# Starting Out With LED

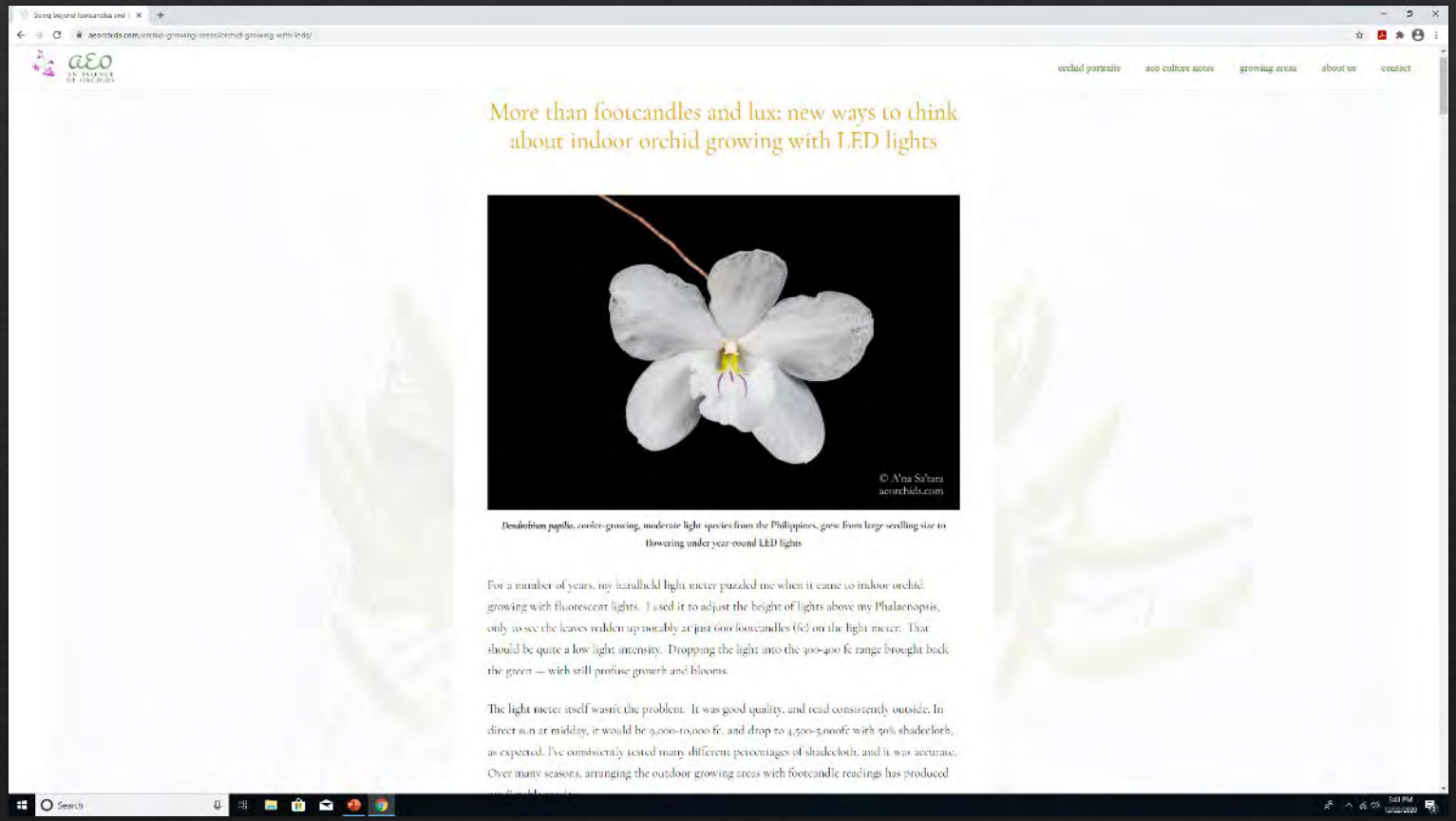
The Highlights in 20 min

By Brandon Silvester, St. Augustine Orchid Society

# Most Important points of entire talk

- There is a huge difference in targeted light intensities in an artificial light (LED) setting vs using outdoor sunlight
- Outdoor light starts low, builds up to a maximum from roughly 11am-2pm and then reduces
- LED light is a constant intensity for all hours, all day, everyday of your set photoperiod
- Rule of thumb is take a plants lower end recommended blooming light intensity for a greenhouse setting and cut that value in half under lights.
- To grow and bloom most cultivated orchids, 1000-2000fc(200-400PAR) is the most light that a grower will ever need to target for their plants under grow lights.
- Deep shade plants like Paphs and Phals will generally only tolerate 400-600fc
- Trust in your experience with a plant rather than trust target light numbers

# More than footcandles and lux: new ways to think about indoor orchid growing with LED lights with permission of An'a Sa'tara



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## More than footcandles and lux: new ways to think about indoor orchid growing with LED lights

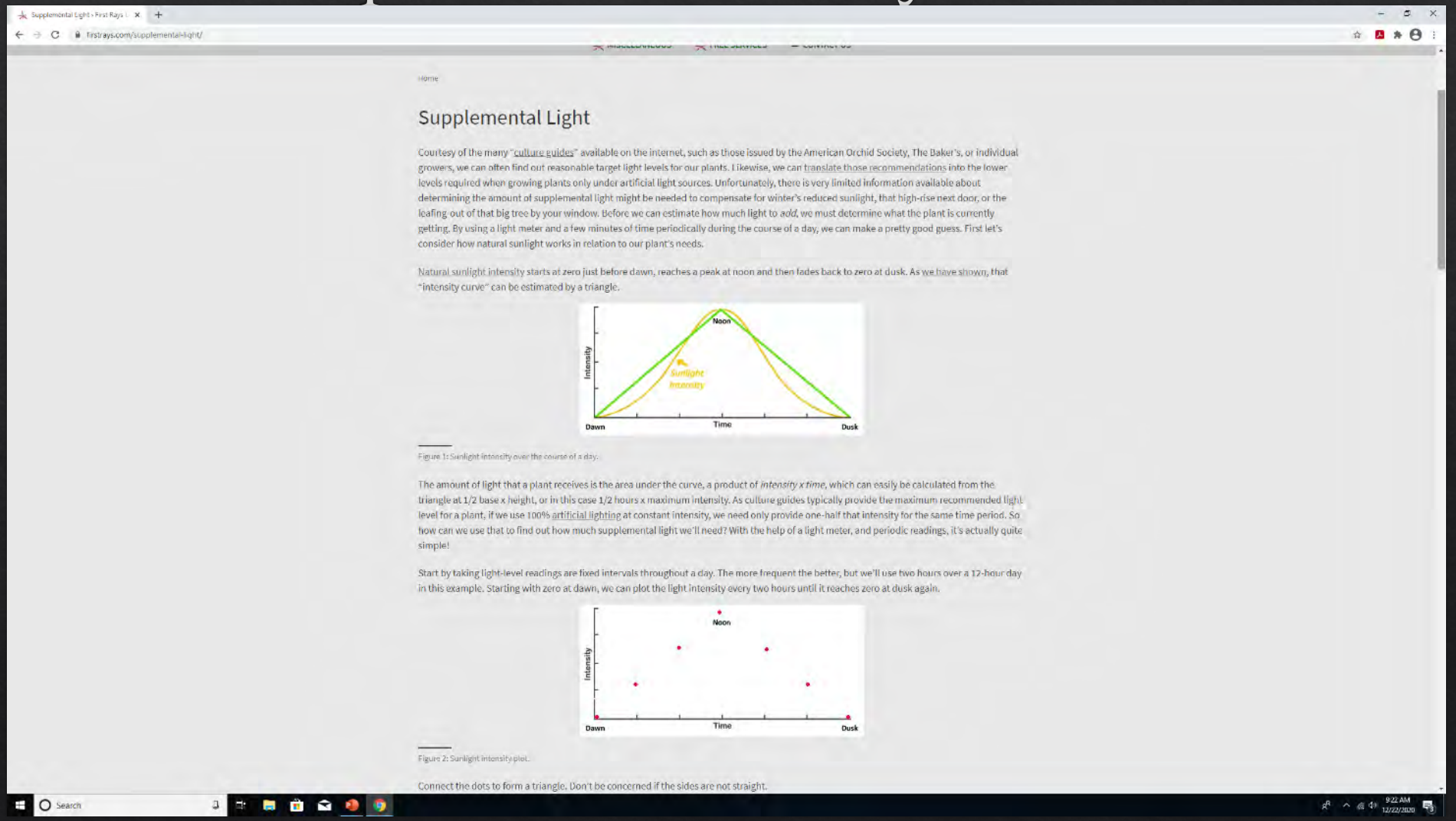



*Dendrobium papilio*, cooler-growing, moderate light species from the Philippines, grew from large seedling size to flowering under year-round LED lights

For a number of years, my handheld light meter puzzled me when it came to indoor orchid growing with fluorescent lights. I used it to adjust the height of lights above my Phalaenopsis, only to see the leaves redden up notably at just 600 footcandles (fc) on the light meter. That should be quite a low light intensity. Dropping the light into the 300-400 fc range brought back the green — with still profuse growth and blooms.

The light meter itself wasn't the problem. It was good quality, and read consistently outside. In direct sun at midday, it would be 9,000-10,000 fc, and drop to 4,500-5,000fc with 50% shadecloth, as expected. I've consistently tested many different percentages of shadecloth, and it was accurate. Over many seasons, arranging the outdoor growing areas with footcandle readings has produced

# https://firstrays.com/supplemental-light/ with permission of Ray Barkalow



Home

## Supplemental Light

Courtesy of the many "culture guides" available on the internet, such as those issued by the American Orchid Society, The Baker's, or individual growers, we can often find out reasonable target light levels for our plants. Likewise, we can translate those recommendations into the lower levels required when growing plants only under artificial light sources. Unfortunately, there is very limited information available about determining the amount of supplemental light might be needed to compensate for winter's reduced sunlight, that high-rise next door, or the leafing out of that big tree by your window. Before we can estimate how much light to *add*, we must determine what the plant is currently getting. By using a light meter and a few minutes of time periodically during the course of a day, we can make a pretty good guess. First let's consider how natural sunlight works in relation to our plant's needs.

Natural sunlight intensity starts at zero just before dawn, reaches a peak at noon and then fades back to zero at dusk. As we have shown, that "intensity curve" can be estimated by a triangle.




Figure 1: Sunlight intensity over the course of a day.

The amount of light that a plant receives is the area under the curve, a product of *intensity x time*, which can easily be calculated from the triangle at 1/2 base x height, or in this case 1/2 hours x maximum intensity. As culture guides typically provide the maximum recommended light level for a plant, if we use 100% artificial lighting at constant intensity, we need only provide one-half that intensity for the same time period. So how can we use that to find out how much supplemental light we'll need? With the help of a light meter, and periodic readings, it's actually quite simple!

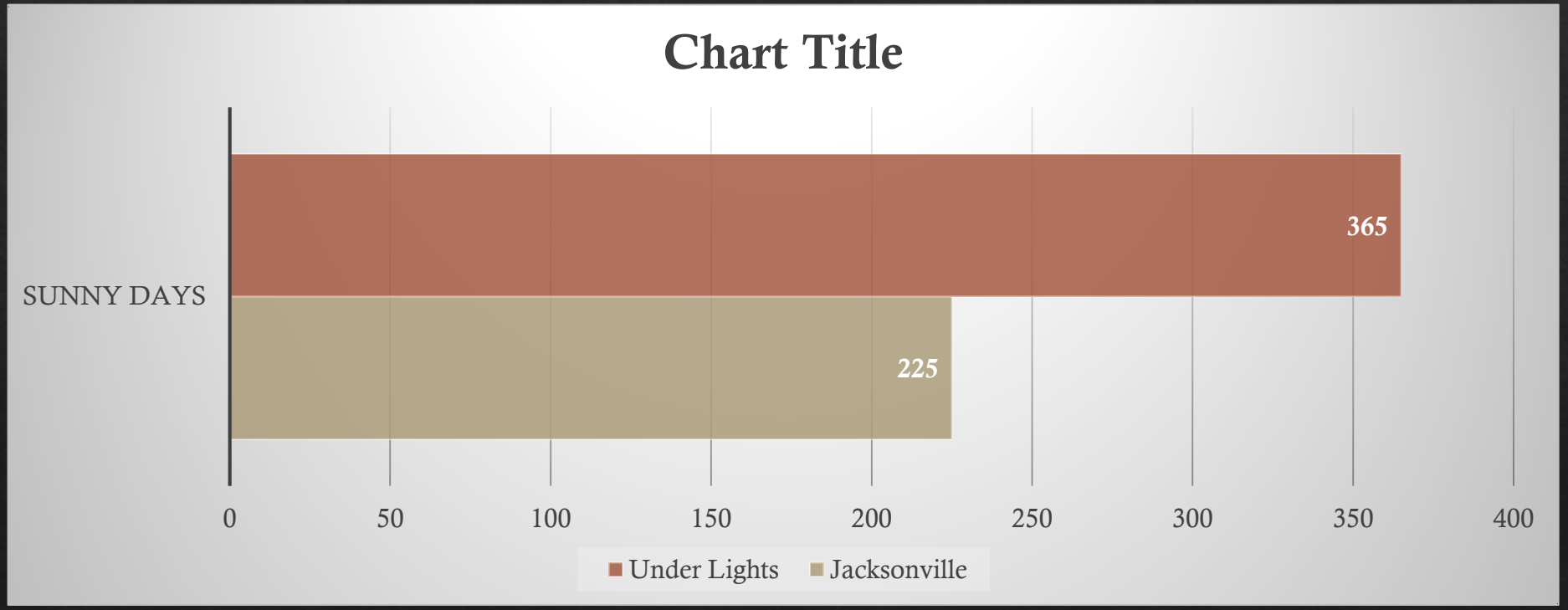
Start by taking light-level readings are fixed intervals throughout a day. The more frequent the better, but we'll use two hours over a 12-hour day in this example. Starting with zero at dawn, we can plot the light intensity every two hours until it reaches zero at dusk again.




Figure 2: Sunlight intensity plot.

Connect the dots to form a triangle. Don't be concerned if the sides are not straight.

# 38% More “Sunny Days” under lights vs Jacksonville Average



# Light Meters

- Any artificial lighting system provides a constant illumination strength so measuring the light intensity matters.  There will be no reduction in intensity over the course of the day, ever, so to much light can cause damage to the chlorophyll or put a plant in survival mode/photoinhibition.
- Some Free Phone apps are fairly close, always safest to assume light is stronger than measured
- Low cost and fairly accurate AP-881E Lux meter is about 35USD on Amazon-but you will need to learn some conversions
- A Quality light meter(80-150 USD) will measure full spectrum LED within about 5% of a purpose built PAR Meter(300-700 USD)…but that's a lot of money that could have been spent on plants!
- Whichever you choose, a light meter will eliminate most of the guess work in lighting intensity

# Orchids are shade adapted plants

- Most start their lives in a consistently damp crevice with a fungal host.  Generally not the brightest spot in the world.
- Most can break even photosynthetically with 25-50fc, approximately .25-.5% of full noontime summer sun 10,000fc
- Most can show some growth( albeit very dark green, floppy, never to bloom growth) at around 200-300fc in nature
- The main point its not hard to give an orchid enough light to survive; with full spectrum LED we need to avoid unintentionally giving too much light

# Safe Values/Good neighbors

- Suggested safe starting values: probably wont burn your plants
- Bulbophylum, Phalaenopsis, Paphiopedilum, Phragmipedium, Oncidium
- 400-600fc, 80-120 PPFD, 10-14 hours
- Exceptional plants from exceptional ecosystems do exist, but be vigilant when pushing past these numbers without a strong knowledge of your plants native environment.  Burns and bleaching are possible.
- Some of these plants prefer intermediate temperatures and higher light levels along with night temps over 78 were too stressful.

# Safe Values/Good neighbors

- Cattleya, Dendrobium, Ascocentrum
- 1000-2000fc, 200-400 PAR, 10-14hours depending on species/hybrid
- Seedlings with smaller root systems may want less light initially, particularly species
- Nobile Dendrobiums appear to tolerate up to 3500fc or 700 PPFD
- Leaf growth looks best at 1500-3000fc, 300-600 PPFD
- Still require a cold dry rest to bloom

# Safe Values/Good neighbors

- Catasetum and Cymbidium
- Depends heavily on species/hybrid makeup and genetic expression
- 1000-3500fc or 200-700 PPFD
- Under my brightest lights some are tolerant to around 3500-4500fc or 700-900 PPFD. Waiting to see if these leaves burn out/bleach out with time.
- I don’t own any standard size Vanda and haven’t experimented on them under lights yet. 2000fc-2500fc, 400-500 PPFD would probably be a maximum for a constant light setting. 1000fc or 200PPFD would probably be a very happy starting point.

# Too much light!!

Brassavola nodosa

Laelia tenebrosa

Laelia purpurata

# Same plants after 2 months at a lower intensity

Brassavola nodosa

Laelia tenebrosa

Laelia purpurata

# Almost too much light

Catasetum pileatum

Ascocentrum miniatum

SVO hybrid

Phal Mituo King

# My first fixtures

- LED shop lights from Home Depot Lowes
- Lithonia Lighting 4 ft. 40-Watt Black Integrated LED Diamond Plate Shop Light- $45
- Output at fixture 950 PPF (4750fc), 6 inches from fixture 250 PPFD (1250fc)
- Commercial Electric-4 ft. 4-Light 80-Watt White Integrated Heavy Duty Utility LED Shop Light with Pull Chain-$60
- At fixture 300 PPF (1500fc), 6 inches 120 PPFD (600fc)
- Rated to function for 8 years, 50,000 hours.  I hope its true!
- CRI of 80= efficient growing light but ugly photo light

# Shop light only blooming

Ascocentrum miniatum

SVO Hybrid

SVO Hybrid

# Shop light only blooming

Bulbophyllum lasiochilum

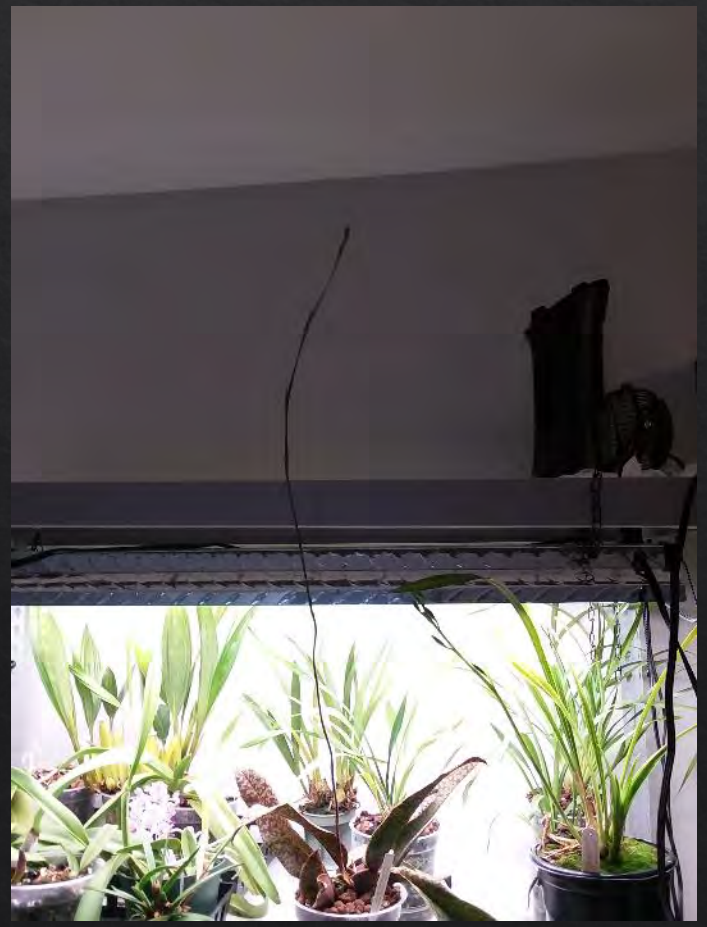
Peaches x Spring Climax

# Shop light only blooming

Brassavola nodosa


Cymbidium Golden Elf

Psycopsis Mendenhall ‘Hlidos’



# Shop light only blooming

Phrag Les Dirouilles

Cal Orchids reedsteem Epidendrum

# Shop light only blooming

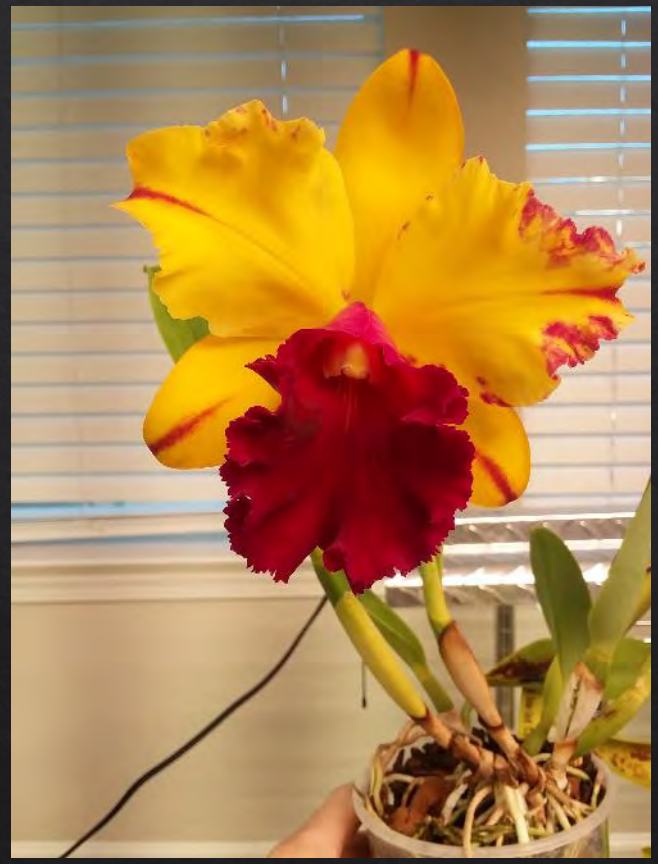
Cattleya cernua

Carter and Holmes cross

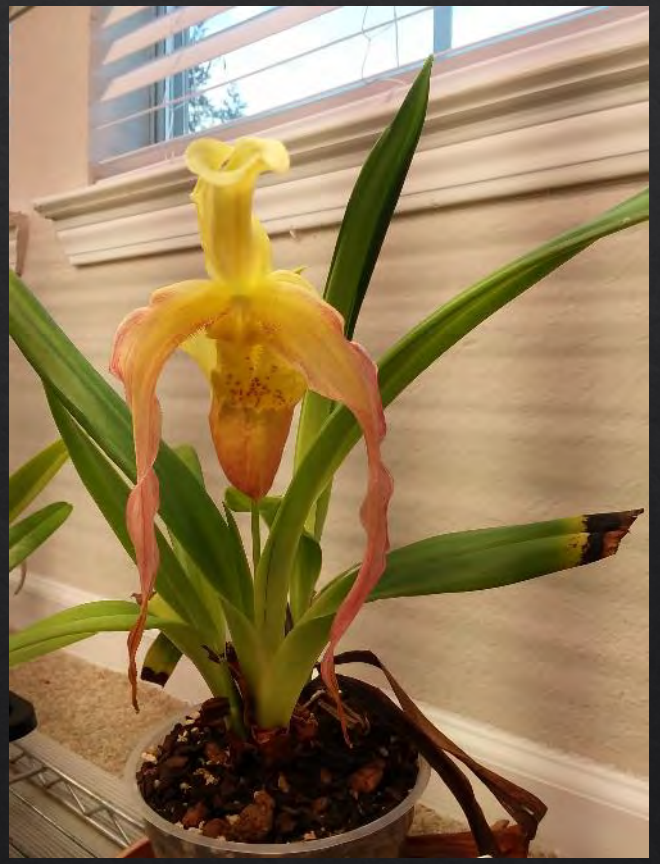
Carter and Holmes cross

# Shop light only blooming

Rynchostylis gigantea



Cattleya Tainan Gold ‘Canary’



Phrag China Dragon

# Shop lights + Cold Rest Outdoors

Dendrobium NOID

Dendrobium Love Memory Fizz

# The apartment growing areas

# Shop light growing areas

# Shop light growing areas

# The professional grade grow lights

# Humidity considerations

- Will be low in your house and lower still under the lights compared to the typical values outside.  AC can easily drop humidity to 35%.
- Humidity is relative so as the air warms, water carrying capacity rises and overall humidity drops.
- For my collection 50-57% humidity is my target range.
- Extended periods at 45% and below are hard on roots and seem to stimulate spider mite activity
- If an evaporative or cool mist humidifier is used, be prepared to clean it often(1-3 day intervals), mold and bacteria will set up quickly.

# Air turnover/temperature considerations

- Greenhouse- 1 to 3 air changes per min/Temperature can get into the 100s
- Home/Apartment-  Per EPA homes receive 0.35 air changes per hour but not less than 15 cubic feet of air per minute (cfm) per person as the minimum ventilation
- Homes apartments usually kept in the mid 70s to 80s
- Your plants potting medium can both dry and stay wet much longer
- Dust and fungal spores aren't kicked out of the air column as quickly

# Pest control considerations

- Mostly limited to soap/alcohol mixes indoors
- The “strong stuff” is often far to toxic to be near for at least 24 hours after application, precluding in home use
- Best to give outdoor grown plants a wash, insecticidal soap spray down, and application systemic pest control a 1-2 weeks before bring them in
- My main concern indoors is spider mites, but all pests should be accounted for before brining plant in.
- No predator species or rain indoors to control pests, allowing rapid proliferation

# Setting up your growing area

- Lights
- Light meter
- Timers
- Ideally tile or concrete floors
- Vinyl for floor protection
- Lining on the stands racks
- Fans for air movement
- Temperature/hygrometer
- Away from foot traffic
- Away from entryways
- Plan rack distances based on future plant height with flowers, not cute seedling sizes

# Useful places to learn online!

- https://www.aeorchids.com/orchid-growing-areas/orchid-growing-with-leds/-orchid light ranges under LED
- https://firstrays.com/supplemental-light/ supplementing in a windowsill
- http://orchidborealis.blogspot.com/ DIY LED, wiring instruction, technical growing info. PhD growing orchids in Fairbanks, Alaska.
- https://www.carnivero.com/pages/ultimate-guide-to-grow-lights-Very through Photobiology section
- MIGRO Youtube-Shane Torpey, LED technical reviews including, light output, spectrum breakdown and efficiency
- Dr. Bruce Bugbee-Apogee Instruments, Far Red: The Forgotten Photons
- Dr. Erik Runkle-Grow Lighting Masterclass

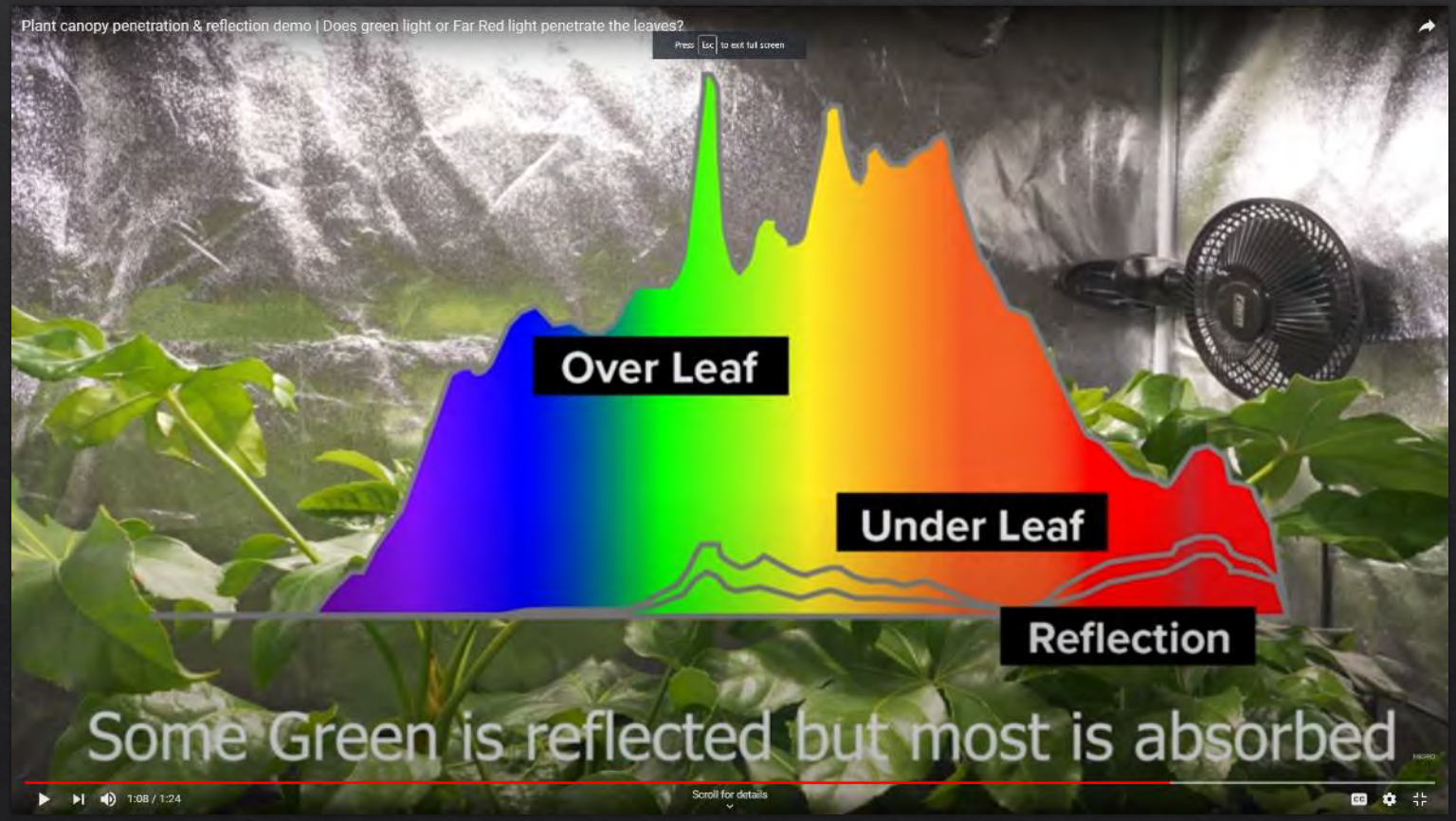
# More useful places to learn online

- Spectroradiometer readings of light above, below and reflected by a leaf
- https://www.youtube.com/watch?v=XHOkkUBhS24

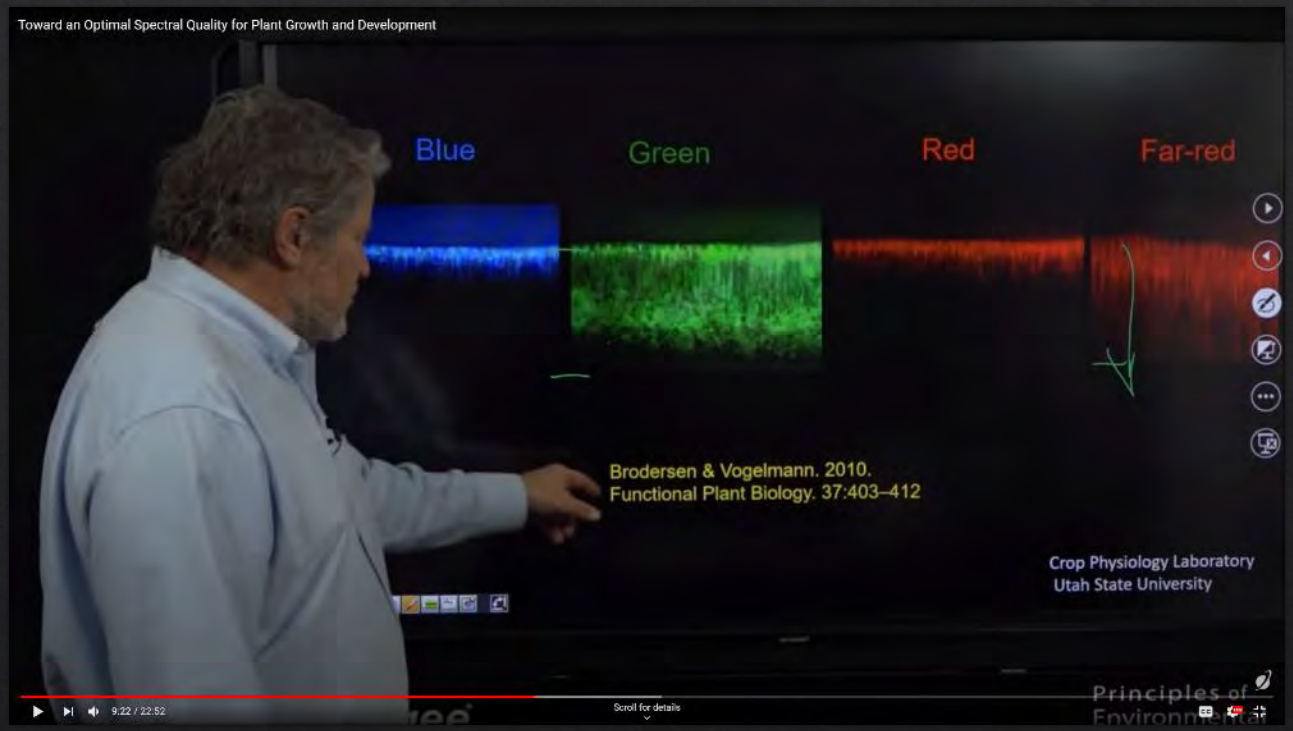
- DLI values per month across the USA
- https://www.extension.purdue.edu/extmedia/ho/ho-238-w.pdf

- Circuit breaker load values
- https://michaelbluejay.com/electricity/maxload.html

# Entering The Science Zone



# Light color transmission in a leaf
# Dr. Bruce Bugbee presenting

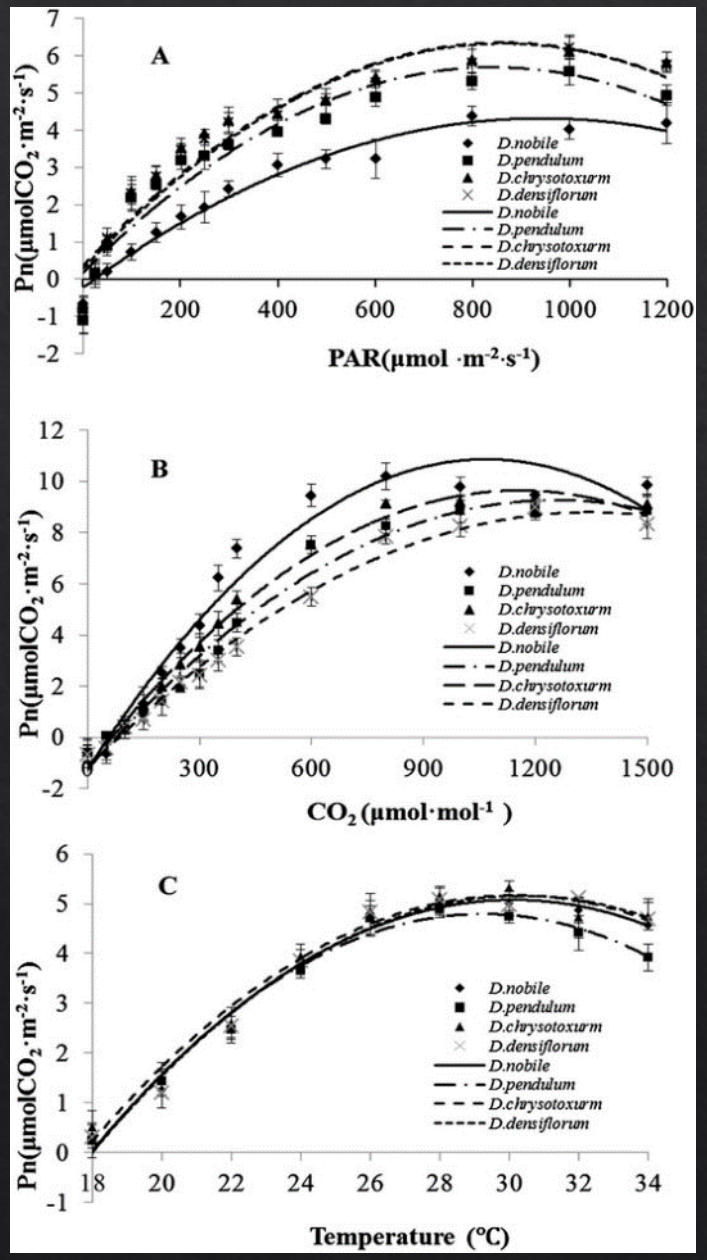


# Photosynthetic Characteristics of Four Wild *Dendrobium* Species in China

Authors: Gang-Yi Wu [1], Jun-Ai Hui [1], Zai-Hua Wang [2], Jie Li [3], and Qing-Sheng Ye [4]

- Research shows most C3 plants peak photosynthetically at 700 PPFD
- That means more light than 700 PPFD/3500 footcandles will not make them grow any faster without the addition of C02 over ambient 300ppm found in the air. At a certain point more light will actually slow photosynthesis down
- Most orchids only need 5-10 PPFD or 25-50 foot candles to break even metabolically.

**Fig. 2.**

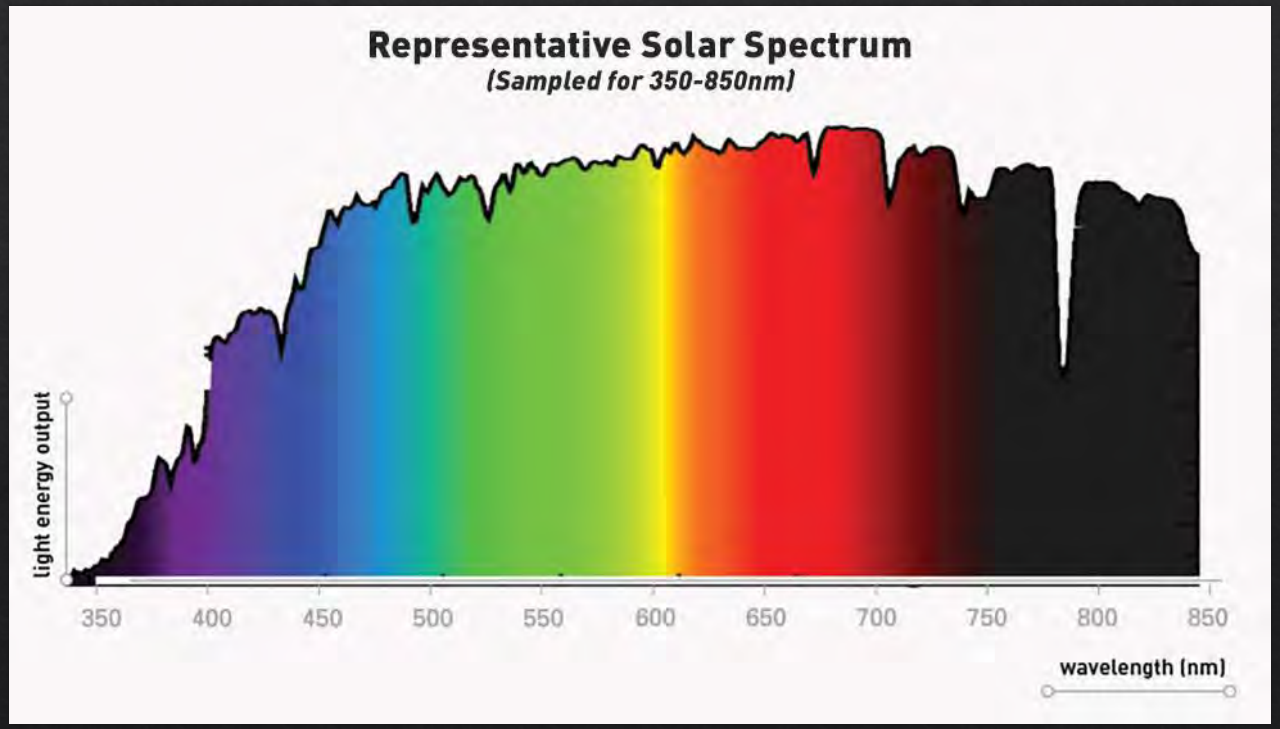



Light intensity (A), CO2 concentration (B), and temperature (C) response curves of the leaves of the four Dendrobium species.

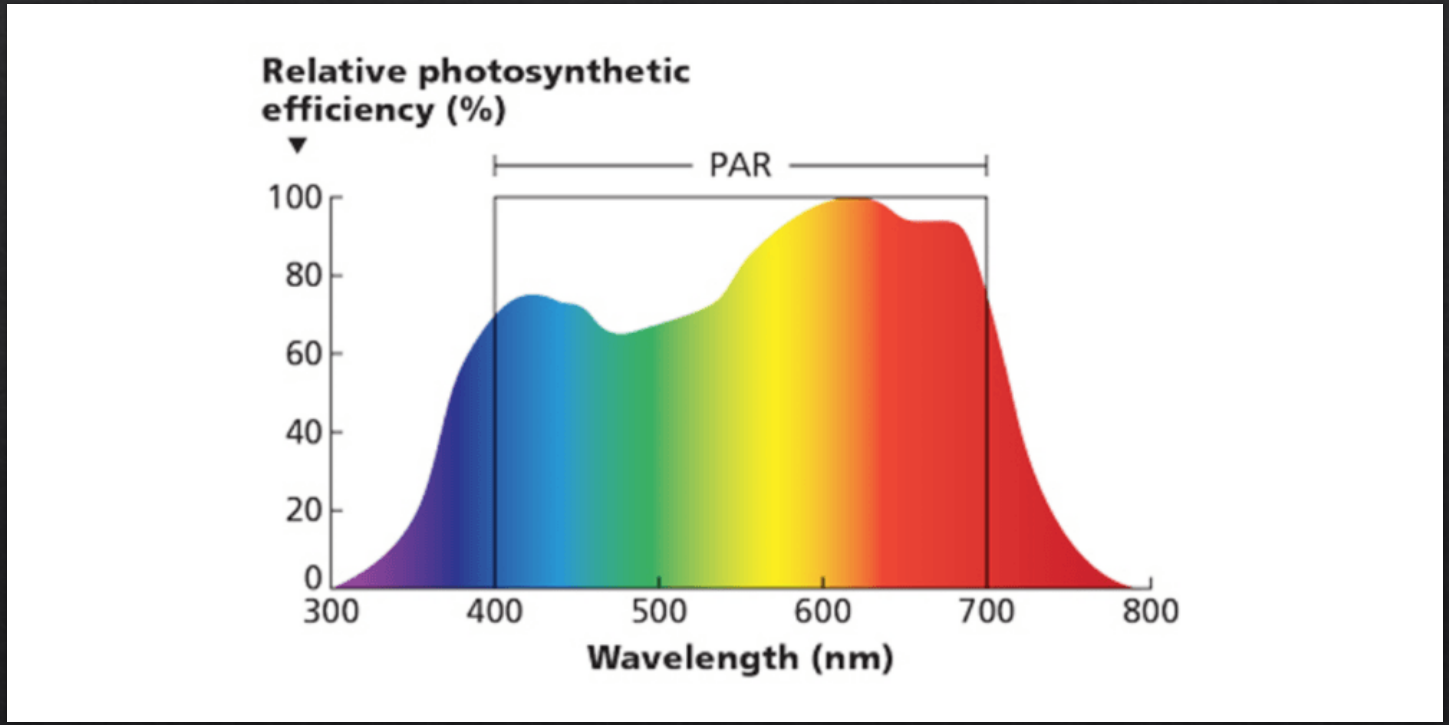
# Photomorphogenic effects-how growth forms

- Plants will grow a bit differently under LED lights
- Most will be more compact, and have tougher leaves
- This is simply due to the larger amount of blue and red light spectrum present, not nutrient deficiencies
- Most shade and deep shade orchids would never have a shot at the blue and red components of light, the upper canopy tends to only transmit green and far red.
- They receive a banquet of red and blue under lights, and don’t need massive leaf areas to capture light, causing very notable changes

# Solar Spectrum



# McCree Curve-how plants respond to photon wavelength

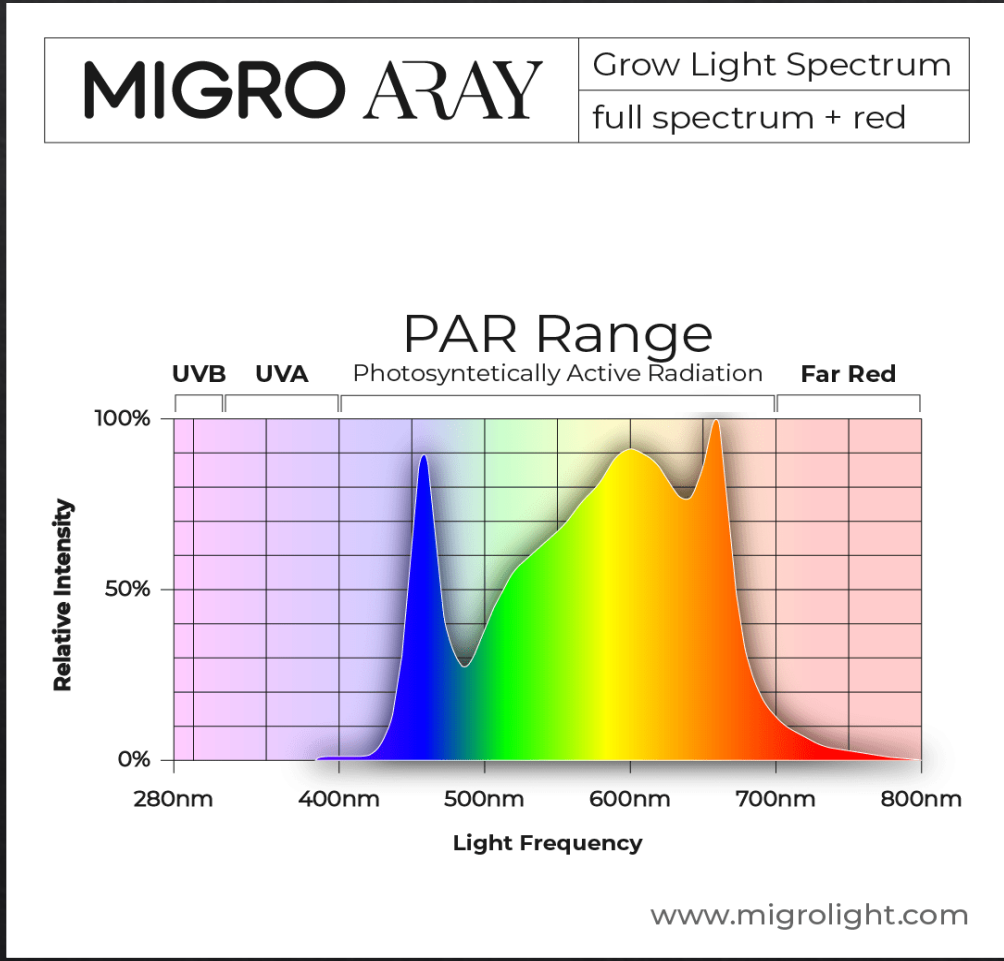


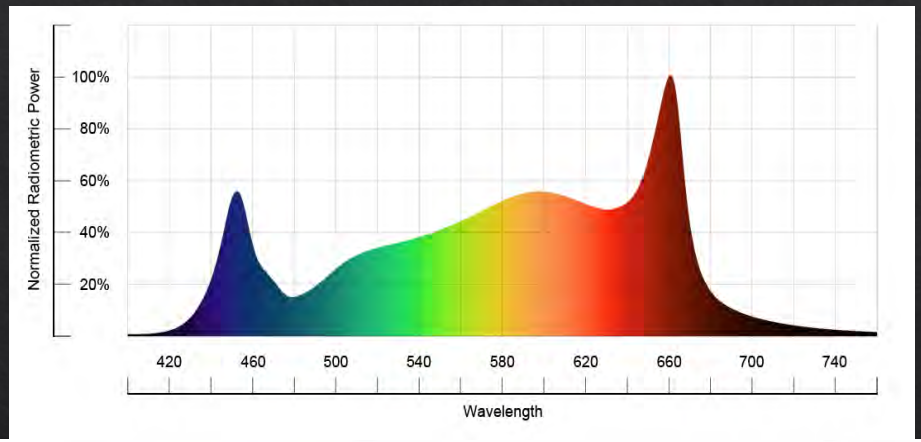
# Windowsill growth vs Shop light growth

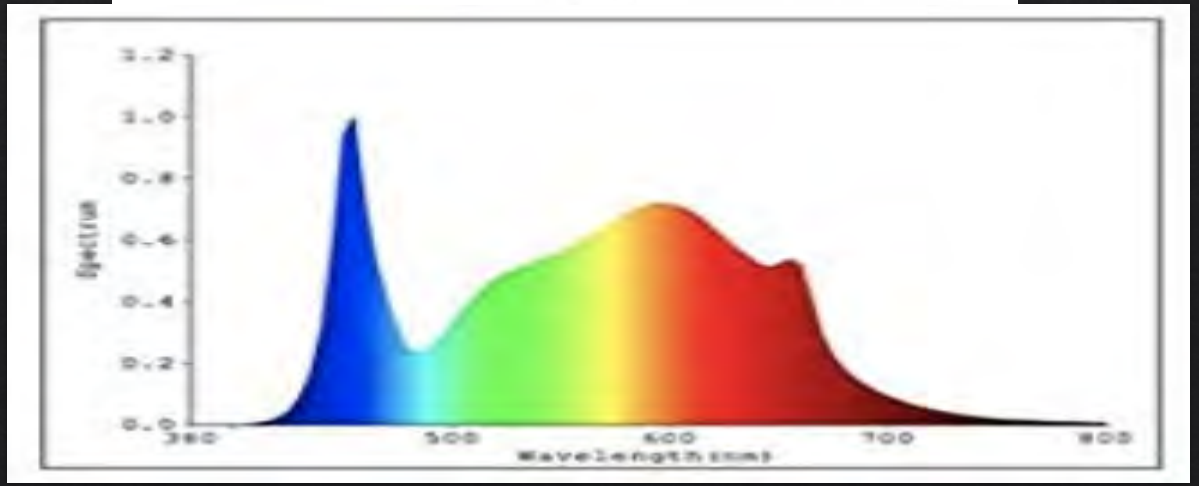
# Windowsill growth vs Shop light growth

# Nursery growth vs Shop light growth

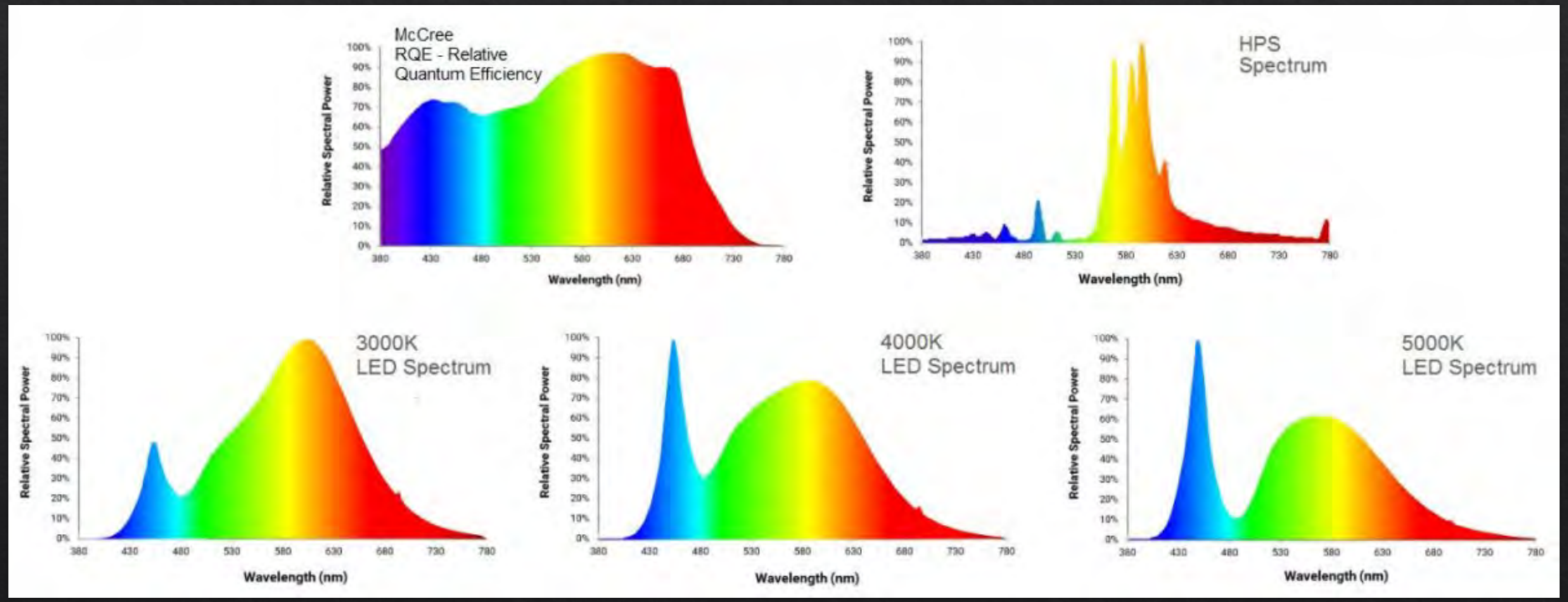
# LED Full Spectra Grow lights



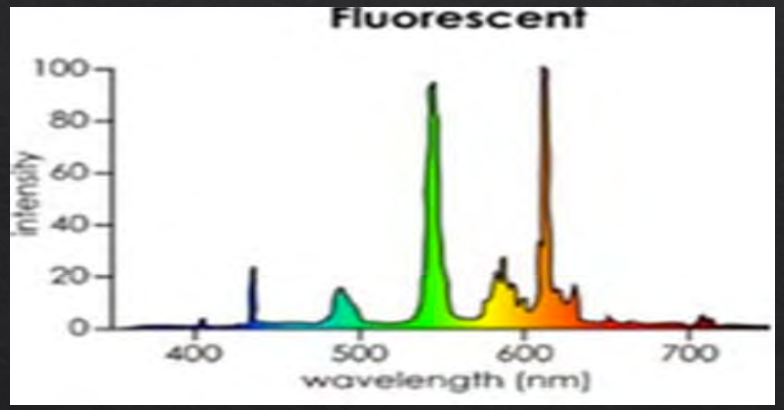



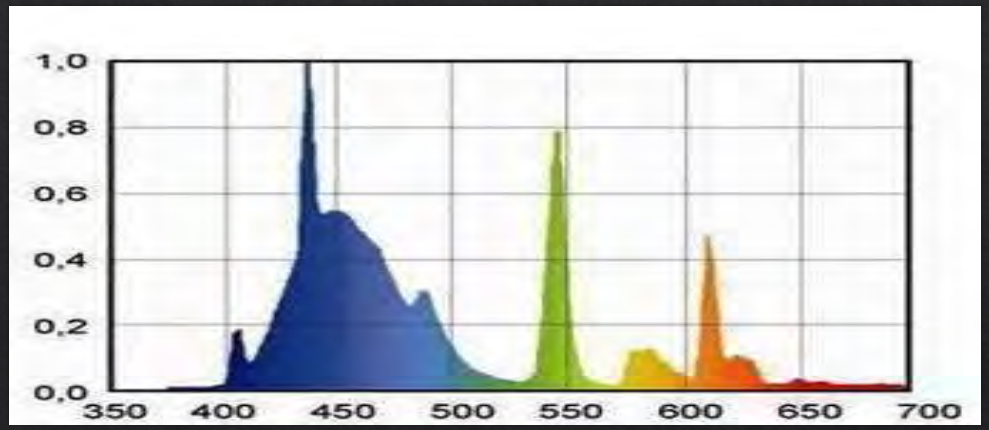



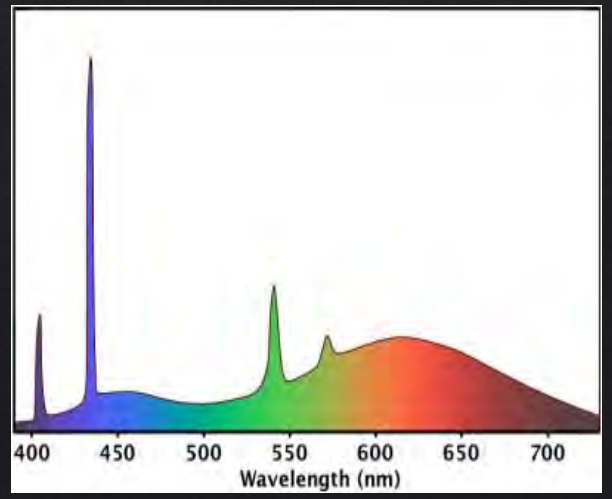
# What Kelvin Means in LED

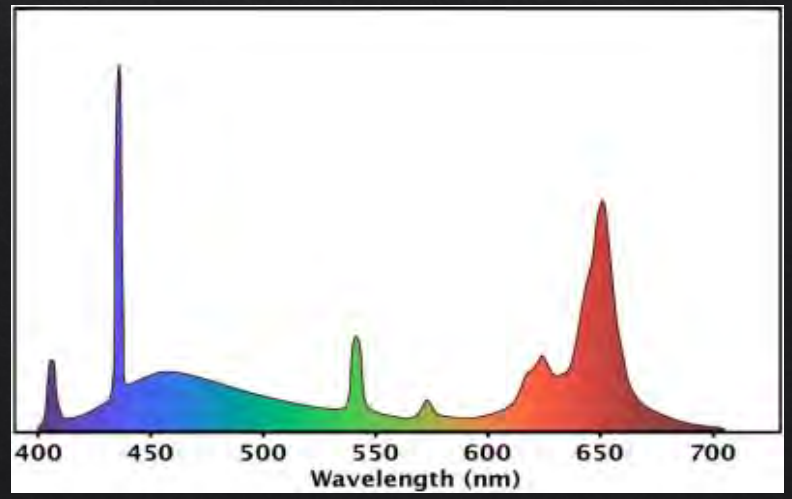


# Fluorescent Grow Light Spectra

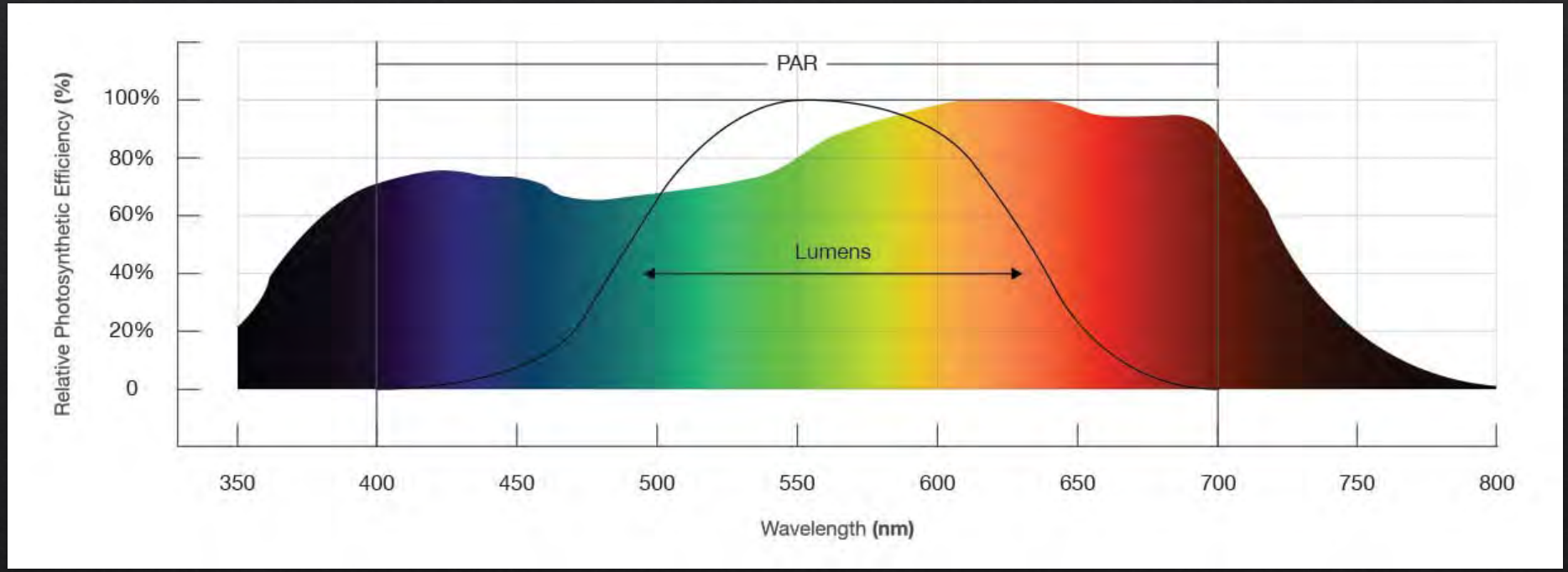


# PAR Range vs Lumen Range



# LED safety basics

- Must know your circuit board load capacity and diagram out your potential growing areas available circuits.
- 15 amps allow for a safe continuous 1440 watt draw on the entire circuit
- 20 amps allow for a safe continuous 1920 watt draw on the entire circuit
- Most big box shoplight LED fixtures run 40 watts to 80 watts per unit
- Professional Cannabis LED fixtures can run 100 watts to 1000 watts per unit
- Know your circuit capacity, be safe.

# Thanks for listening!