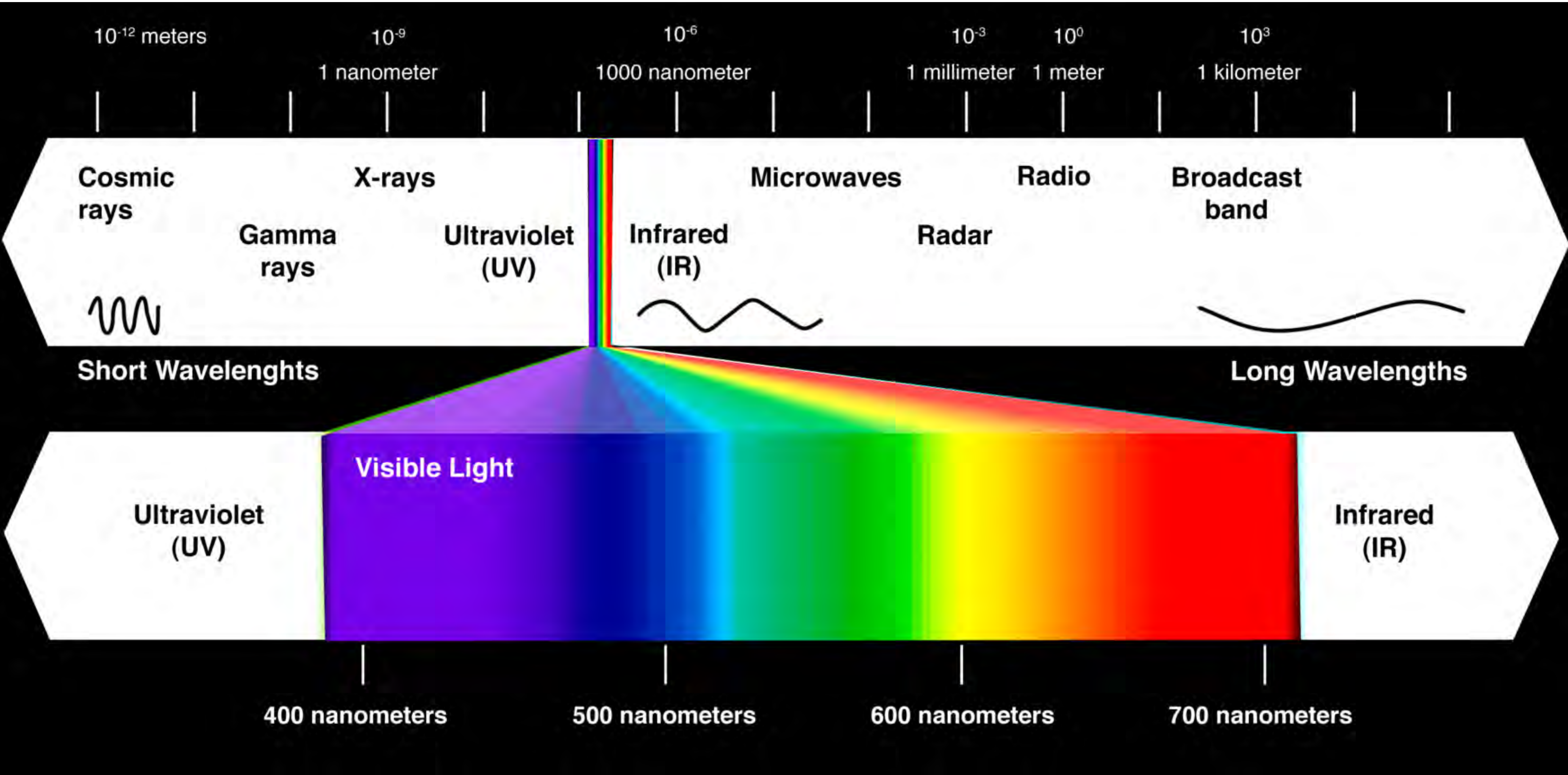
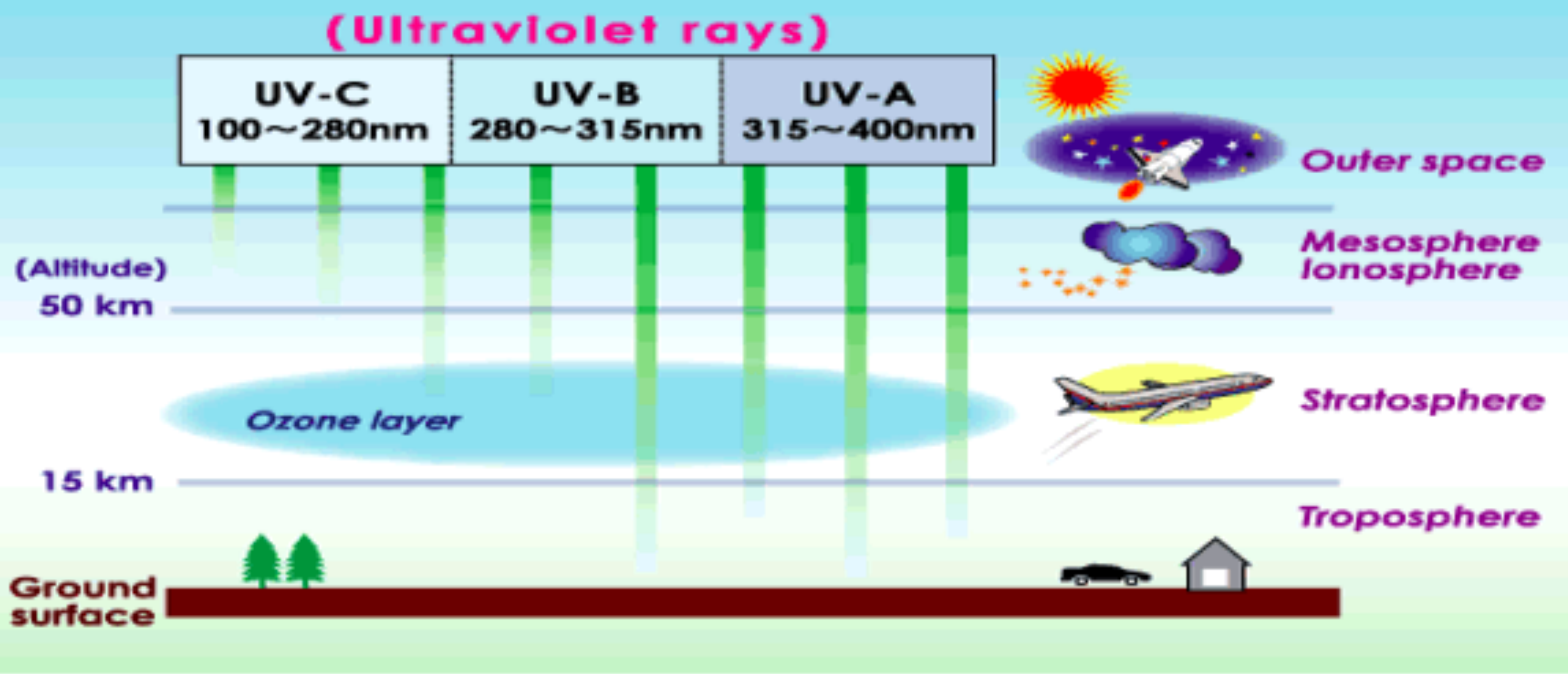
Light spectrum



Ultraviolet light (photons)

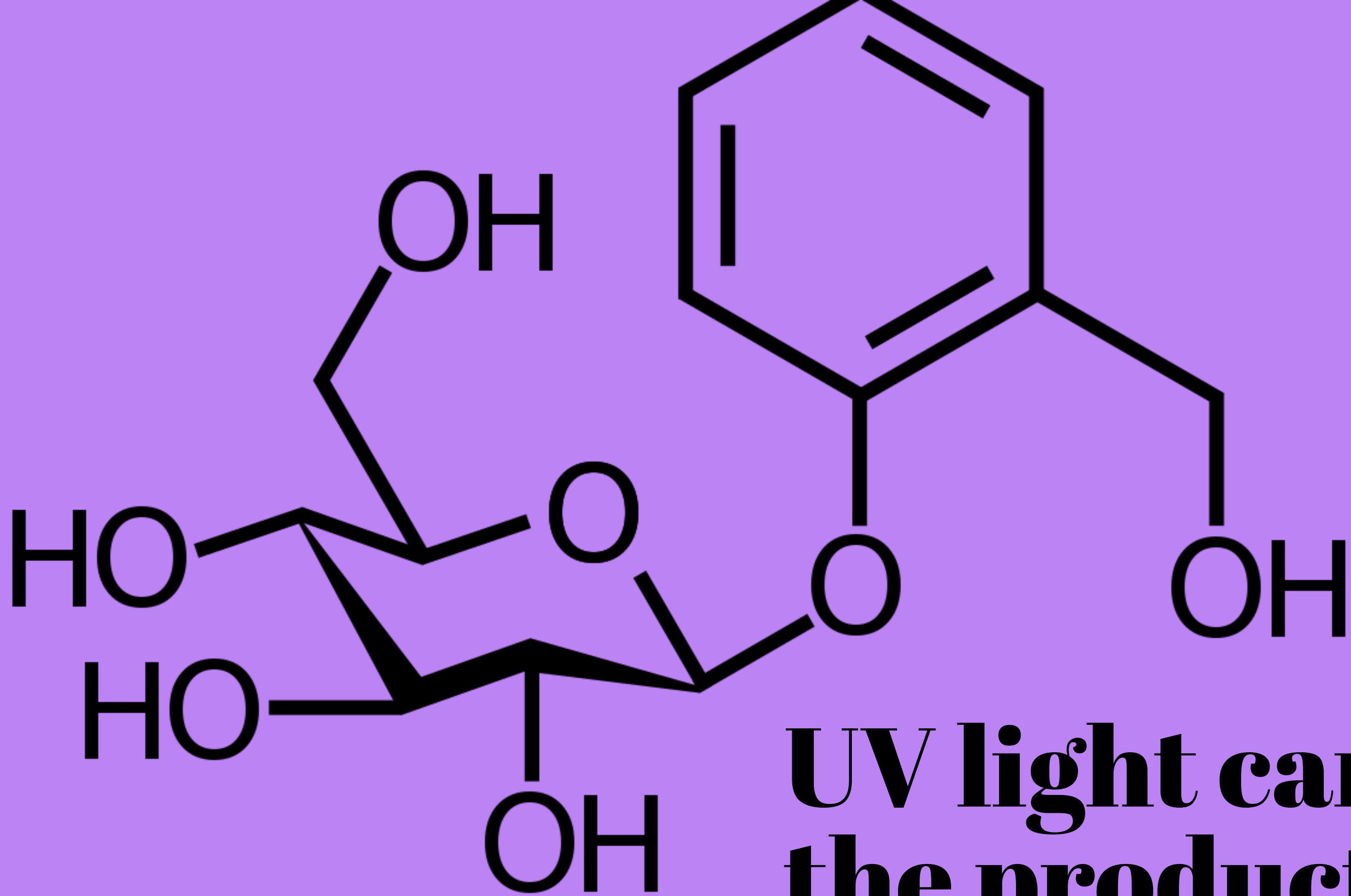
They're 3 types Of UV Light UV-C, UV-A & UV-B they cover the 100nm-400nm portion of the light spectrum



UV-C never makes it past the Ozone layer.

Wavelength (nm)		Effect on Plant Growth
Ultra-violet	280	Significantly reduces photosynthetic rates and quantum yield.[1,2]
	315~400	Thickens plant leaves and promotes pigmentation. May be used to prevent harmful insects.

When plants are hit with ultraviolet light, this event triggers the plant's defense mechanisms. The plant then becomes more resistant to insect attacks.



UV light can increase the production of plant compounds like glycosides, which can make a plant smell and taste better.

Blue light (photons) is the most critical frequency range of the visible light spectrum for plants. A photoreceptive molecule called chlorophyll absorbs photons from blue light and uses that energy to drive photosynthesis.

Wavelength (nm)	Effect on Plant Growth
440~470	Chlorophyll absorption peaks at 439nm and 469nm. The blue spectrum is the most efficiently absorbed spectrum, promoting mainly vegetative growth.

A plant will always grow towards blue light, if the blue light isn't strong enough the plant puts all it's energy to its stem to try and get closer to the blue light, this is how you get long leggy plants.

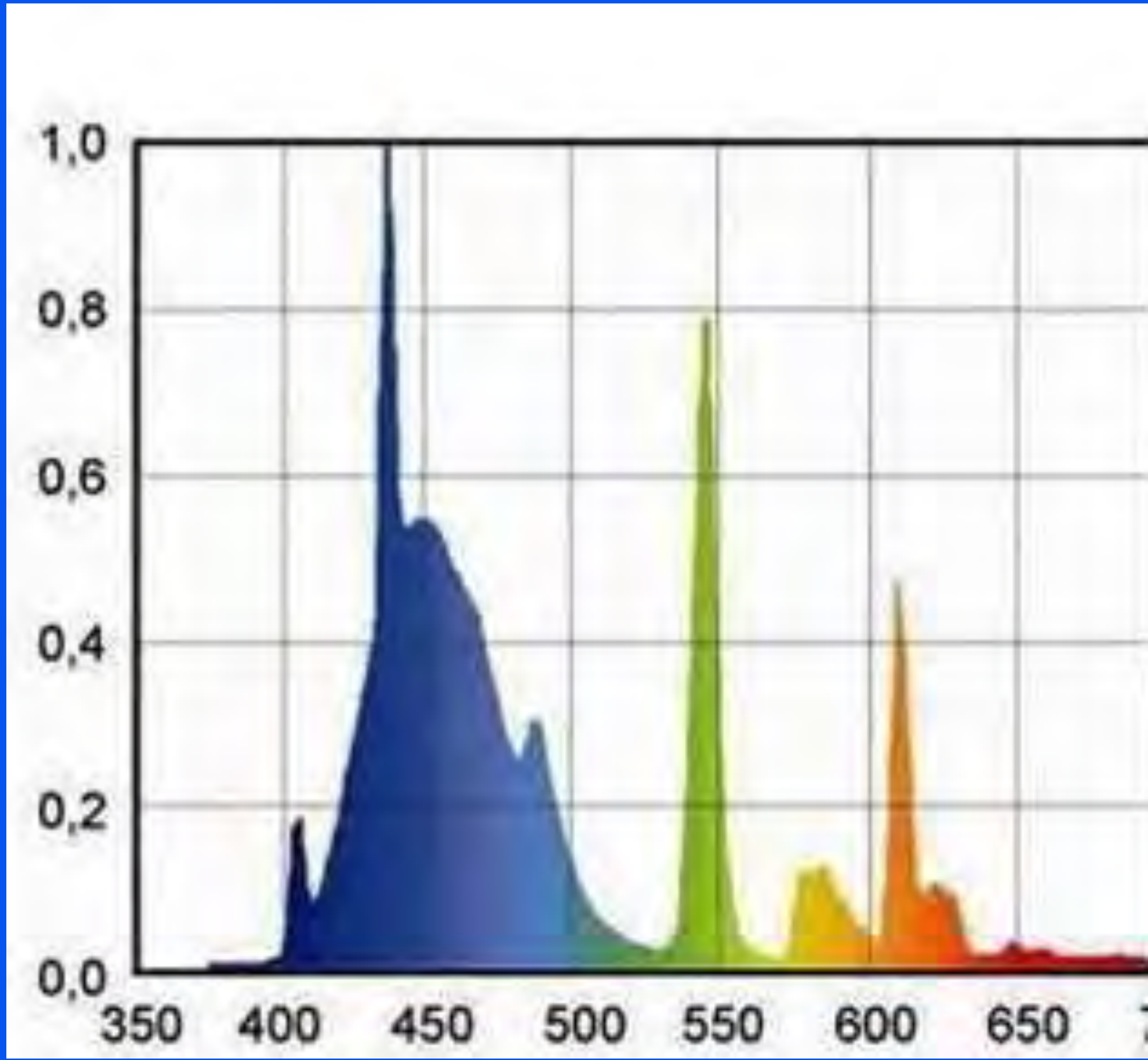
Salvia 'Vista Red'

Seedlings grown indoors at 68 °F for 4 weeks under LEDs for 18 hours/day at PPFD=160 $\mu mol \cdot m^{-2} \cdot s^{-1}$ consisting of (%):

Percentage of Blue Light:

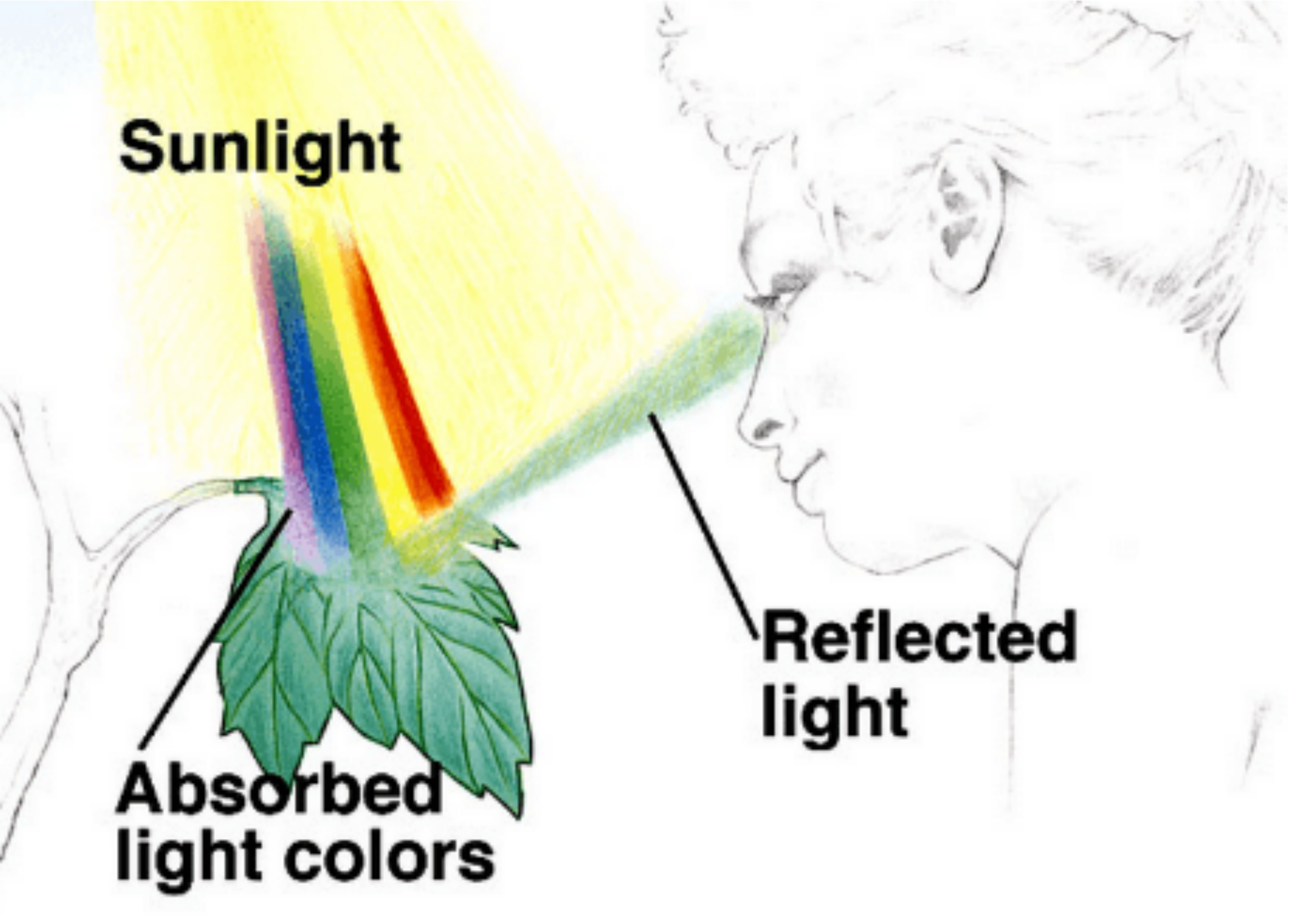
B=blue LED peak=446 nm; R=red LEDs peaks=634 and 664 nm

T-5 Florescent bulbs are perfect for young seedlings because the blue light is dominant in the light spectrum.



Green-Yellow Photons (500-599nm)

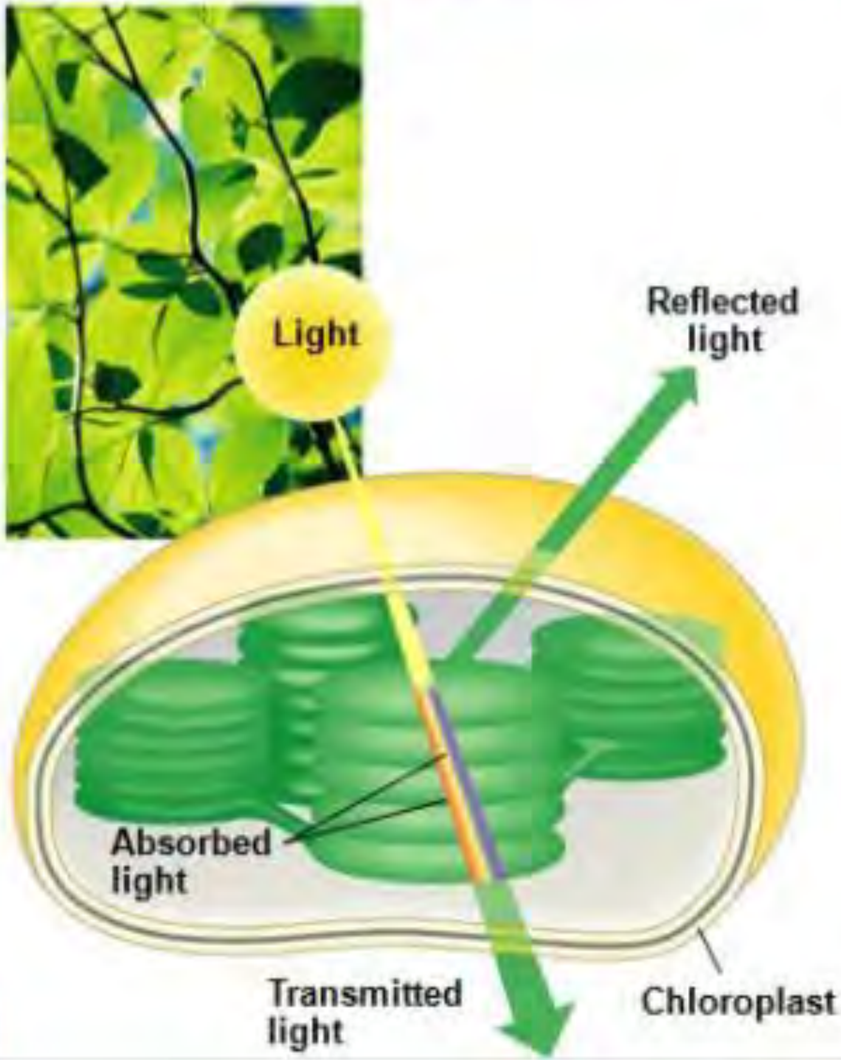
- Provide the least amount of growth per photon
- Provide the best penetration for intra-canopy growth
- Enable visual health assessment


Sunlight
Reflected light
Absorbed light colors

Why Are Plants Seen As Green?

Chlorophylls:

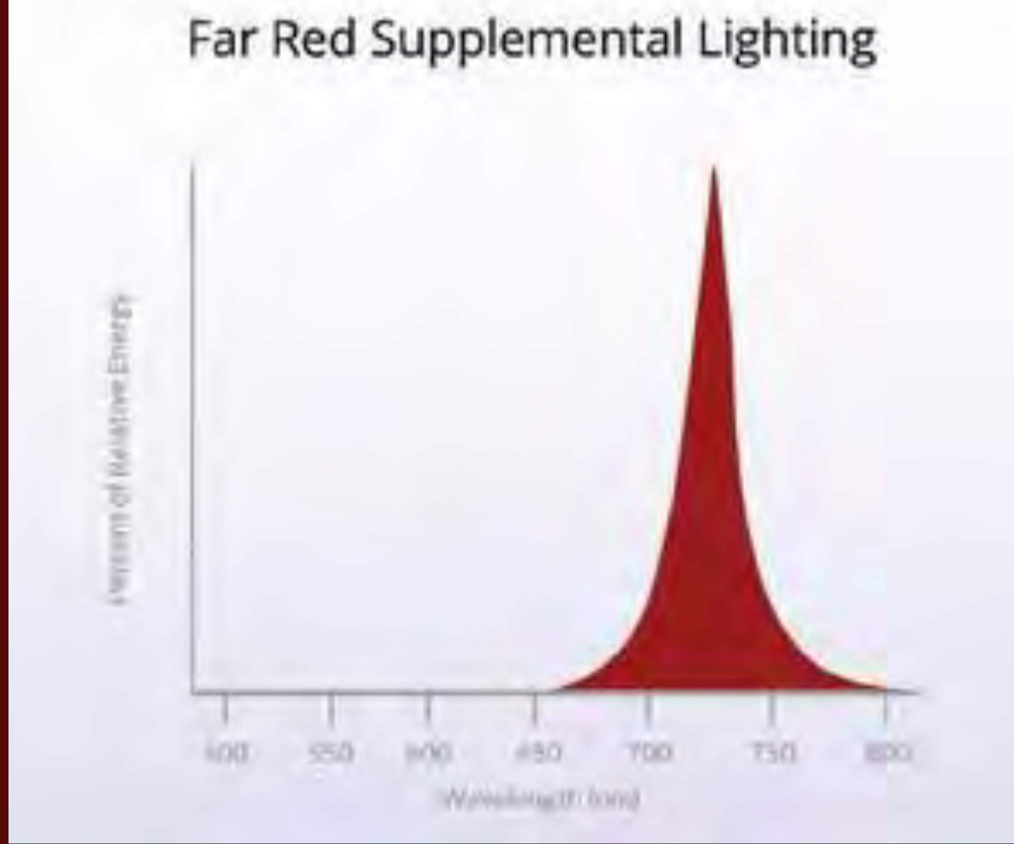
- ✓ Absorb blue and red light while reflect green light
- ✓ Blue and red light:
  - Effectiveness colors to stimulate photosynthesis



Wavelength (nm)	Effect on Plant Growth
640~660	Chlorophyll absorption peaks at 642nm and 667nm. Speeds up seed germination and flower/bud onset. 660nm is the most vital wavelength for flowering.

Red light between 640nm and 660nm produce the most chlorophyll production, with all the chlorophyll production your plant has enough energy to go into to flower, some plants take a combination of high chlorophyll production and a light cycle change to promote flowering.

Far Red Light, This light falls between 710nm & 850nm just before infrared light.



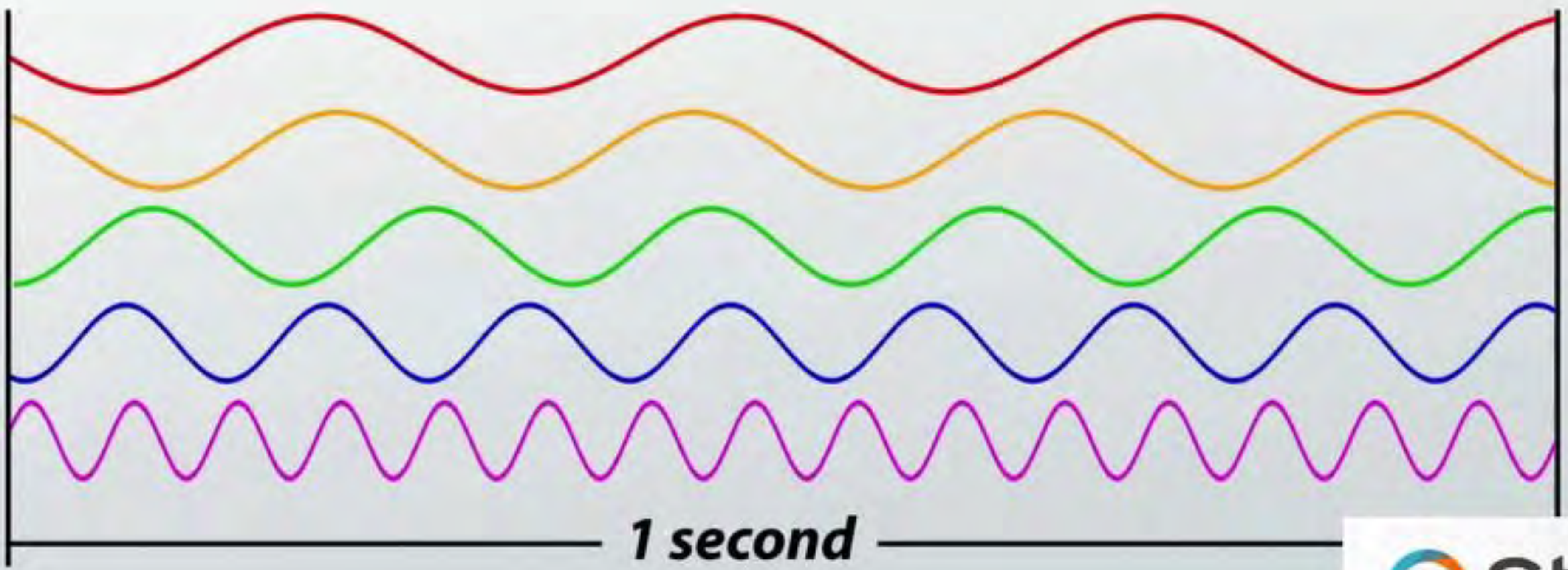
In shady locations you'll find higher levels of far red light so when plants are supplemented FRL they believe they're in a shady location and are at risk of dieing so the plants naturally response is to flower and reproduce as fast as possible, it is for this reason FRL is supplemented when you put your plants into flower, you'll see more blossoms....

After flowing turn off the FRL or the fruit will ripen prematurely.

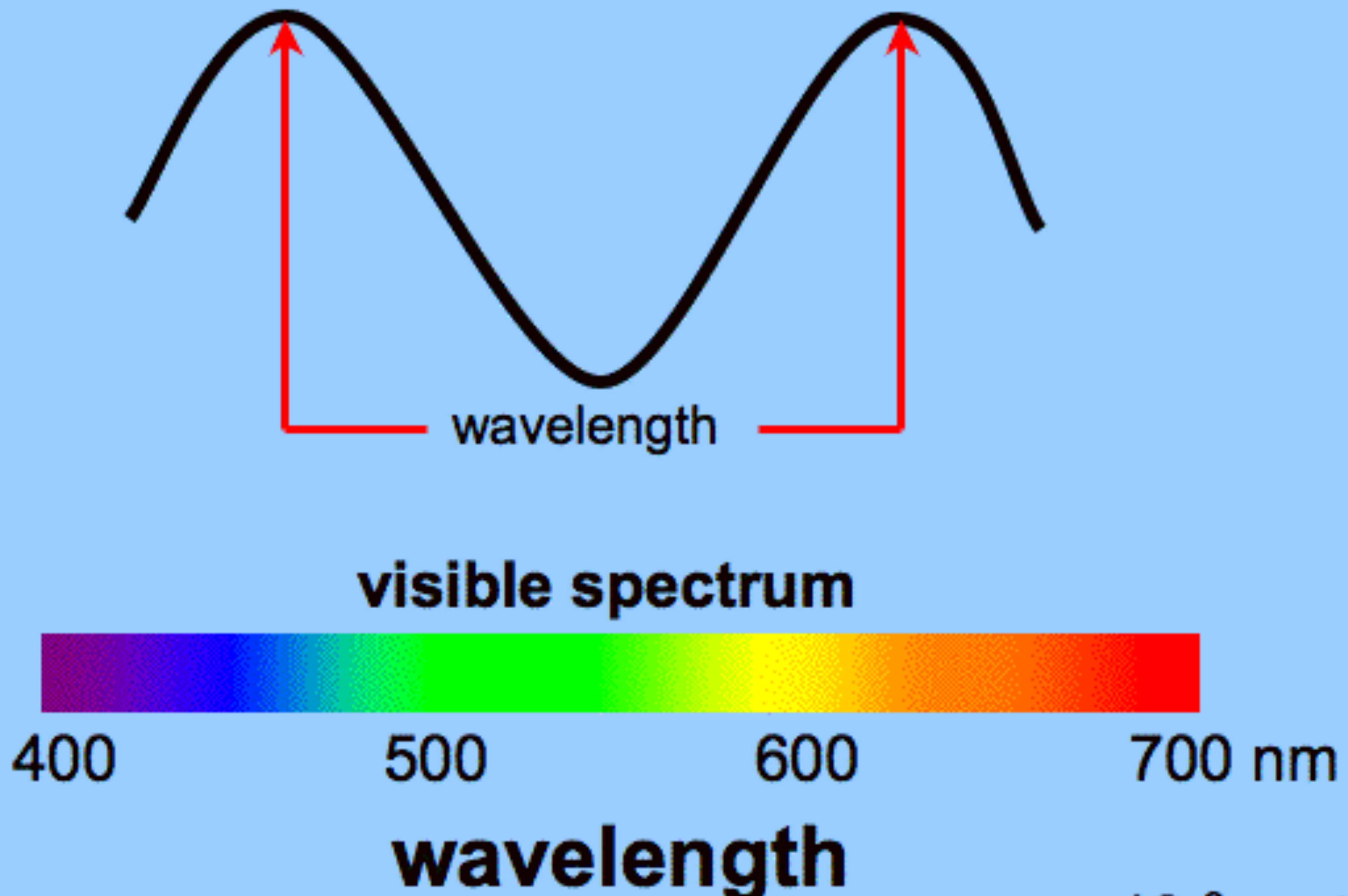
If FRL is added to seeds that are sowed in the ground the percentage of the seeds successfully germinating decreases because the seed believes it's in the shade, the seed won't germinate because there's not enough light to sustain the seedlings growth, however if red light is presented to seeds of certain species the percentage of germination actually increases because red light tell the seedling it's in the sun and has a good chance at life.

KEY PROPERTIES OF LIGHT

Hertz (Hz)

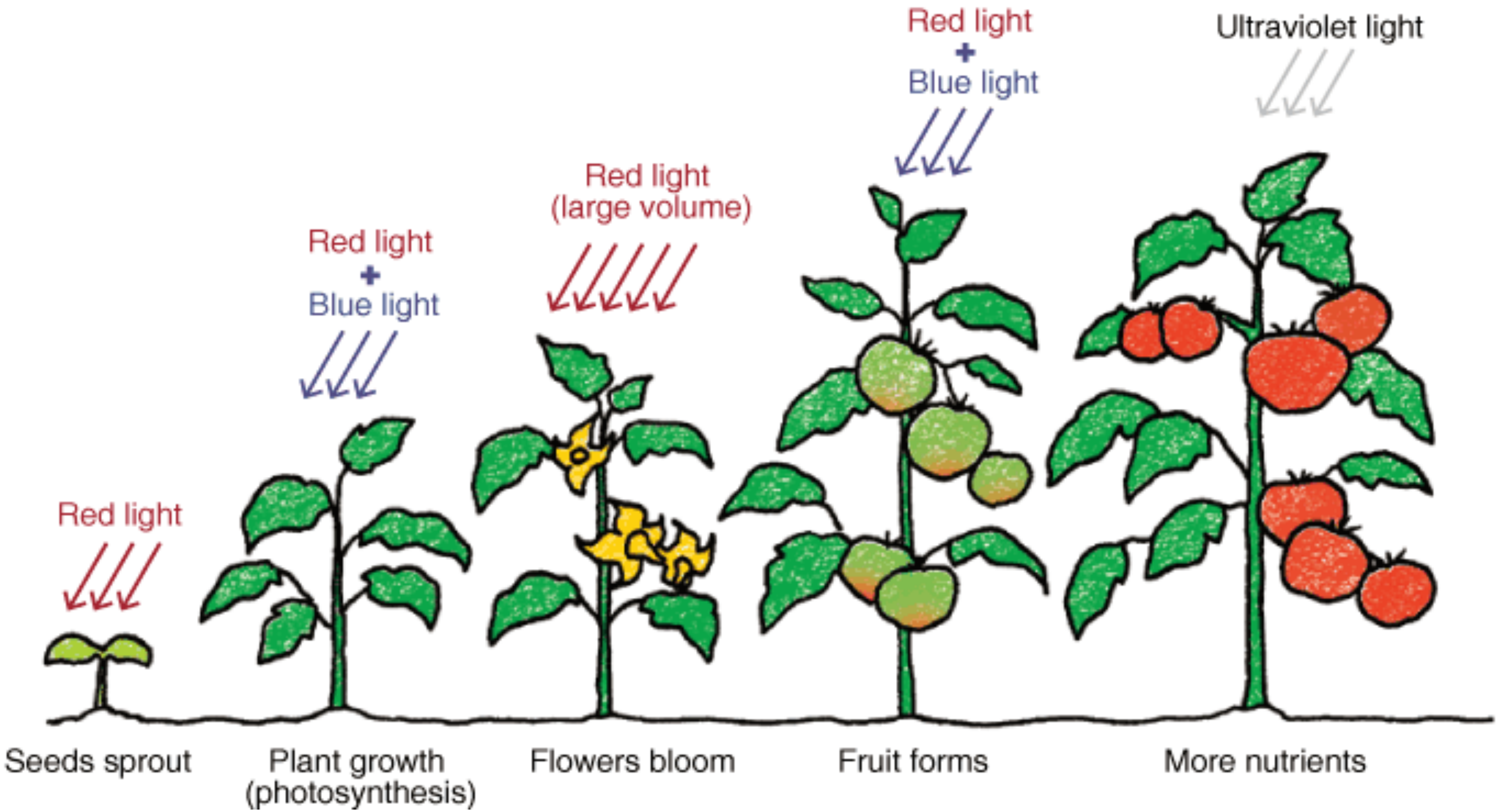


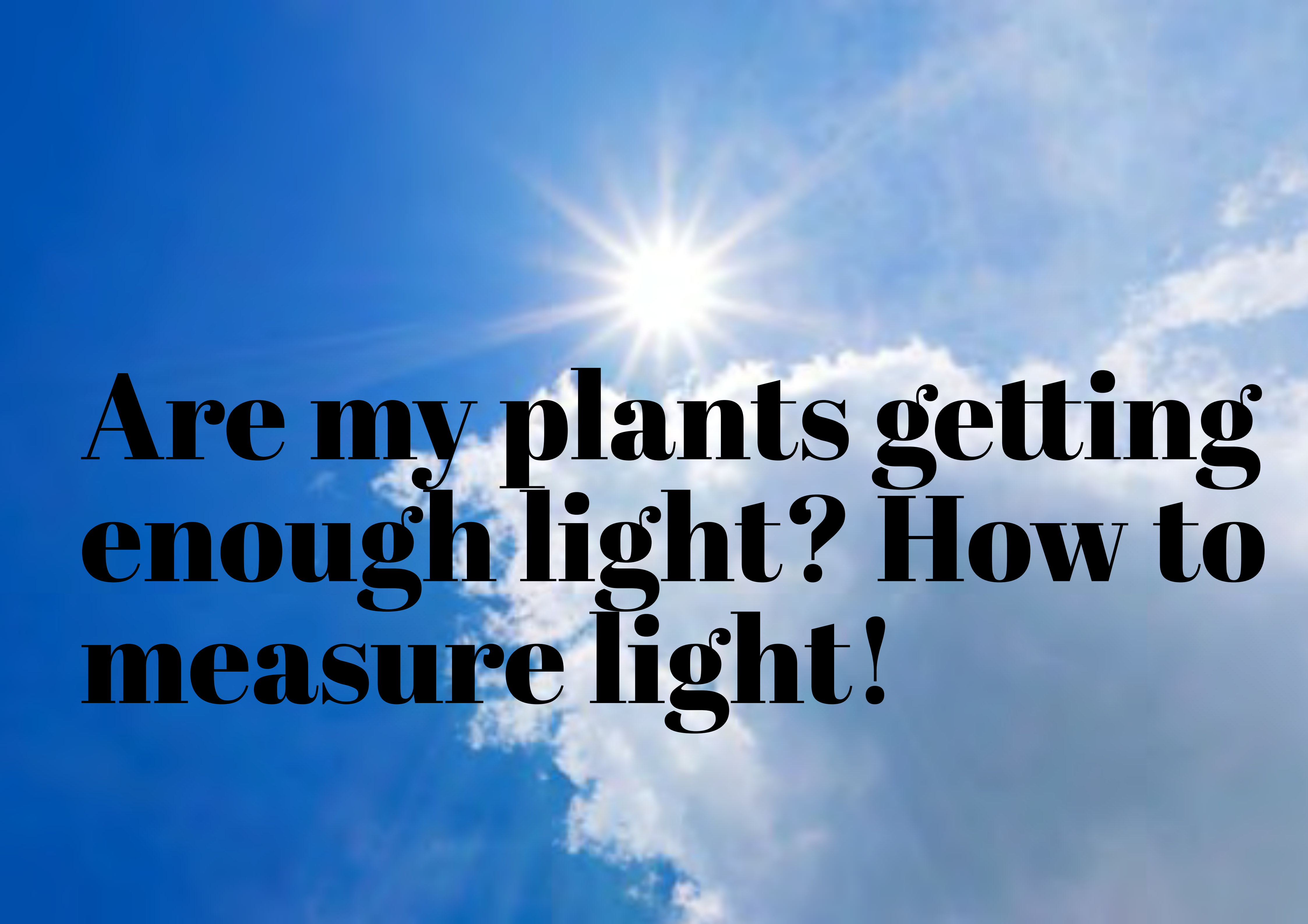
Light: An Energy Waveform With Particle Properties Too

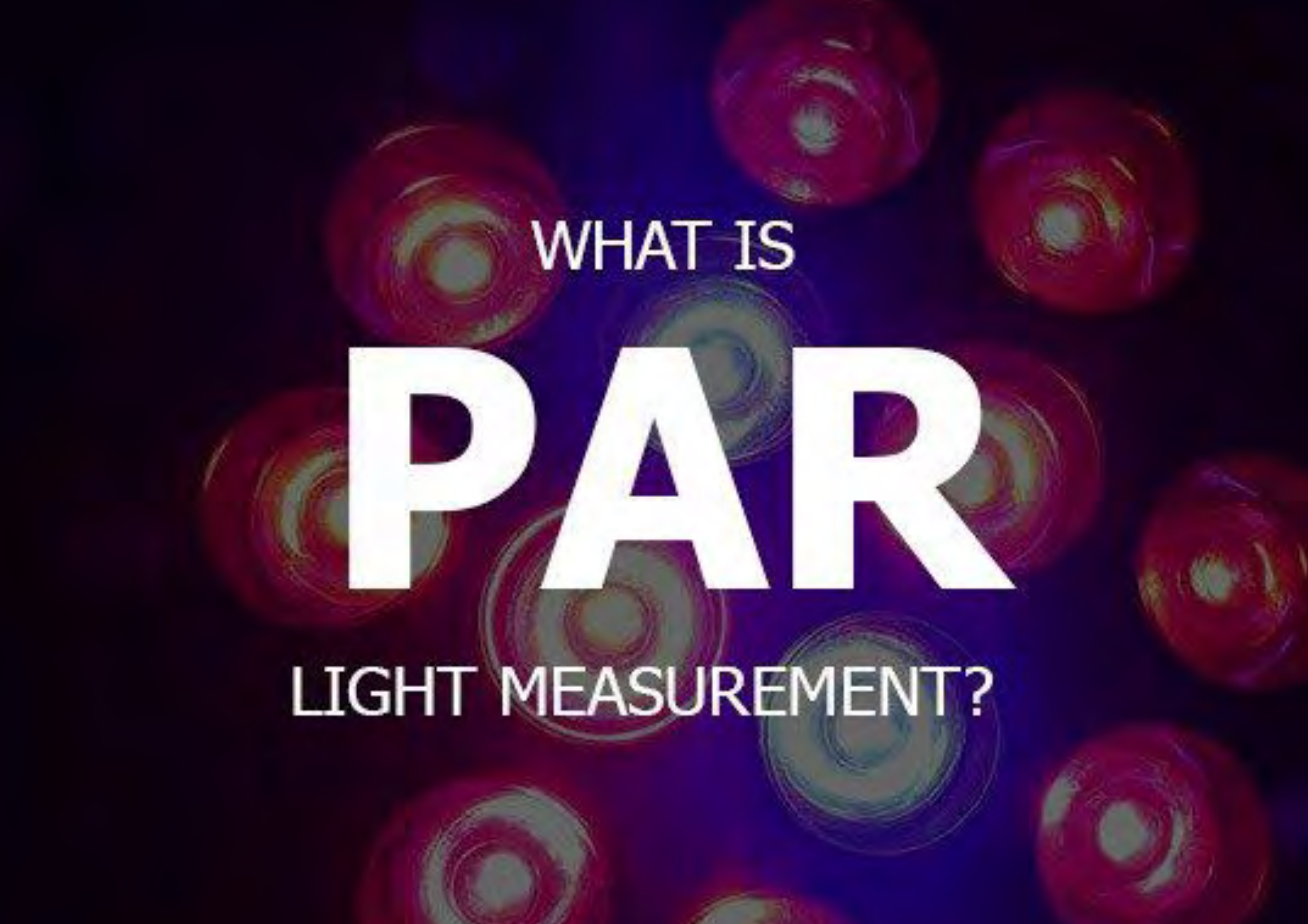


10^{-9} meter

0.000000001 meter!


Red light
Red light
+
Blue light
Red light
(large volume)
Red light
+
Blue light
Ultraviolet light
Seeds sprout
Plant growth
(photosynthesis)
Flowers bloom
Fruit forms
More nutrients


Are my plants getting enough light? How to measure light!


WHAT IS
PAR
LIGHT MEASUREMENT?

Photosynthetically Active Radiation (PAR) is the light waves from 400nm to 700nm this is the light you plant uses for most of it's photosynthesis.

photosynthetic photon flux density (PPFD) is the measure of photons in the 400nm to 700nm light spectrum that fall on a meter square per second, this is your flow of light (umol's)

PAR meters like this one measure in umol's

Now that you know the flow (umol's) you can figure out the total quantity being delivered to your plant (mol's) 1,000,000 umol's = 1 mol

Example 1

I have a pepper plant that needs 30 mol's of light per day to reach full photosynthesis, I set a led light up over top my pepper plant, I check the umol's with my PAR meter.....300 umol's per second! Let's figure how many that is per hour..
300 umol's x 60 seconds x 60 minutes = 1,080,000 umol's!
Divide your umol's by 1,000,000 to get how many mol's your plant received....1.08 mol's, so if I left that light on for 24 straight hours my pepper plant will receive 25.92 mol's (not enough to reach my plants full photosynthesis potential)

Example 2

I have a green led light set up over my pepper plant, this time I lower my light and my PAR meter now reads 500 umol's that gives me 1.8 mol's per hour, I can achieve full photosynthesis in theory in 16.5 hours..... but my plant ends up not looking so good and has very little yield....WHY?

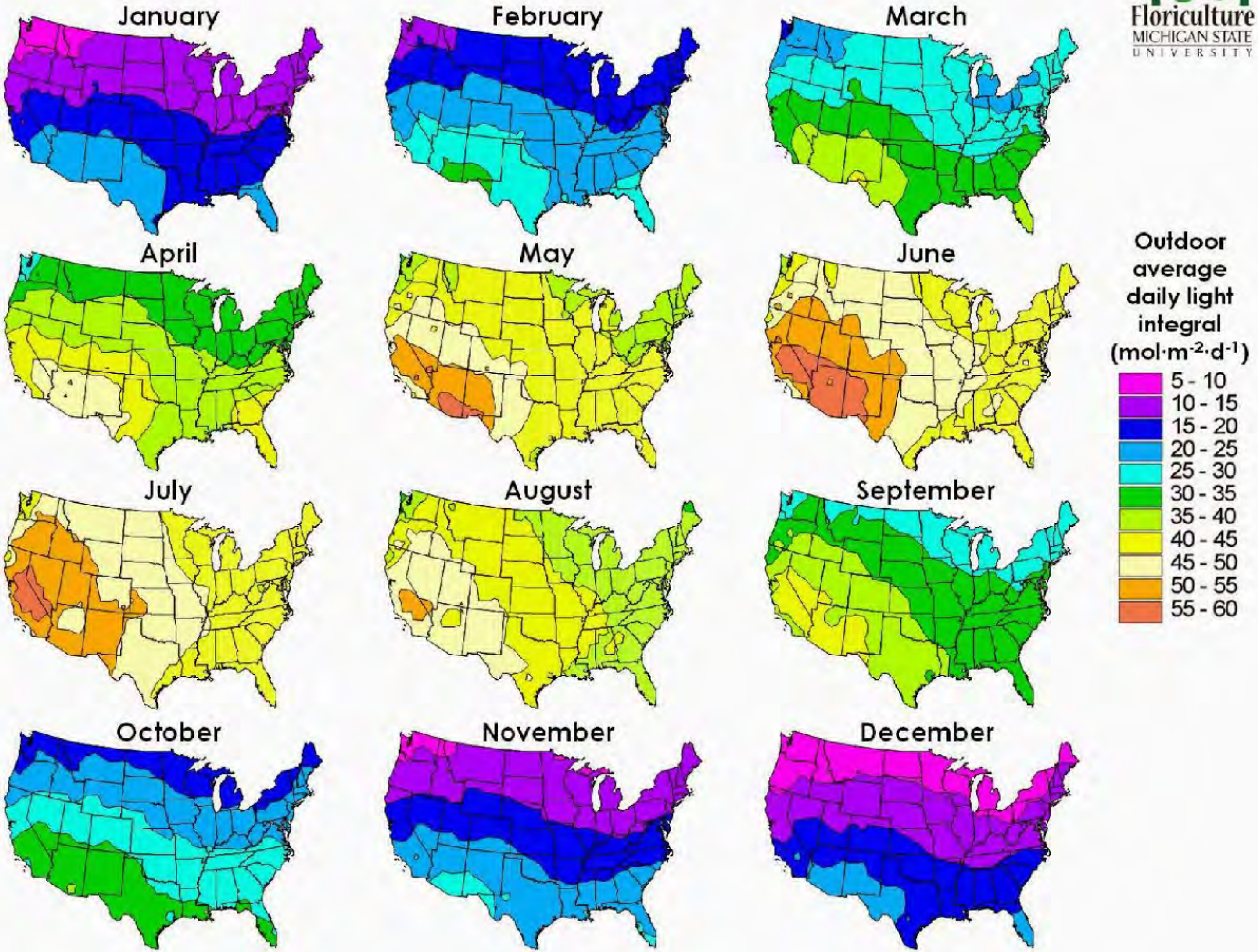
Example 3

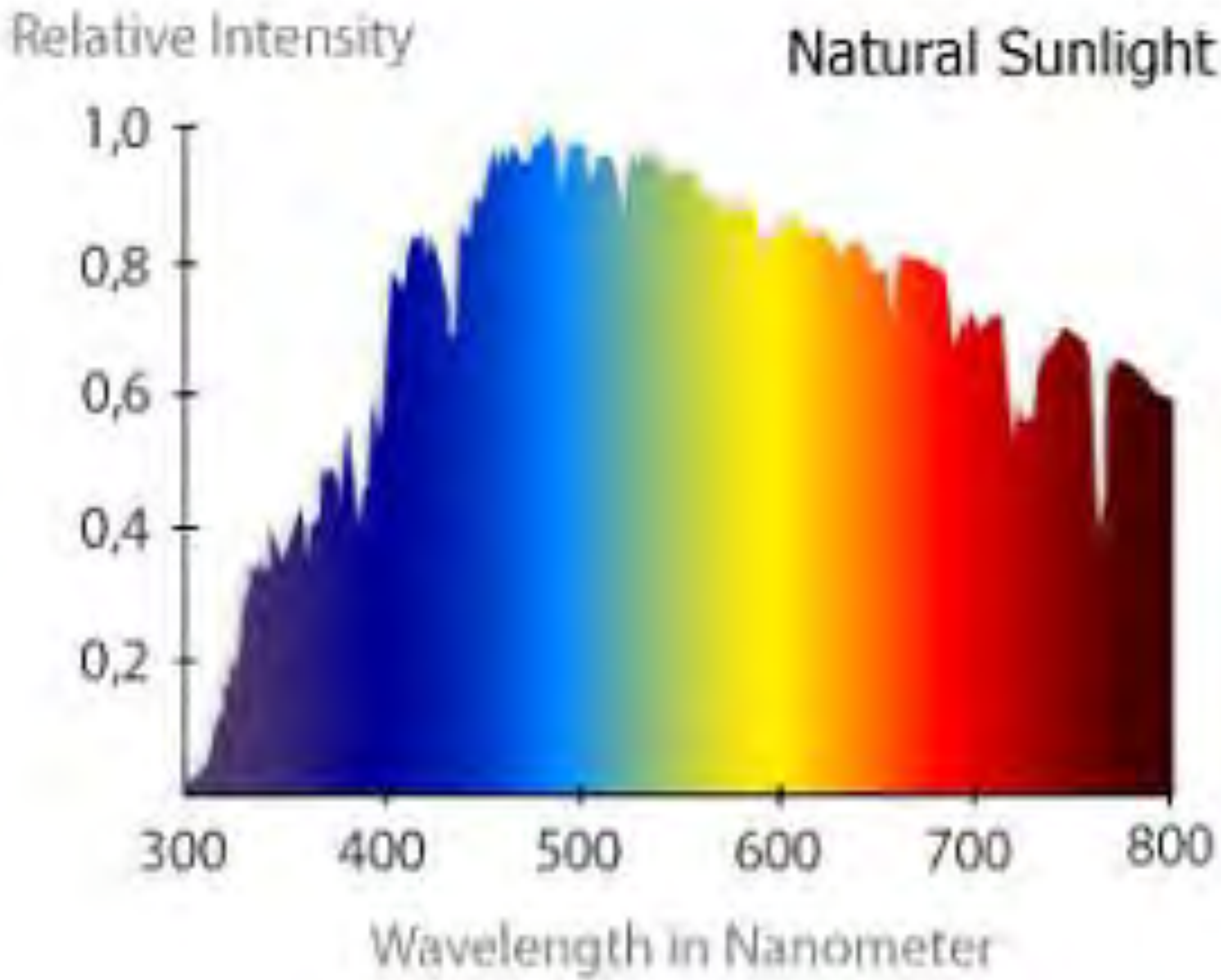
After my failed pepper plant with the green light I invest in a grow LED light that has a favorable amount of light in the blue and red spectrum, I set up my lights so I'm giving my plants 500 umol's per second and achieve full photosynthesis in 16 hours... my plant looks great! Towards the end of flower I introduce a UV-A light to my spectrum to enhance the flavor of my peppers....

Outdoor Daily Light Integral (DLI) Maps

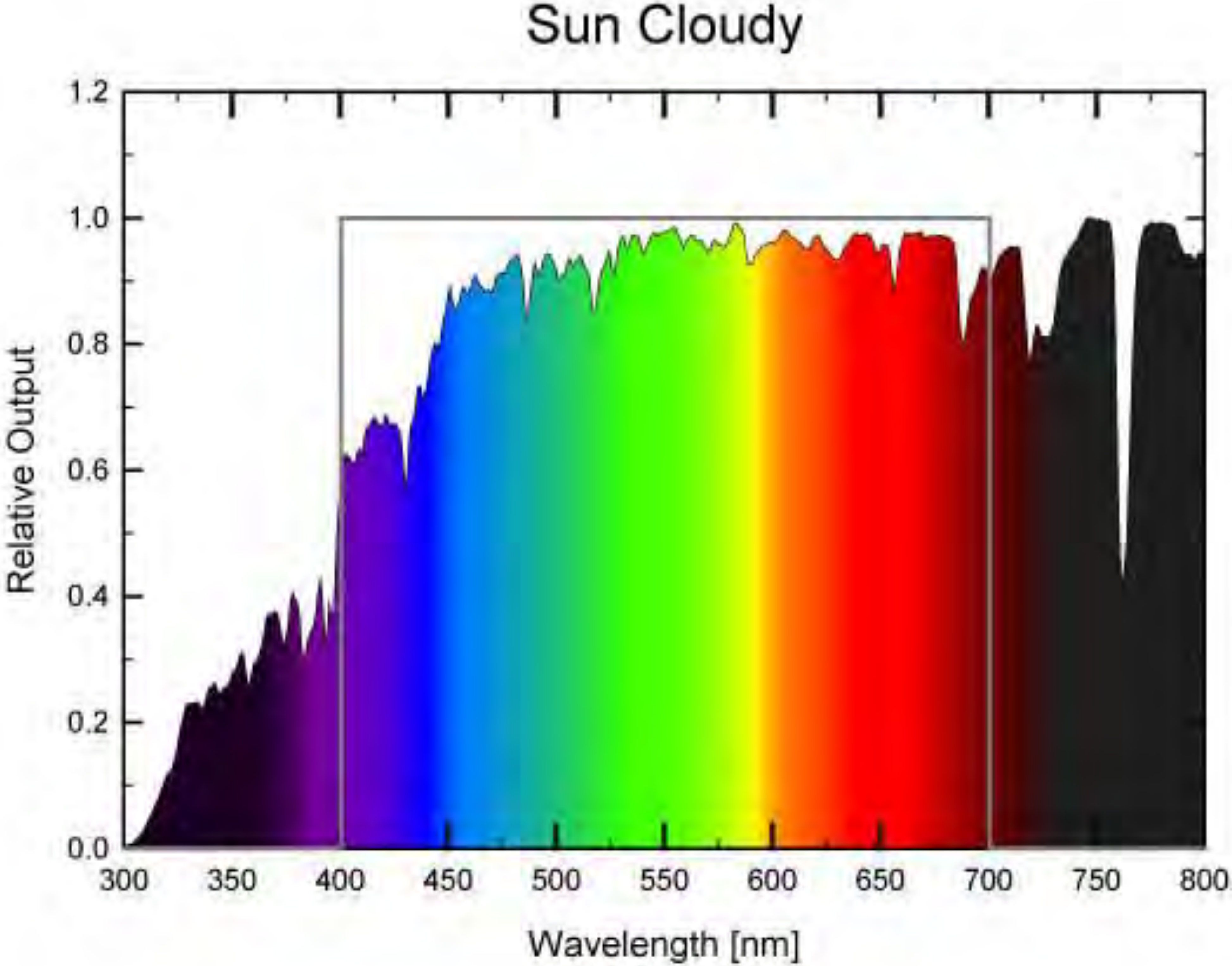
developed by Jim Faust, Clemson University

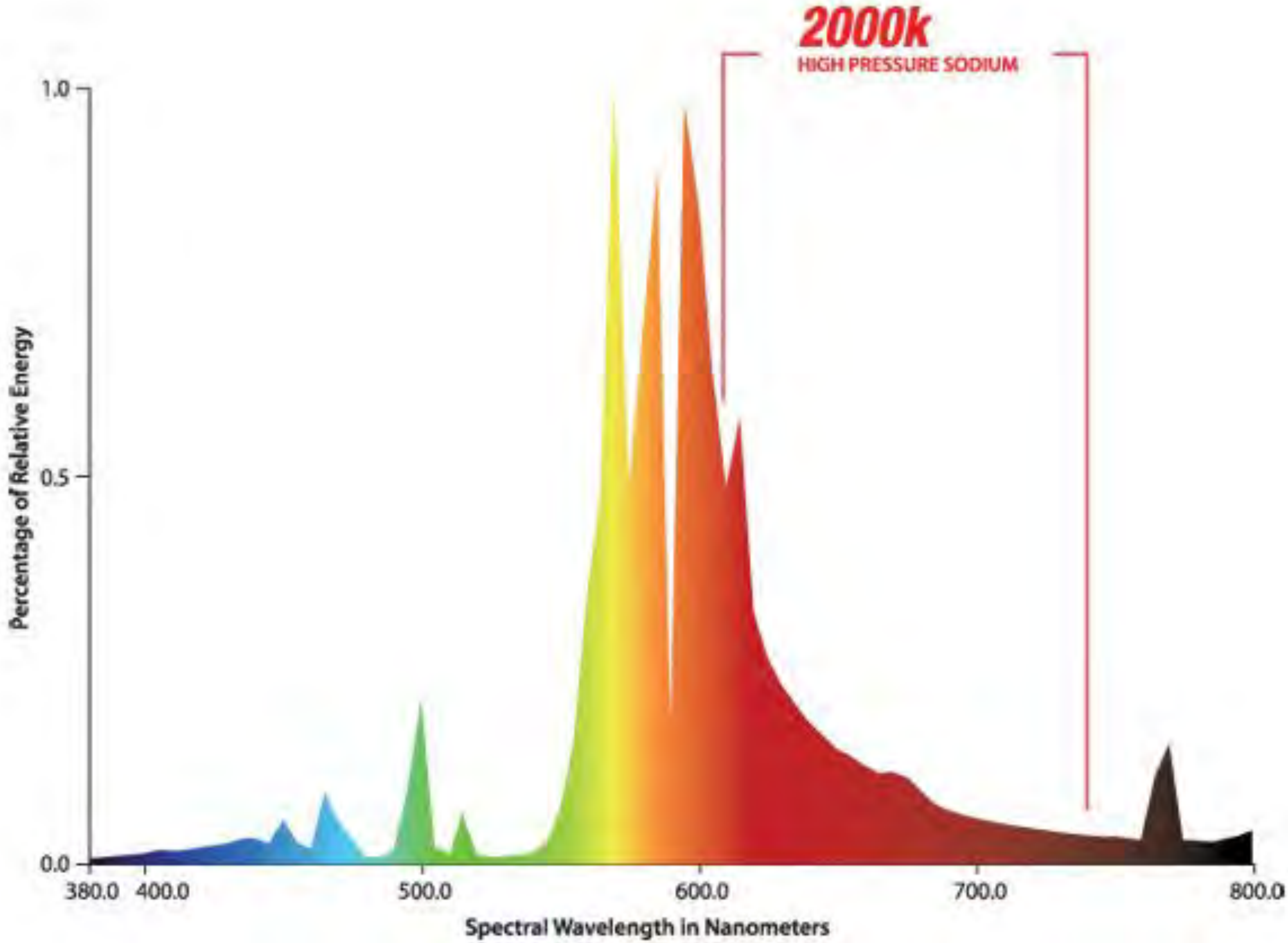
Floriculture
MICHIGAN STATE
UNIVERSITY





Relative Intensity
Natural Sunlight
1,0
0,8
0,6
0,4
0,2
300
400
500
600
700
800
Wavelength in Nanometer


Sun Cloudy
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Relative Output
300
350
400
450
500
550
600
650
700
750
800
Wavelength [nm]


2000k
HIGH PRESSURE SODIUM
1.0
0.5
0.0
Percentage of Relative Energy
380.0
400.0
500.0
600.0
700.0
800.0
Spectral Wavelength in Nanometers

LED heavy in the blue and reds, saves energy by leaving out greens/yellow to be more efficient.