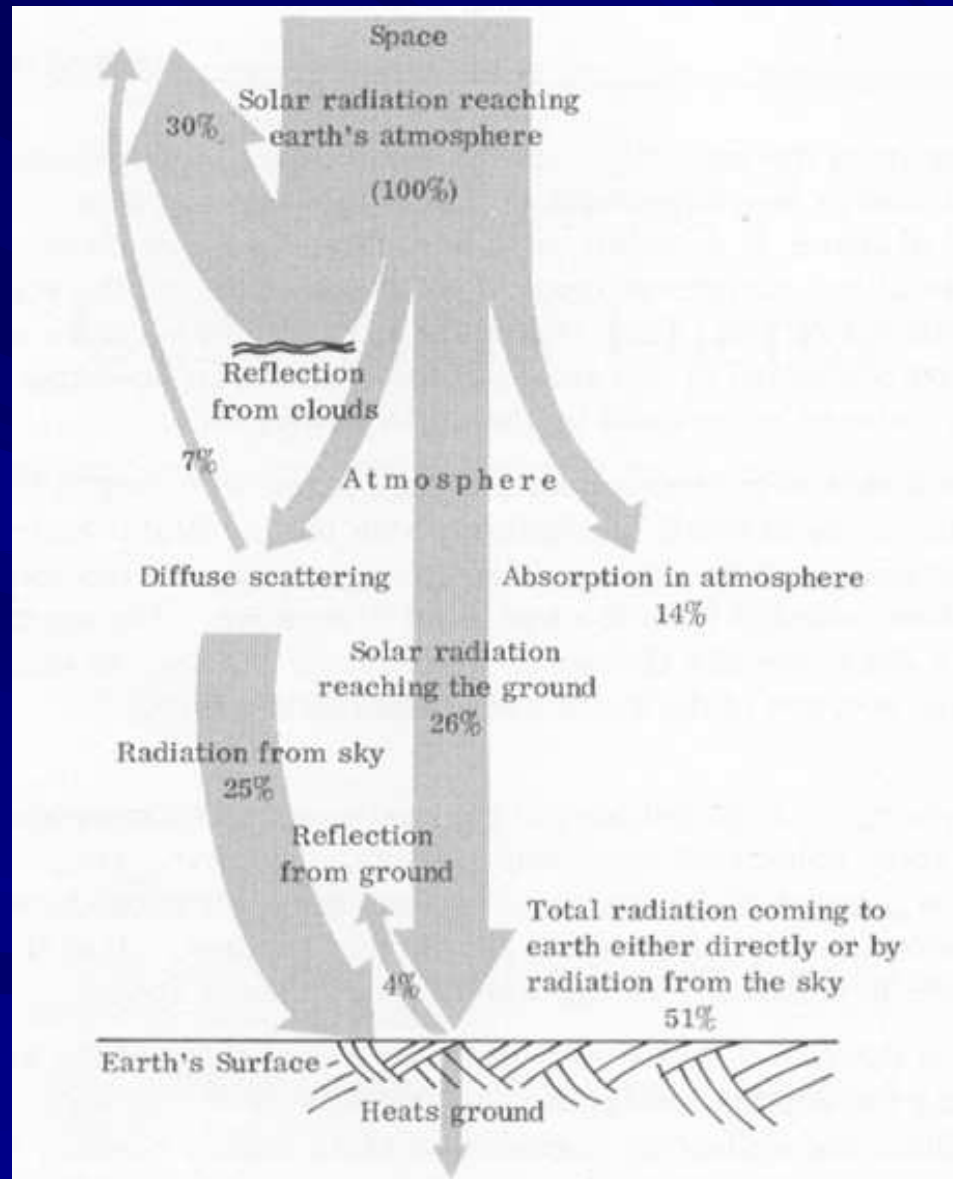
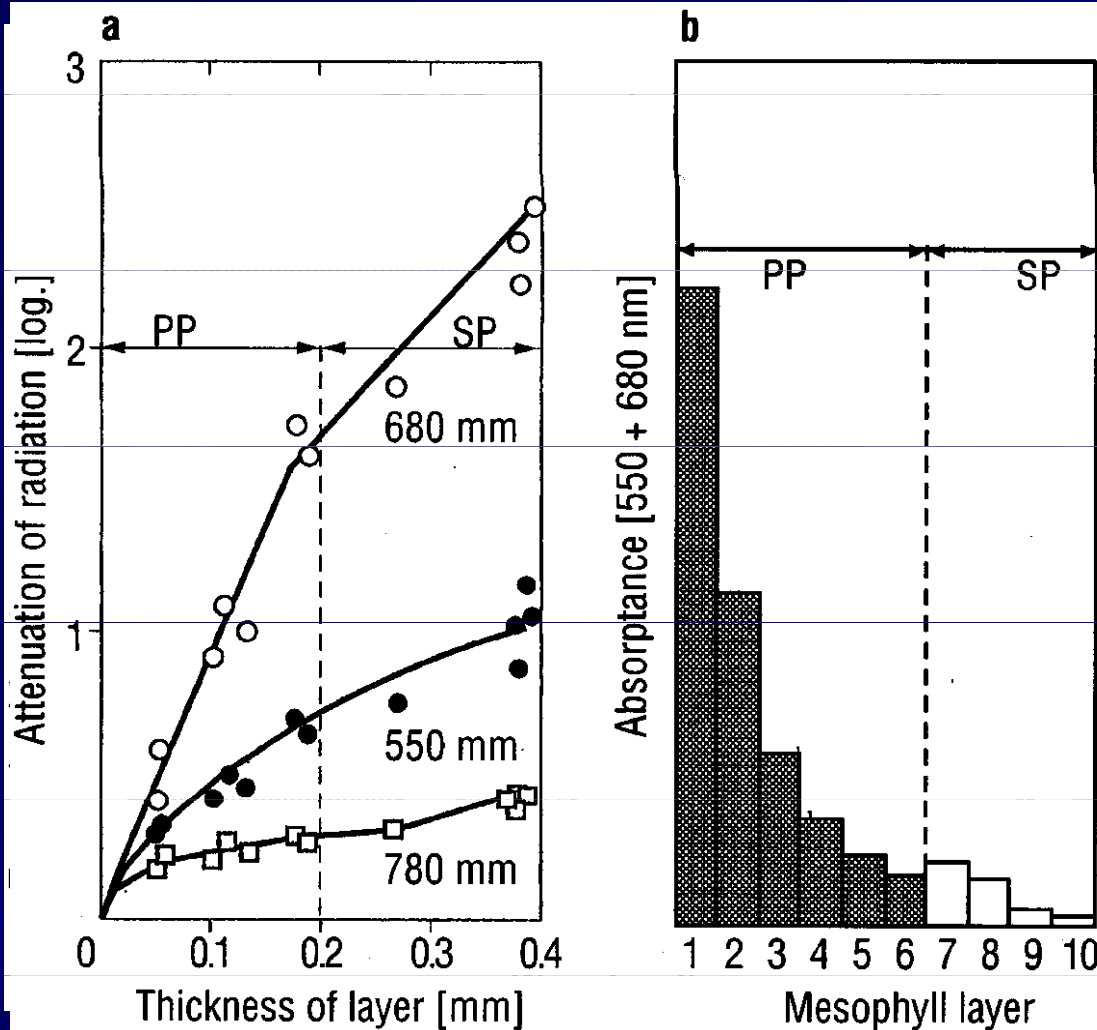


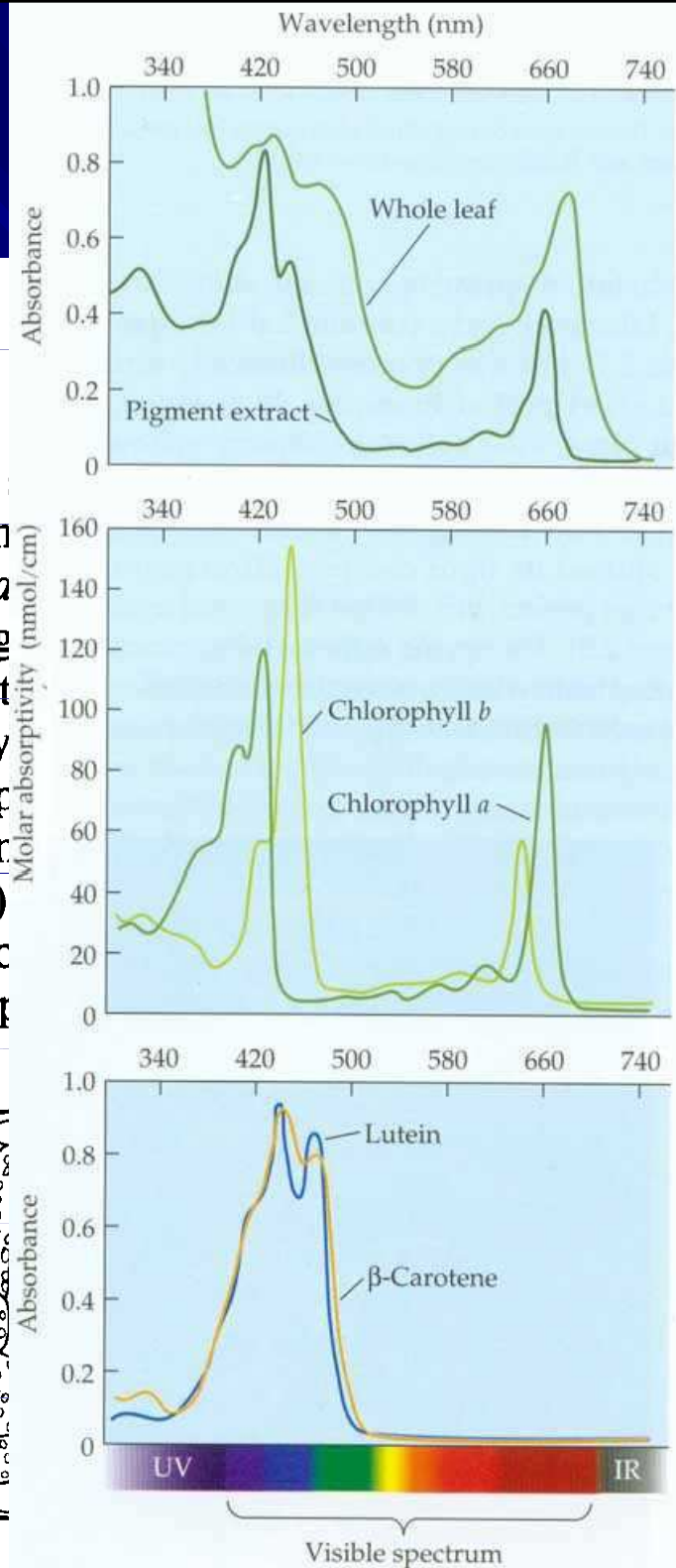
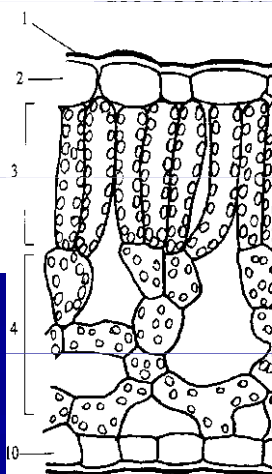
Figure 2.1 Energy input to earth's surface at midday

# Modifikace záření rostlinou

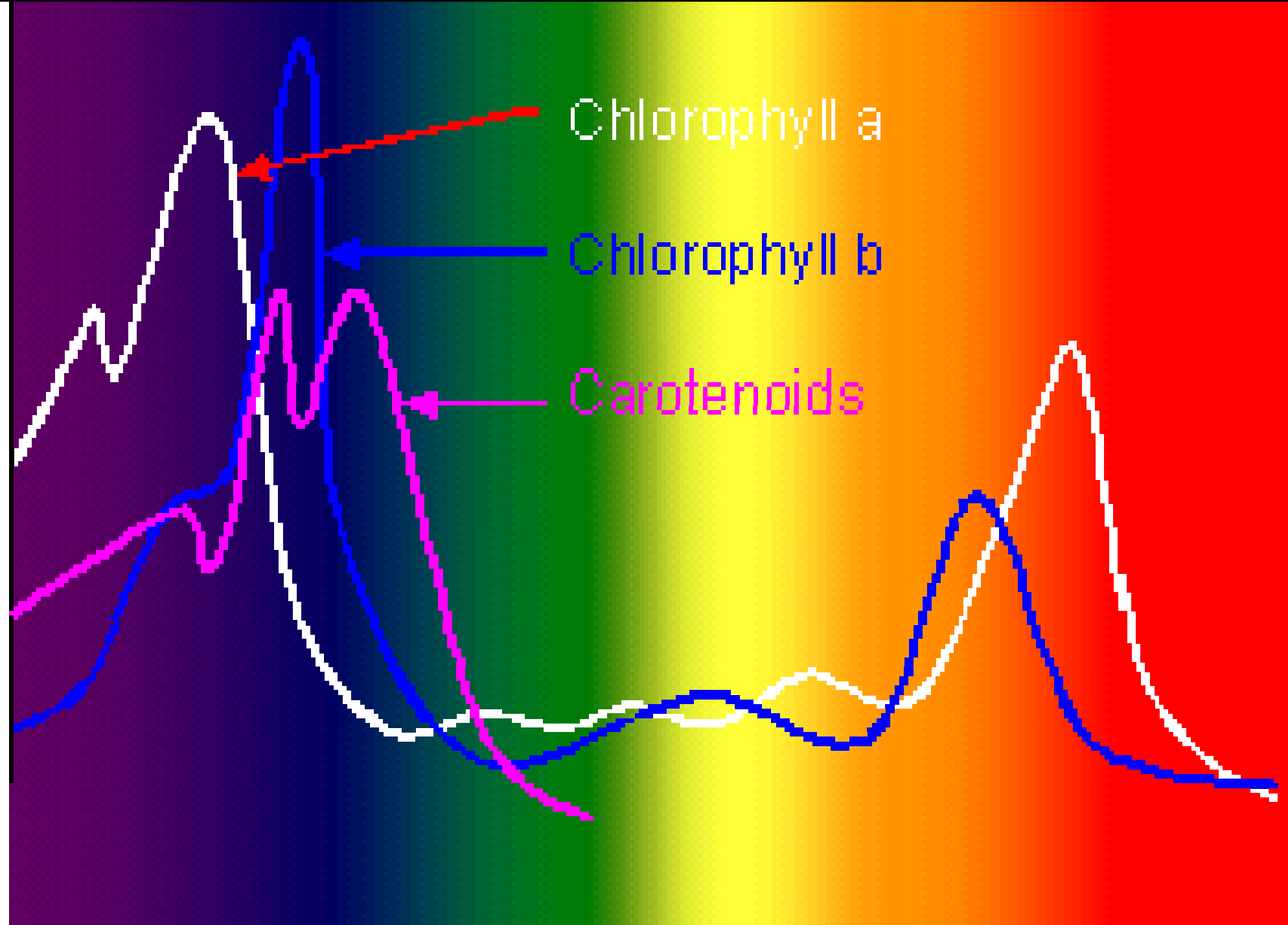


**Fig. 1.31**  
radiation  
*Camellia*  
tion (neg  
transmitt  
parenchy  
spongy p  
the greer  
(680 nm)  
regions c  
**b** Absorp

transmittance and absorptance of a poplar leaf (*Populus deltoides*) as a function of wavelength. (After Gates 1965)



absorption



Chlorophyll a

Chlorophyll b

Carotenoids

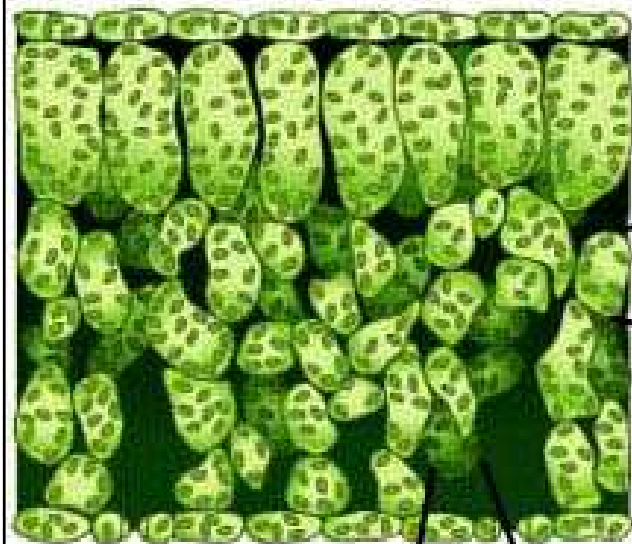
400

500

600

700

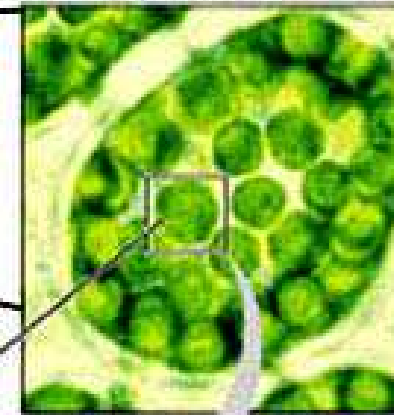
# Absorpce PAR chloroplasty



Leaf cross-section

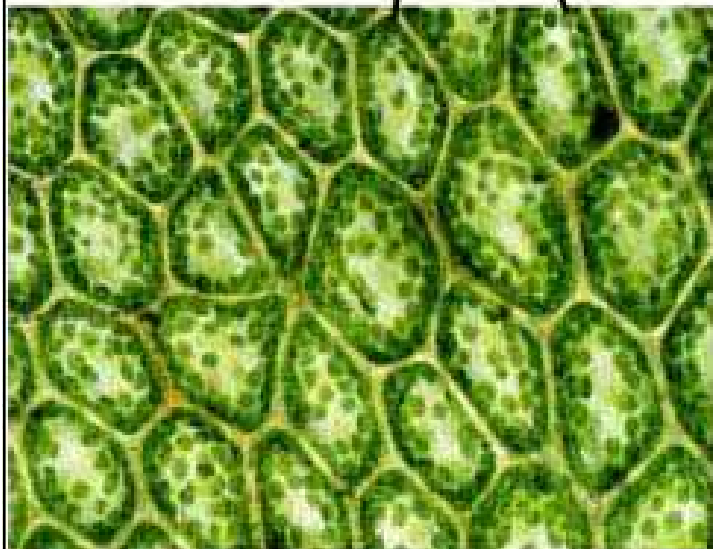
No chloroplasts  
in epidermis

Mesophyll cell

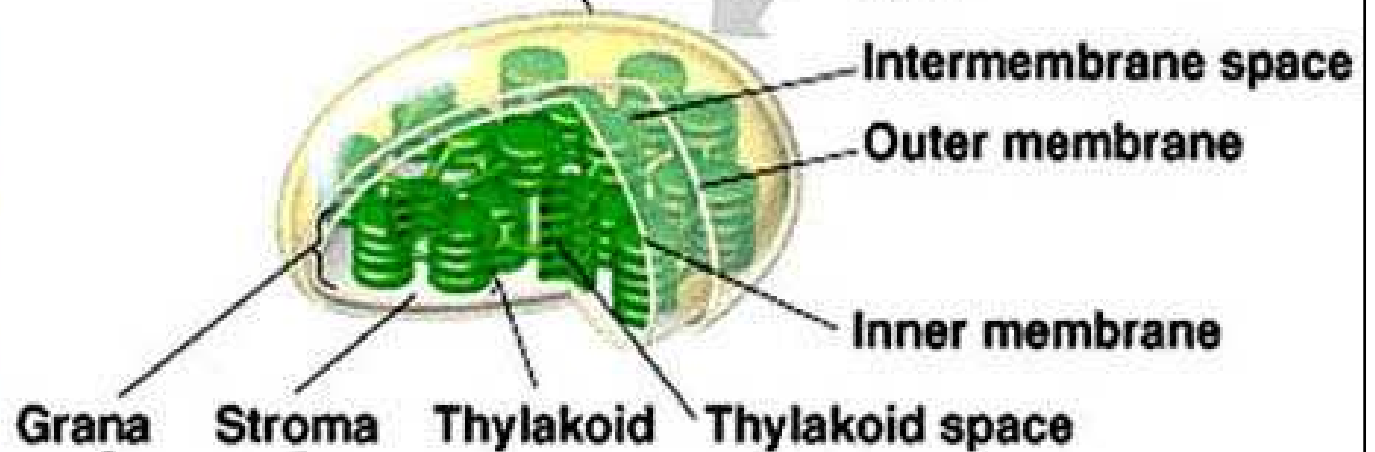


5 μm

Chloroplast

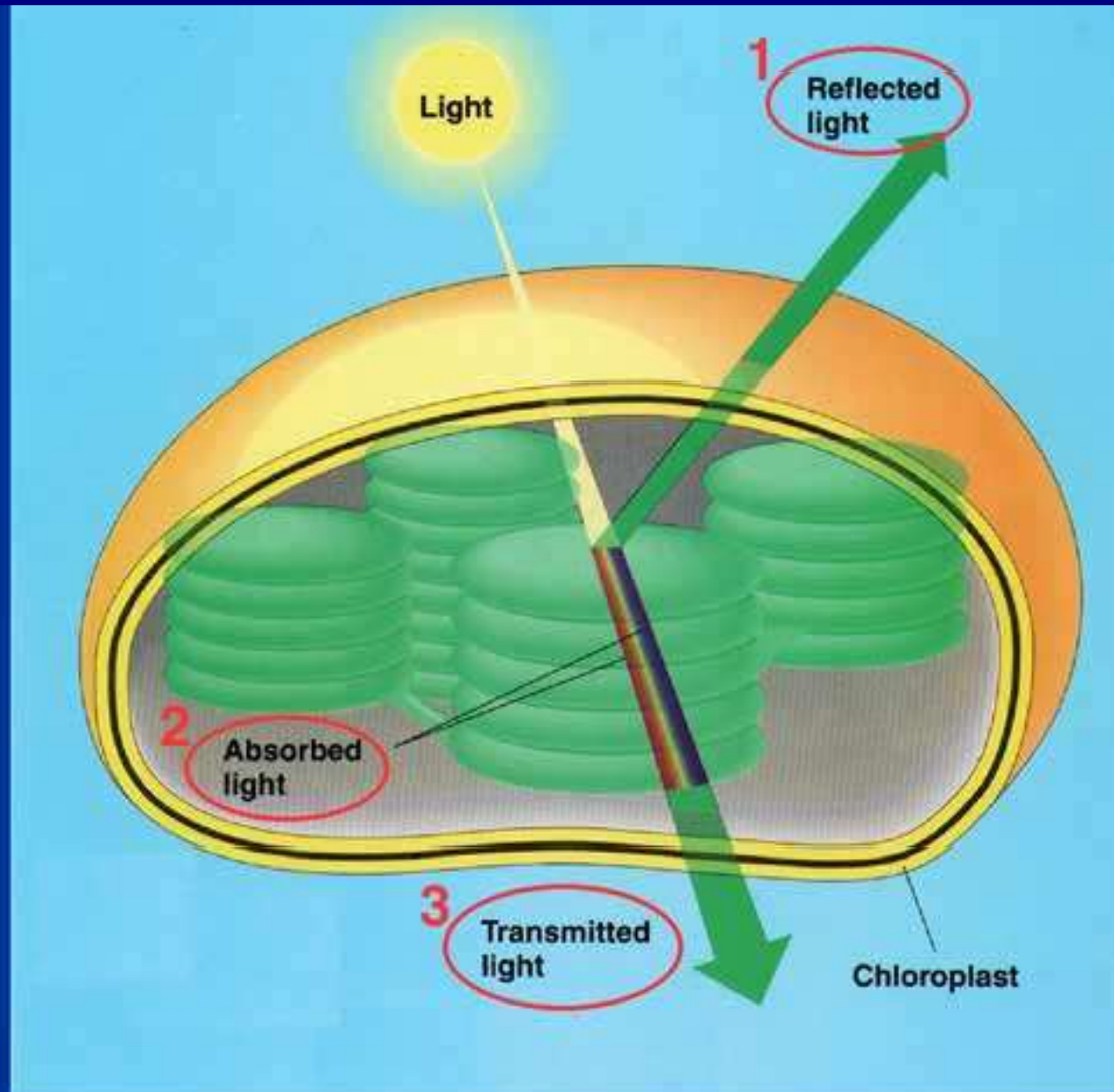


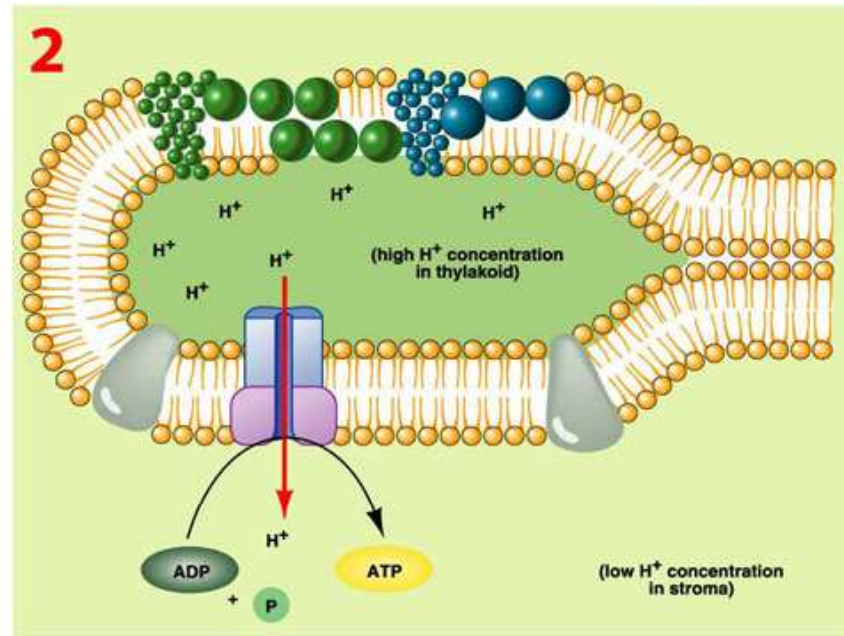
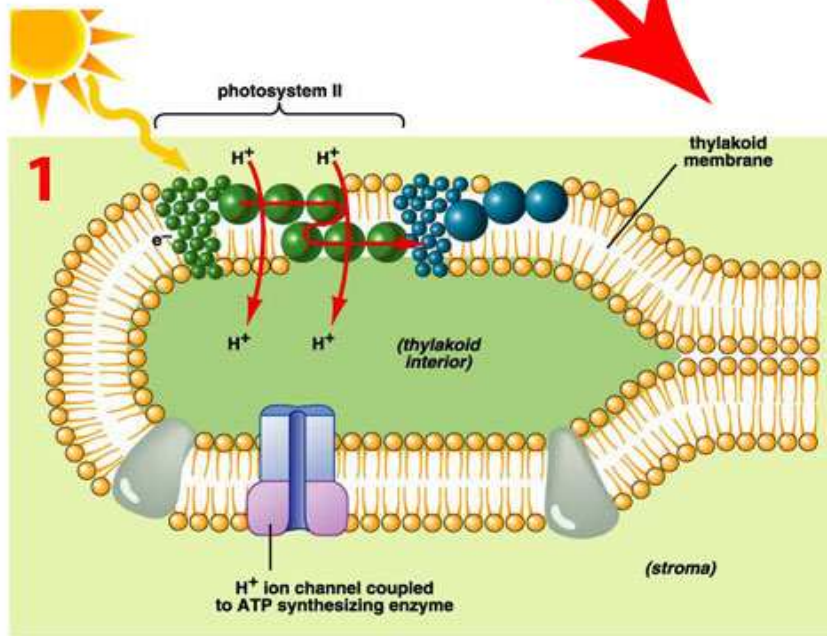
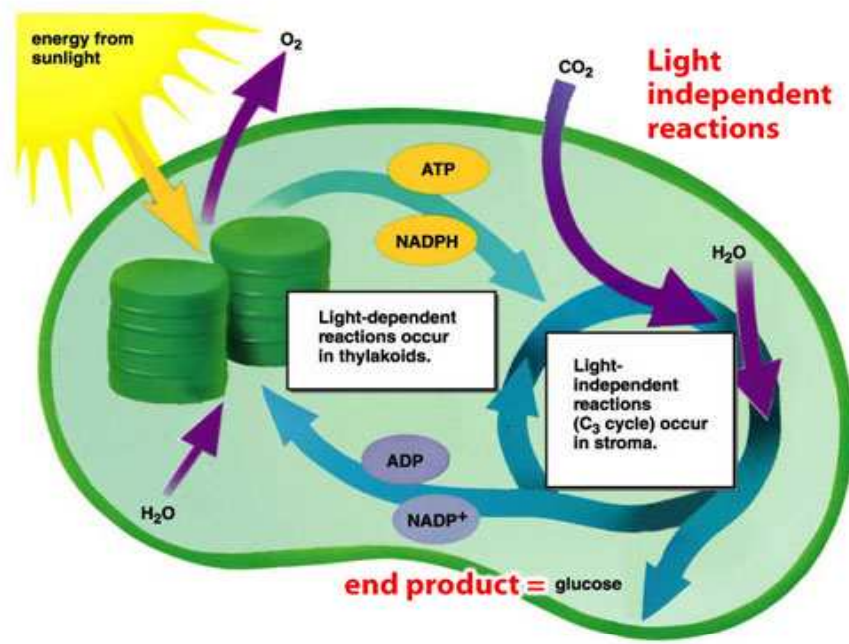
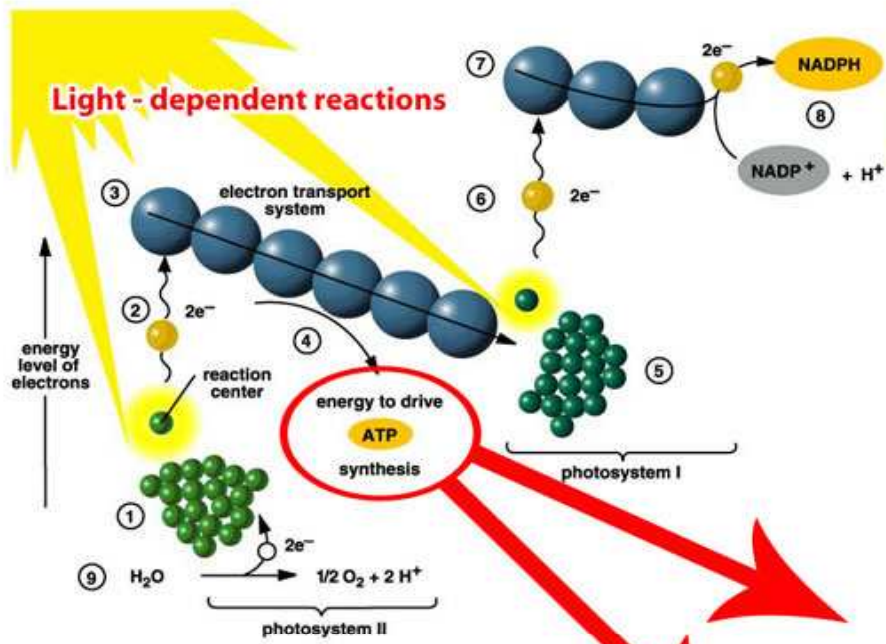
Cells containing chloroplasts



# Interakce dopadajícího záření s fotosyntetizujícím objektem (listem):

- odraz, absorpce, průnik







# Modifikace záření porostem

- relativní ozáření (relativní světelný požitek) - intenzita ozáření uvnitř rostlinného porostu v procentech plného ozáření dosaženého na volné ploše
- $I_z = I_0 \cdot e^{-k \cdot LAI}$      $k$  - exktinkční koeficient, LAI - leaf area index

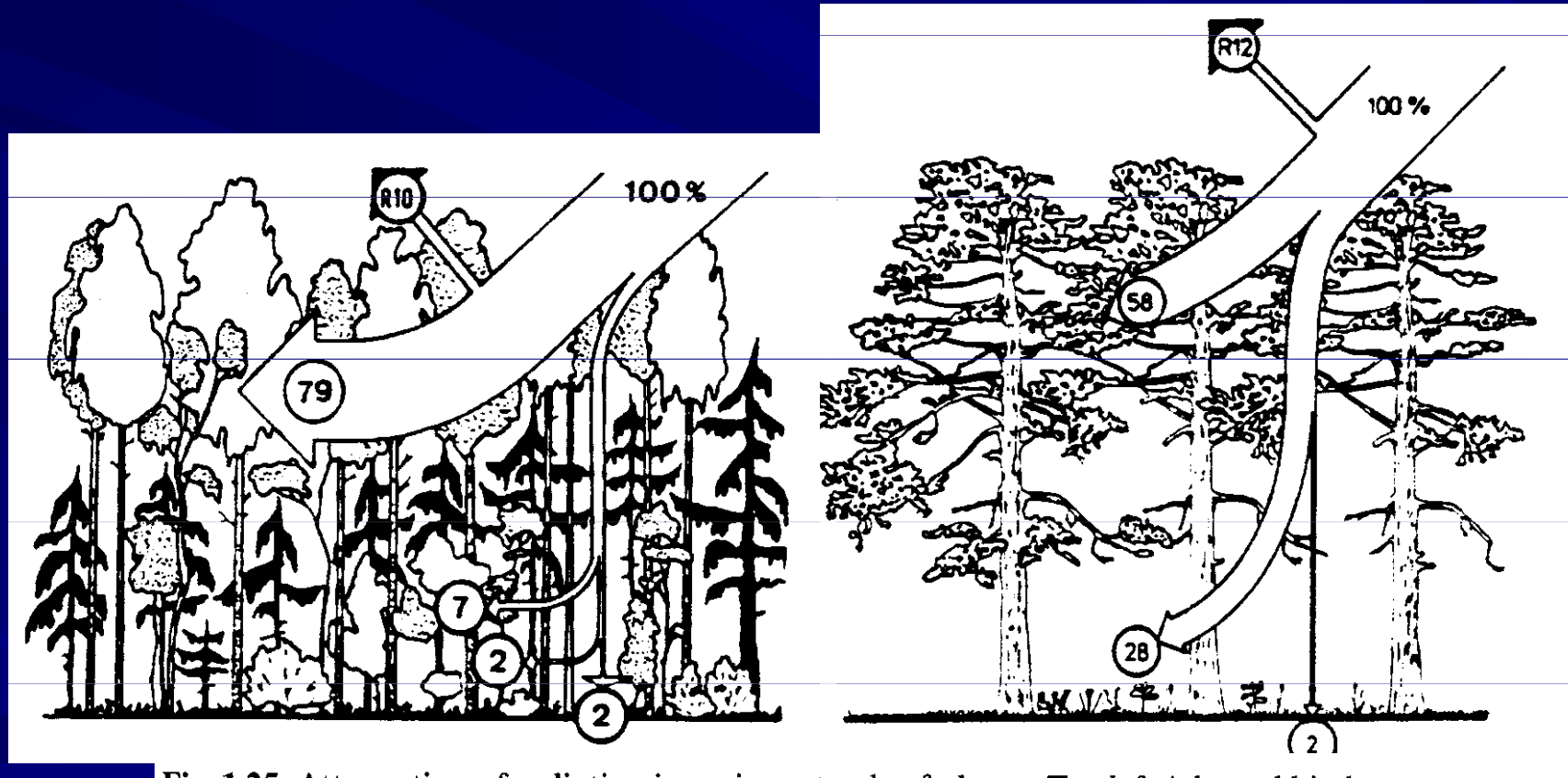


Fig. 1.25. Attenuation of radiation in various stands of plants. *Top left* A boreal birch-spruce mixed forest (Kairiukstis 1967); *top right* a thin pine forest (Cernusca 1977); *below left* a sunflower field (Hiroi and Monsi 1966); *below right* a maize field (Allen et al. 1964).  $R$  canopy reflectance. Most of the radiation penetrating dense, flat-leaved stands is absorbed and scattered in the upper third, whereas in stands with narrow, erect leaves the radiation is more evenly distributed

# Modifikace záření porostem

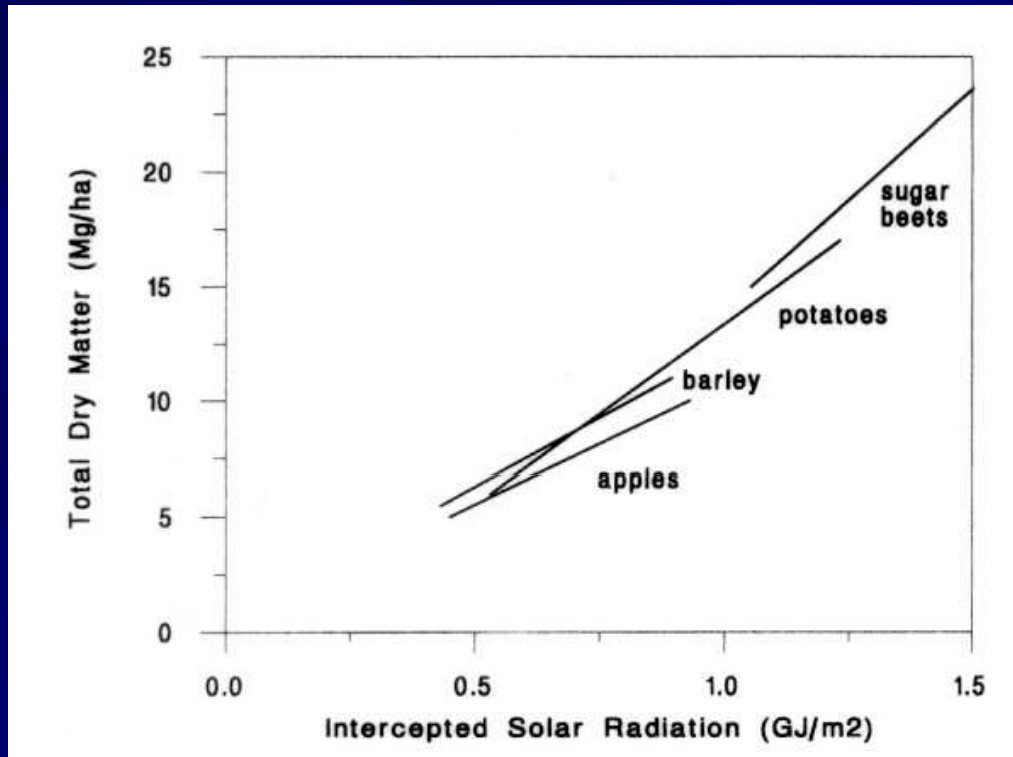
- relativní ozářenost (relativní světelný požitok) - intenzita ozáření uvnitř rostlinného porostu v procentech plného ozáření dosaženého na volné ploše
- $I_z = I_0 \cdot e^{-k \cdot LAI}$      $k$  - extinkční koeficient, LAI - leaf area index

$k$  - extinkční koeficient:

louky, rákosiny  $k = 0.3-0.5$

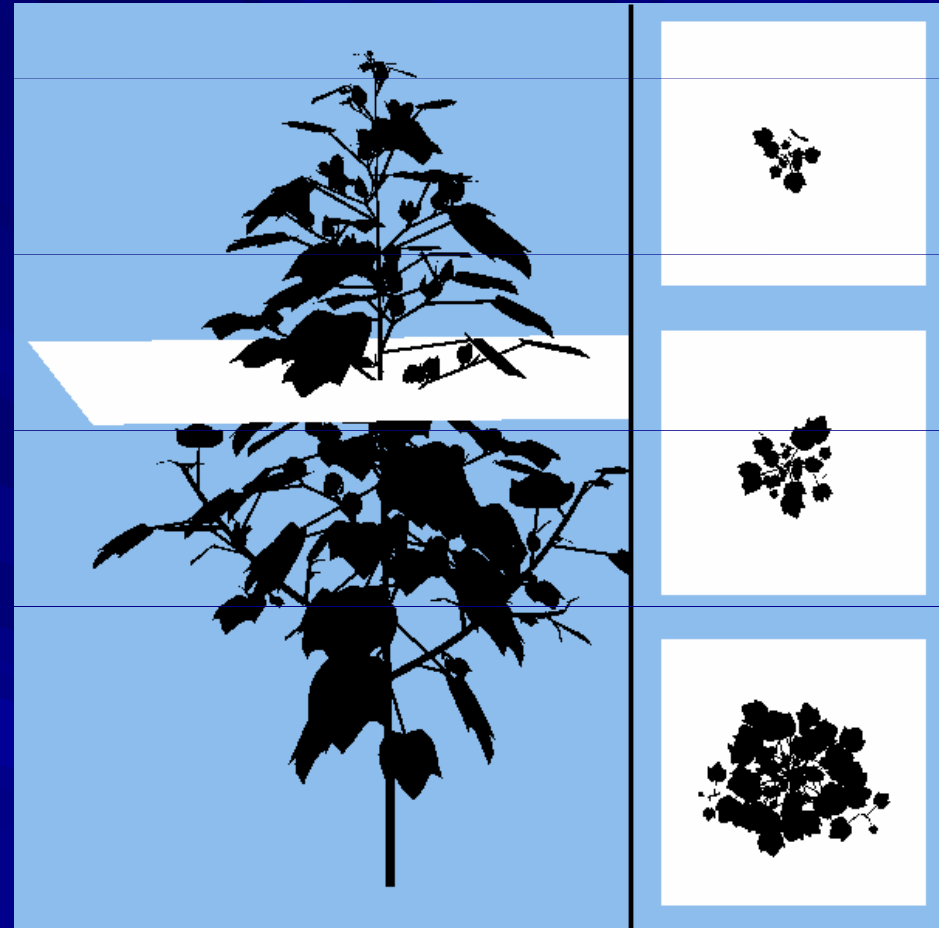
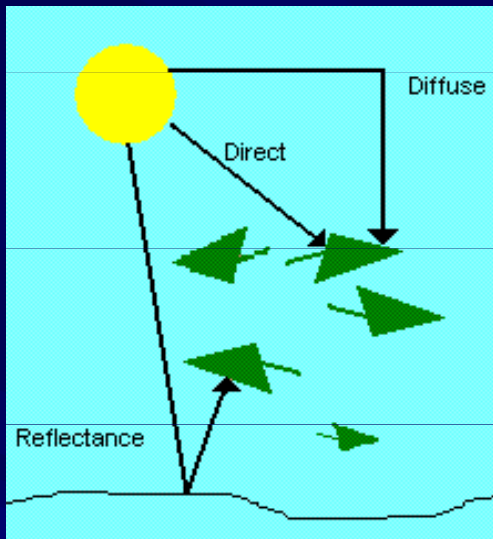
společenstva bylin  $k = 0.7$

# Monteith (1977)



$$A = efS_t$$

# Intercepce záření v porostu



- <http://www.nrri.umn.edu/ecophys/shading.html>
- [http://www.biologie.uni-hamburg.de/b-online/virtualplants/ipi\\_ic14.html](http://www.biologie.uni-hamburg.de/b-online/virtualplants/ipi_ic14.html)
- [http://www.worldagroforestrycentre.org/sea/Products/AFModels/Slim/images/3d\\_view.jpg](http://www.worldagroforestrycentre.org/sea/Products/AFModels/Slim/images/3d_view.jpg)

# Metody měření indexu listové plochy (LAI)

- Destruktivní (stanovení projekční plochy)
  - fotoplanimetry, scannery
- S využitím Lambert-Beerové zákona
  - LAI metr, interceptometr, přímým měřením záření
- Metodou hemisférické fotografie
- Matematickou simulací struktury porostu

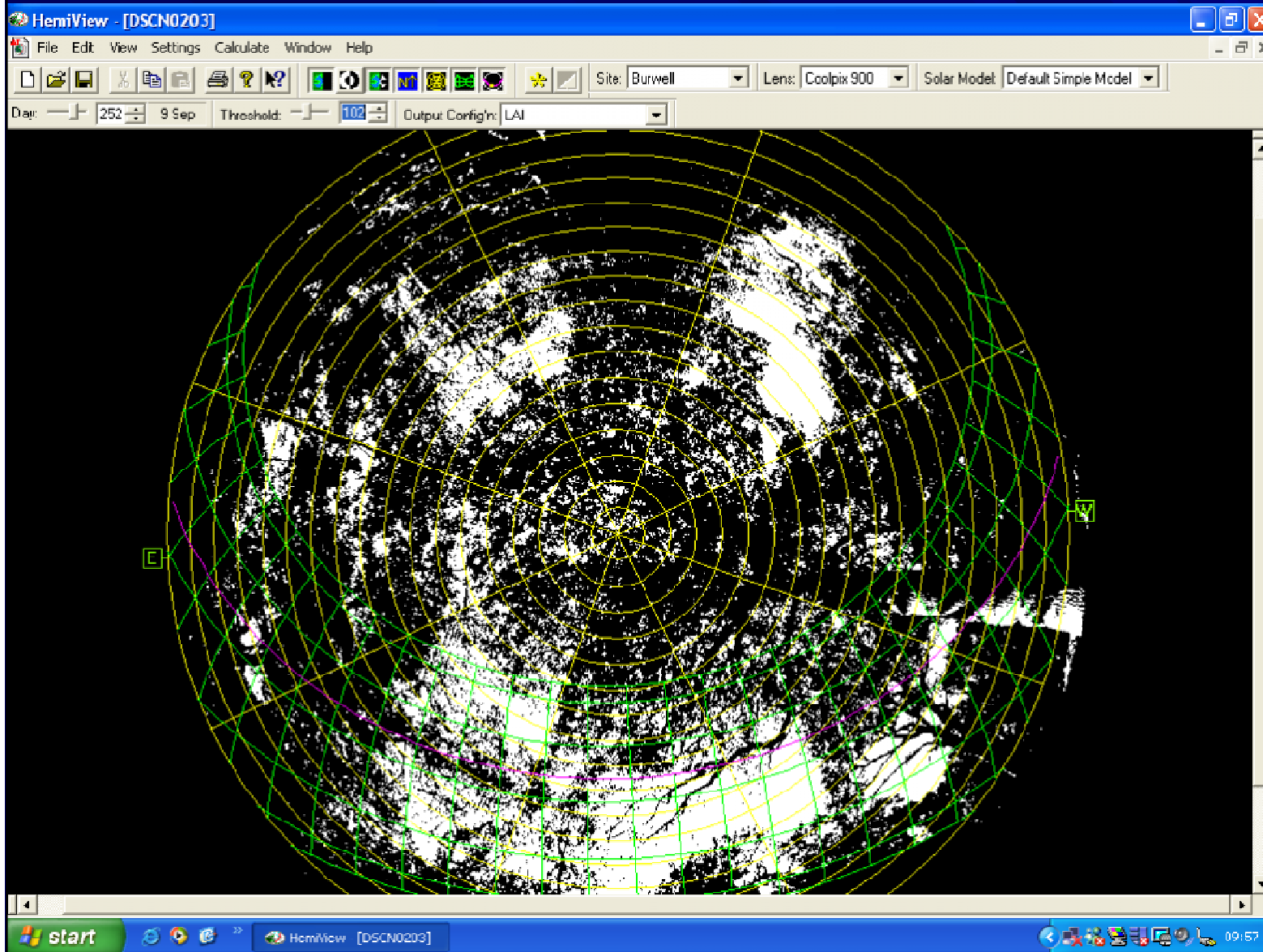
# Přístroje měřící LAI, PAR



- <http://www.waqtechprojects.com/products/agronomics/crop-science/light-measurement/plant-canopy-measurement>
- [www.zealquest.cn](http://www.zealquest.cn)

# Leaf area index

## nepřímé metody stanovení/měření



Hemisférická fotografie  
plus vyhodnocovací  
software



■ <http://www.duke.edu/~jspippen/work/face.htm>

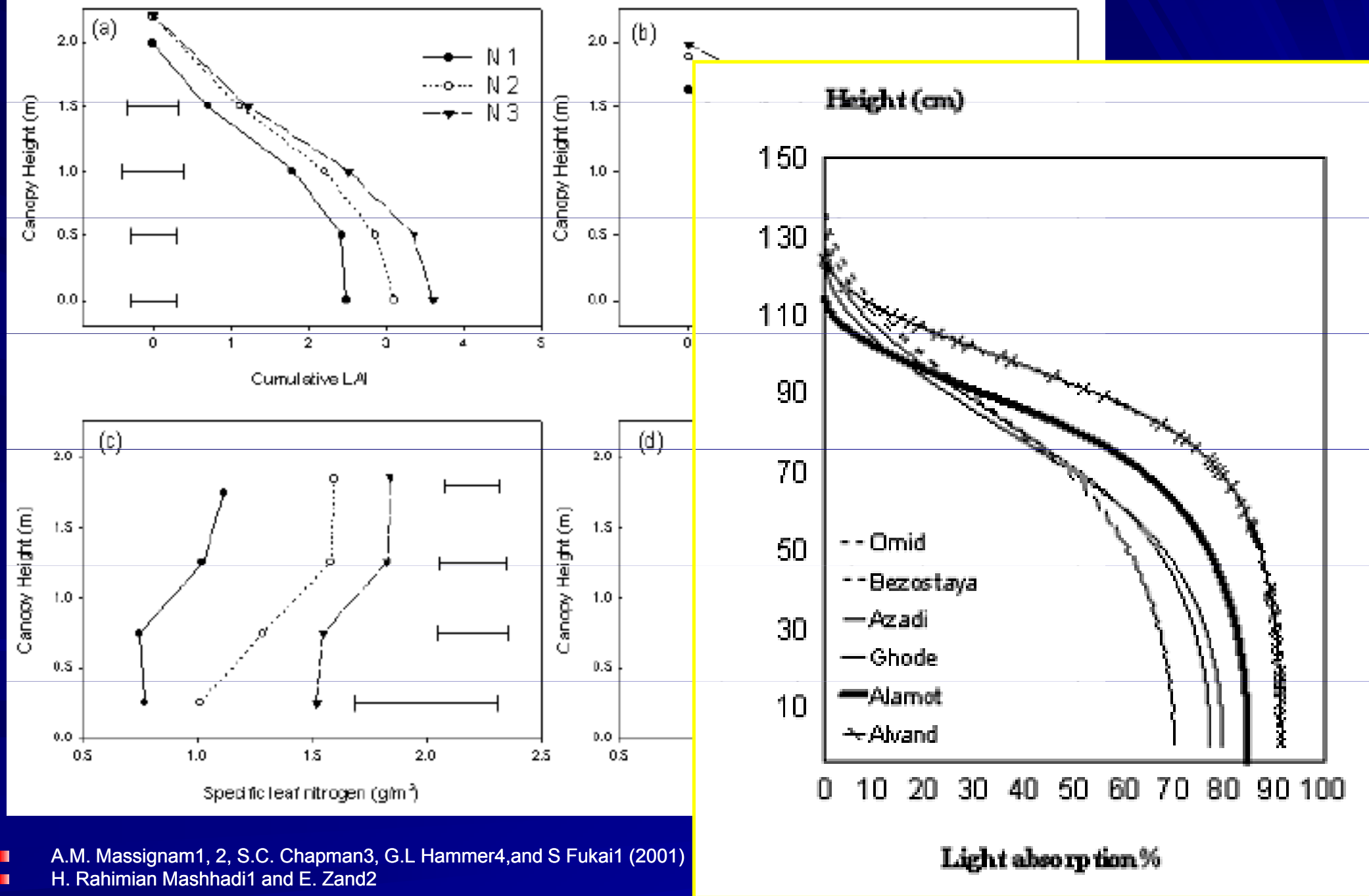


# Fotoplanimetry



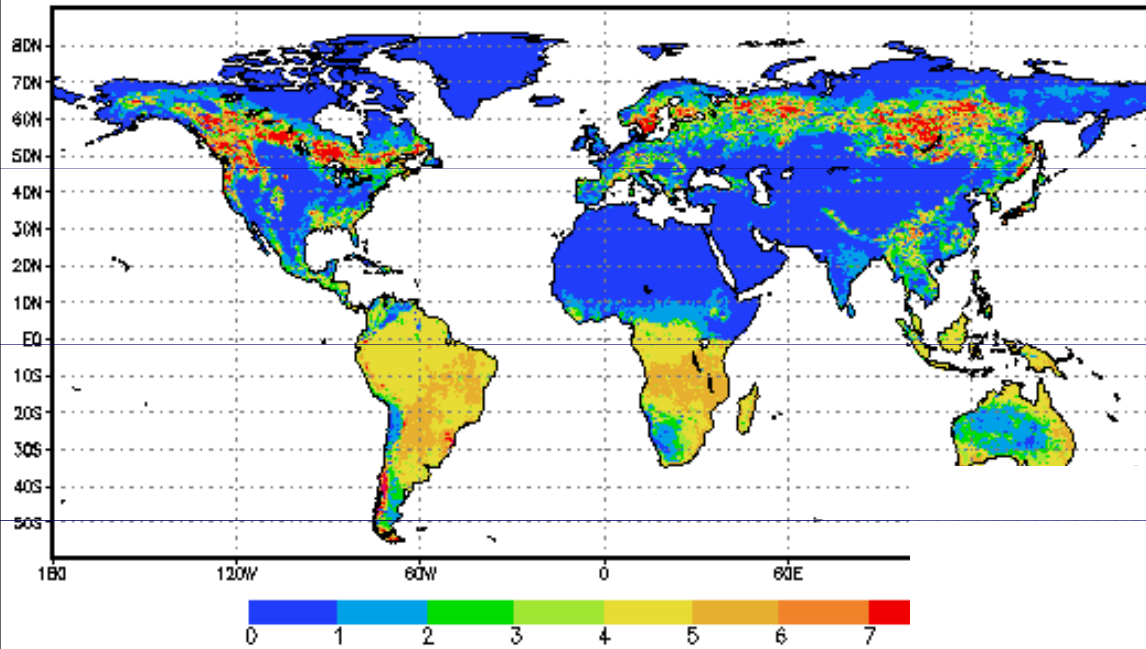
■ <http://www.uky.edu/Ag/Agronomy/Department/sbr/images/updates/ky/0709/crewRemovingLeaflets.jpg>

# Cumulative LAI

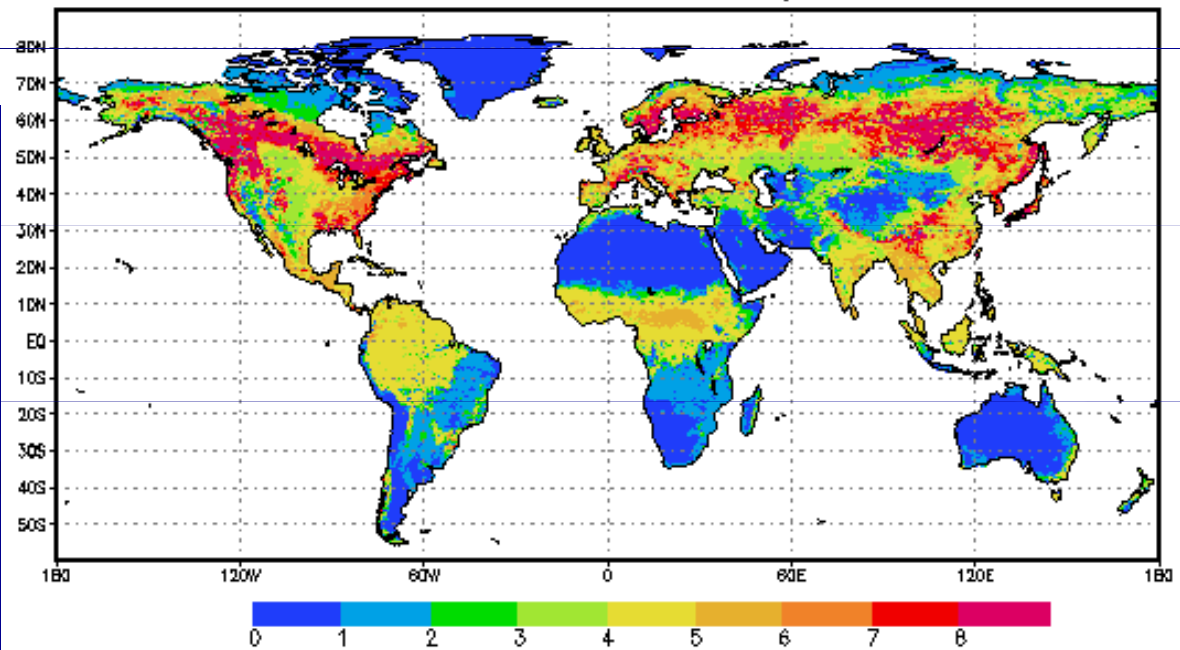


# Leaf area index

## Leaf Area Index – January



## Leaf Area Index – July

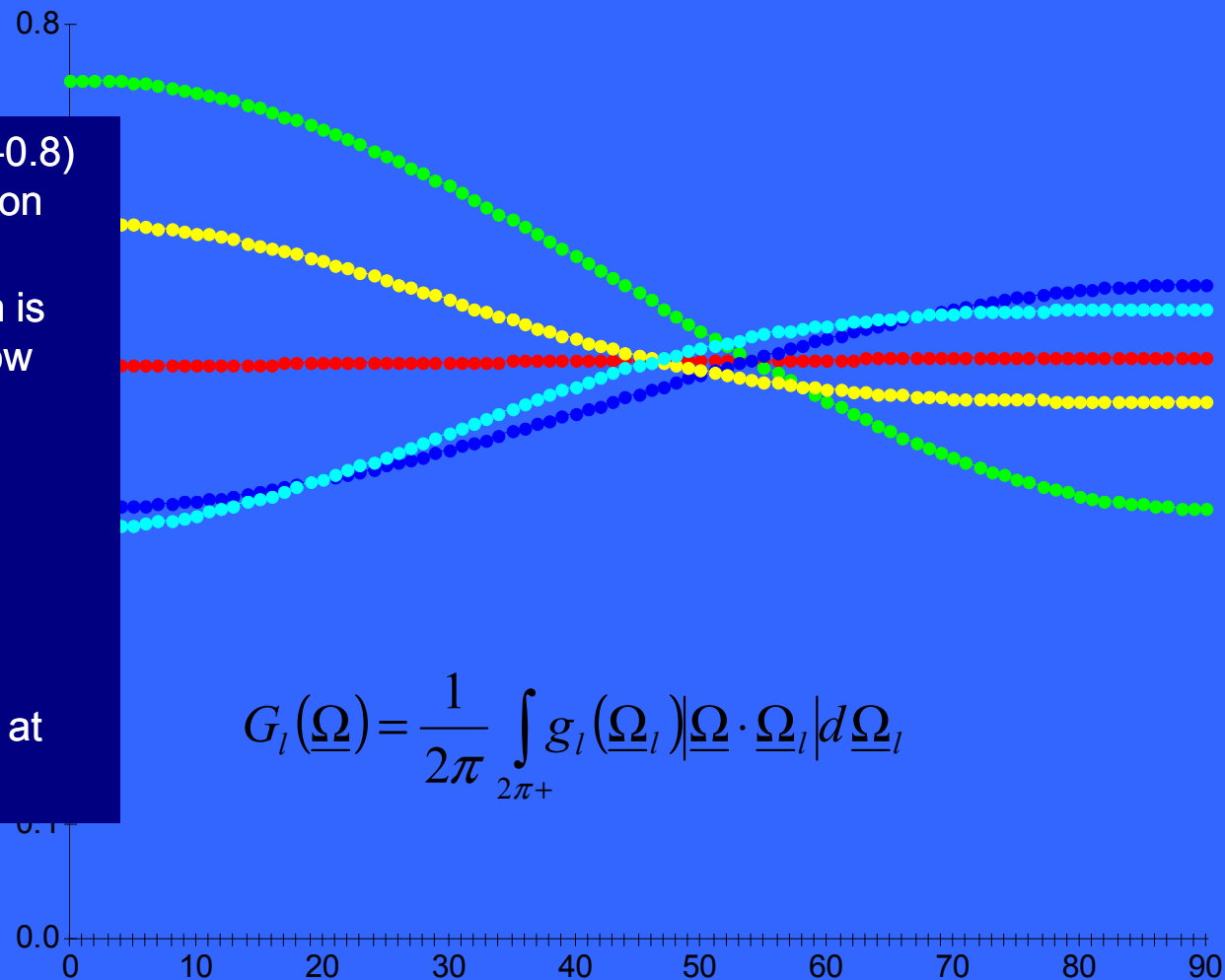


# Pojmy

- LAI      Leaf area index
- LAD      Leaf area density
  
- Light interception, Light attenuation
- Canopy profile
- LAI / LAD, LA distribution

# Optical Extinction Coefficient for Oriented Leaves

- range of G-functions small (0.3-0.8) and smoother than leaf inclination distributions;
- planophile canopies, G-function is high (>0.5) for low zenith and low (<0.5) for high zenith;
- converse true for erectophile canopies;
- G-function always close to 0.5 between 50° and 60°
- essentially invariant at 0.5 over different leaf angle distributions at 57.5°.



$$G_l(\underline{\Omega}) = \frac{1}{2\pi} \int_{2\pi^+} g_l(\underline{\Omega}_l) |\underline{\Omega} \cdot \underline{\Omega}_l| d\underline{\Omega}_l$$

- spherical
- planophile
- erectophile
- plagiophile
- extremophile



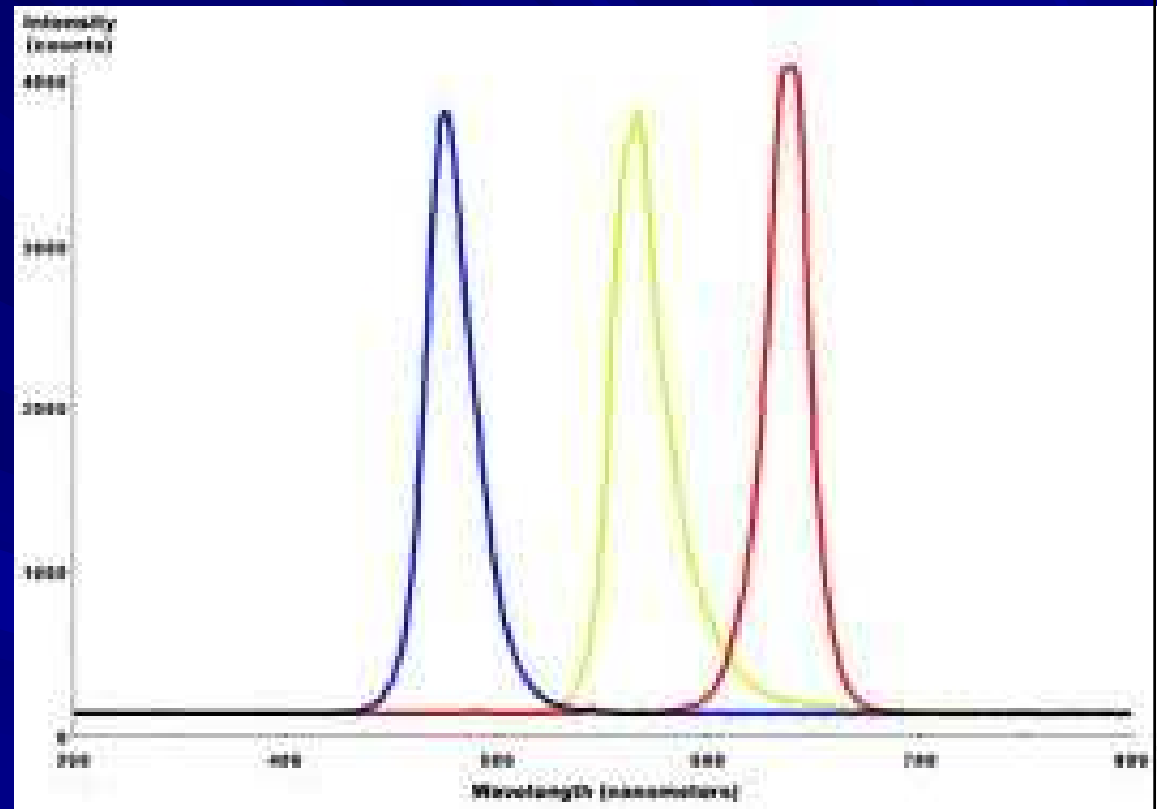
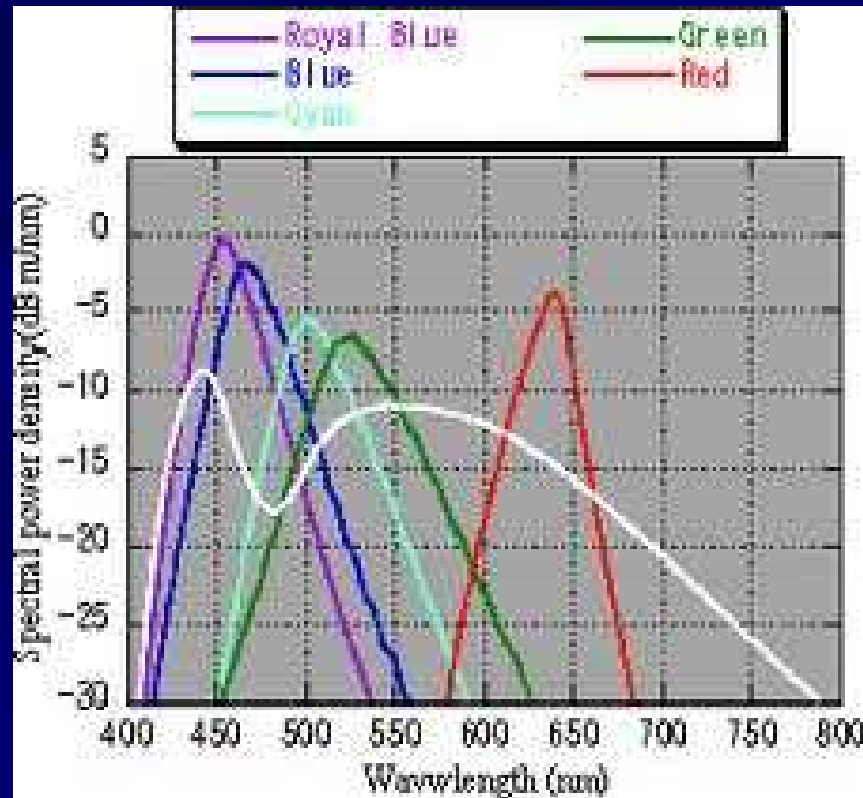
■ <http://www.duke.edu/~jspippen/work/face.htm>

# Fotoplanimetry



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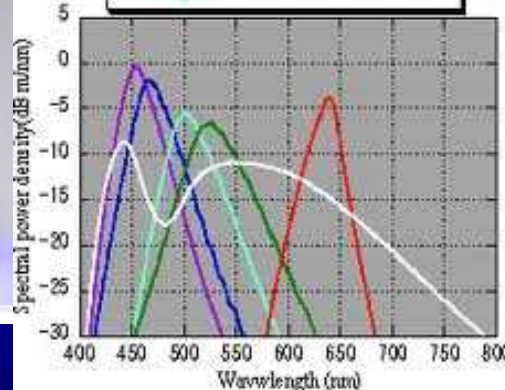
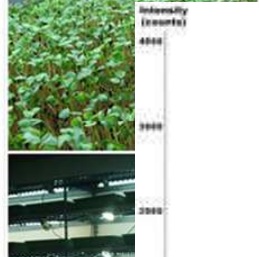
# LED jako zářivé zdroje



■ R G B



# Light sources



## Common Sources of Visible Light

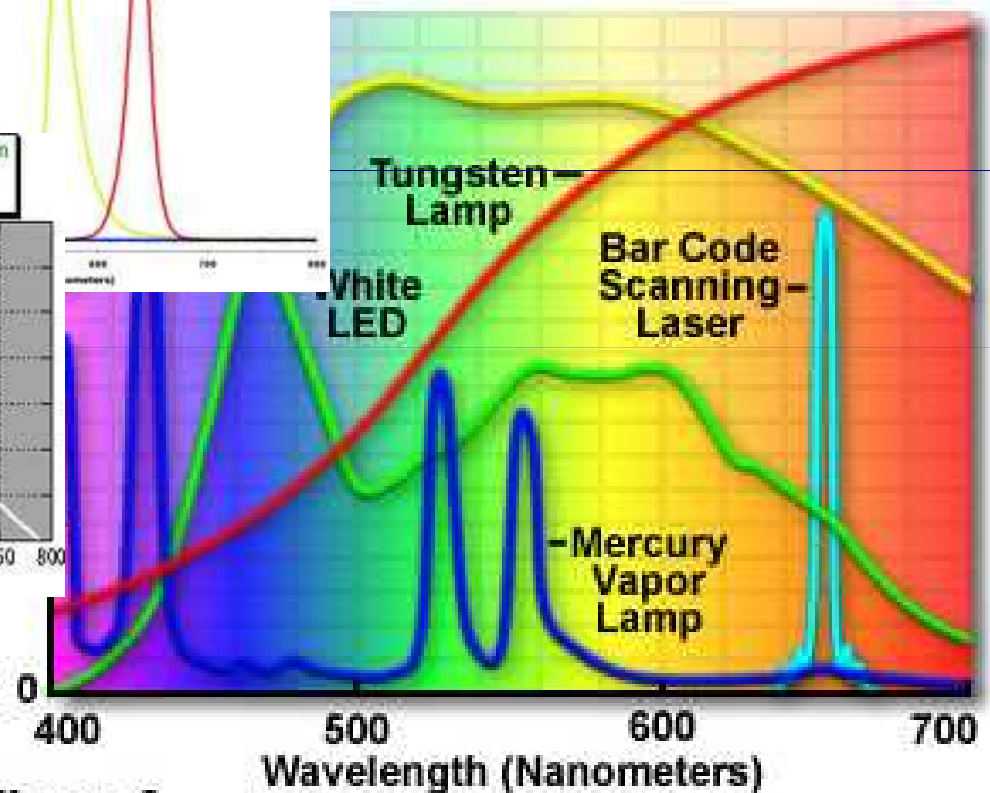


Figure 3

- <http://www.jsitek.com/eng/bichury.php>
- <http://www.growthtechnology.com/lightwave-T5.asp>
- <http://intiridesigns.com/articles/color.php>

# Sluneční záření

- Solární konstanta =  $1.36 \text{ kW/m}^2$  [ $\text{kJ/m}^2.\text{s}$ ]

**Table 1.6.** Effect of radiation on plant life. (Ross 1981)

Spectral region	Wavelength (nm)	Percent of solar radiant energy	Photo-synthetic	Effects of radiation		
				Photo-morpho-genetic	Photo-destruc-tive	Thermal
Ultraviolet	290 – 380	0 – 4	Insignifi-cant	Slight	Signifi-cant	Insignifi-cant
Photosynthetically active range (PhAR)	380 – 710	21 – 46 <sup>a</sup>	Signifi-cant	Signifi-cant	Slight	Significant
Infrared	750 – 4000	50 – 79 <sup>a</sup>	Insignifi-cant	Signifi-cant	Insignifi-cant	Significant
Longwave radiation	4000 – 100 000		Insignifi-cant	Insignifi-cant	Insignifi-cant	Significant

<sup>a</sup> Depending on position of sun and degree of cloud cover.

