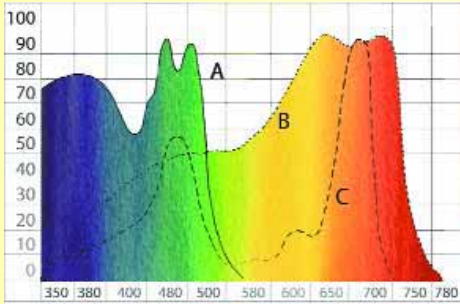


CHAPTER NINE LIGHT, LAMPS & ELECTRICITY

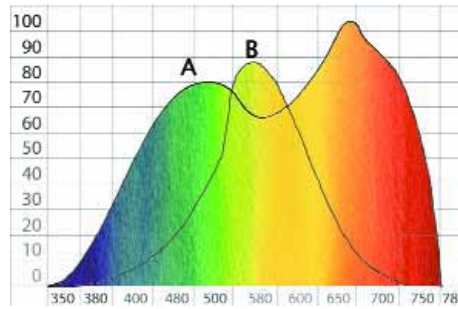


A single handle raises and lowers an entire roomfull of lights!



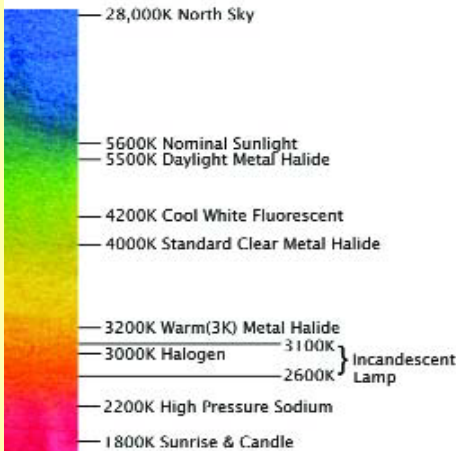
Spectrum of A. Photosynthetic response, B. Light spectrum humans use to see, C. Chlorophyll synthesis

This graph shows the exact level at which A. Phototropic response, B. Photosynthetic response, and C. Chlorophyll synthesis take place.



The single humped line in the center of the graph represents the visible light spectrum humans see. The dual humped line represents the spectrum cannabis needs to grow.

Kelvin Scale



Light, Spectrum, and Photoperiod

Marijuana needs light to grow. The light must have the proper spectrum and intensity to ensure rapid growth. Light is comprised of separate bands of colors. Each color in the spectrum sends the plant a separate signal. Each color in the spectrum promotes a different type of growth.

PAR and Light Spectrum

Plants need and use only certain portions of the light spectrum. The most important colors in the spectrum for maximum chlorophyll production and photosynthetic response are in the blue and red range. The main portion of light used by plants is between 400 and 700 nanometers (nm)* This region is called the Photosynthetically Active Radiation (PAR) zone.**

"PAR watts" is the measure of the actual amount of specific photons a plant needs to grow. Photons are a measure of light energy. Light energy is radiated and assimilated in photons. Photosynthesis is necessary for plants to grow and is activated by the assimilation of photons. Blue photons are worth more PAR watts than red photons, but scientists have difficulty measuring the exact difference.

Each color of light activates different plant functions. Positive tropism, the plant's ability to orient leaves toward light, is controlled by spec-

Bulb Rating	CTC Rating in degrees Kelvin
Warm	3000
Neutral	4000
Cool	6000

Bulb	Kelvin Temp	CRI
Cool White	4150 K	62
Lite White	4150 K	62
Warm White	300 K	52
Deluxe Daylight	8500 K	84
Vitalight	5500 K	96
Noon Sunlight	5300 K	100

trum. Light bulbs deliver only a part of the necessary light marijuana needs to grow. However, they deliver enough! Most of marijuana's light needs can be met by artificial means.

*One nanometer (nm) = one billionth (10^{-9}) of a meter. Light is measured in wavelengths; the wavelengths are measured in nanometers.

**Some scientists still disagree as to the exact PAR zone and make their calculations based on 350 to 750 nanometers. PAR watts measured with this scale will be a little higher.

Measuring Light

Virtually all light is measured in foot-candles, lux, or lumens. Foot-candles and lux measure light visible to the human eye. The human eye sees much less of the light spectrum than plants "see." The eye is most sensitive to light between 525-625 nanometers. The importance of the blue and red portions in the spectrum is diminished greatly when light is measured in foot-can-

dles, lux, or lumens. A foot-candle is a unit of illumination equal to the intensity of one candle at a distance of one foot. The lux scale is similar to that of the foot-candle; one foot-candle is equal to 10.76 lux.

Humans see light differently than plants do. Compare the graphs above to see how the light you see differs from the light a plant uses to grow. Plants use the photosynthetically active response (PAR) portion of the spectrum. Humans use the central portion of the spectrum, while plants are able to use large portions of the spectrum not measured by light meters that record foot-candles, lux, and lumens.

Light is also measured in spectrum with Kelvin temperature which expresses the exact color a bulb emits. Bulbs with a Kelvin temperature from 3000 to 6500 are best for growing marijuana. The PAR section above explains that plants use specific portions of the spectrum—a complete range from blues to reds. Lamps with a spectrum similar to PAR-rated bulbs can use Kelvin temperature of a bulb to ascertain the approximate PAR rating of the lamp. Color spectrum results from a specific mix of different colors. High intensity discharge bulbs are very similar in spectrum. Making these safe assumptions, a rough PAR rating could be extrapolated from a Kelvin temperature rating.

The Color Corrected Temperature (CCT) of a bulb is the peak Kelvin temperature at which the colors in a bulb are stable. We can classify bulbs by their CCT rating which tells us the overall color of the light emitted. It does not tell us the concentration of the combination of colors emitted. Companies use a Color Rendering Index (CRI). The higher the CRI, the better the bulb is for growing.

Light Meters

Most commercial light meters measure light in foot-candles or lux. Both scales measure light to which the human eye reacts to "see." They do not measure photosynthetic response to light in PAR watts.

Light measurements in this book are made in



Although this simple light meter measures light in foot-candles rather than PAR, it still gives an accurate idea of light distribution.

Bulb	Model	Mfrg	MH/HPS Watts	Initial Lumens	Color Deg. K	
Sunmaster	Warm Deluxe	V	MH	1100	133000	385 PAR
AgroSun	AgroSun	V	MH	1000	117000	3250
Multivapor	HO	GE	MH	1000	115000	3800
MultiMetal	Super	I	MH	1000	115000	4200
Metal Halide	Metal Halide	Ph	MH	1000	110000	3700
Solarmax	Veg	V	MH	1000	85000	7200
Super Metalarc	Super	O	MH	1000	115000	3600
Sunmaster	Warm Deluxe	V	MH	1000	117000	315 PAR
Sunmaster	Natural Deluxe	V	MH	1000	117000	315 PAR
Sunmaster	Cool Deluxe	V	MH	1000	80000	315 PAR
Solarmax	Veg / Conversion	V	MH	600	55000	7200
Solarmax	Veg	V	MH	400	32000	7200
Sunmaster	Warm Deluxe	V	MH	400	40000	110 PAR
Sunmaster	Natural Deluxe	V	MH	400	40000	110 PAR
Sunmaster	Cool Deluxe	V	MH	400	32500	110 PAR
Super Metalarc	Super	O	MH	400	40000	4200
Super Metal Halide	Super	Ph	MH	400	4000	4300
AgroSun	AgroSun	V	MH	400	4000	3250
Multivapor	HO	GE	MH	400	40000	4200
Sunmaster	Warm Deluxe	V	MH	250	22000	85 PAR
Sunmaster	Natural Deluxe	V	MH	250	23000	85 PAR
Sunmaster	Cool Deluxe	V	MH	250	21500	85 PAR
Super Metalarc	Super	O	MH	250	23000	4200
Super Metal Halide	Super	Ph	MH	250	23000	4300
Multivapor	HO	GE	MH	250	23000	4200
Hortilux	Super		HPS	1000	145000	2100
Solarmax	Super HPS	V	HPS	1000	147000	2100
Lucalox	HPS	GE	HPS	1000	140000	2100
Sunlux	HPS	I	HPS	1000	140000	2100
Lumalux	HPS	O	HPS	1000	140000	2100
Ceramalux	HPS	Ph	HPS	1000	140000	2100
Solarmax	Super HPS	V	HPS	600	95000	2100
Sunmaster	Super HPS Deluxe	V	HPS	600	85000	358 PAR
Lumalux	Super	O	HPS	600	9000	2200
SonAgro	Plus	Ph	HPS	600	9000	2100
Hortilux	Super	I	HPS	430	58500	2100
Hortilux	Super	I	HPS	400	55000	2100
Solarmax	Super HPS	V	HPS	400	55000	2100
Lucalox	HPS	GE	HPS	400	41000	4000
Sunlux	HPS	I	HPS	400	50000	2100
Lumalux	HPS	O	HPS	400	50000	2100
Ceramalux	HPS	Ph	HPS	400	50000	2100
Hortilux	Super	I	HPS	250	32000	2100
Lucalox	HPS	GE	HPS	250	30000	2100
Sunlux	HPS	I	HPS	250	29000	2100
Lumalux	HPS	O	HPS	250	29000	2100
Ceramalux	HPS	Ph	HPS	250	28500	2100