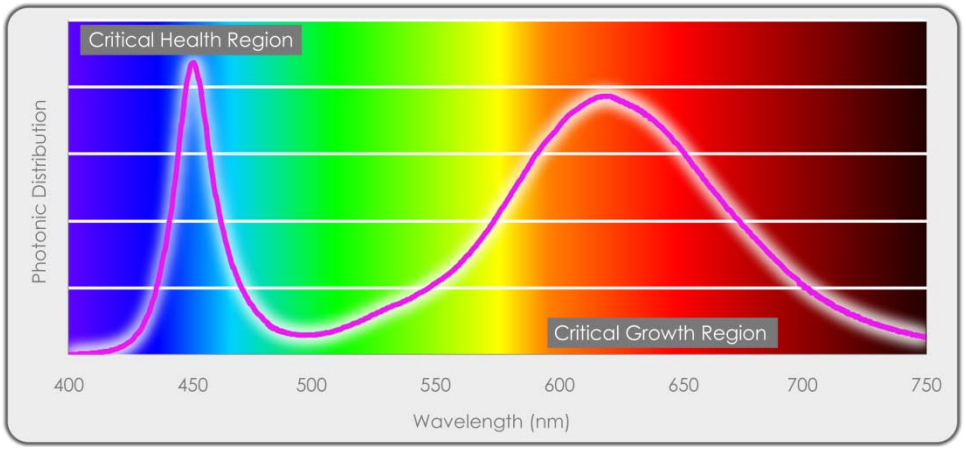
TotalGrow™ Broad Spectrum Light vs. Typical LED Grow Lights

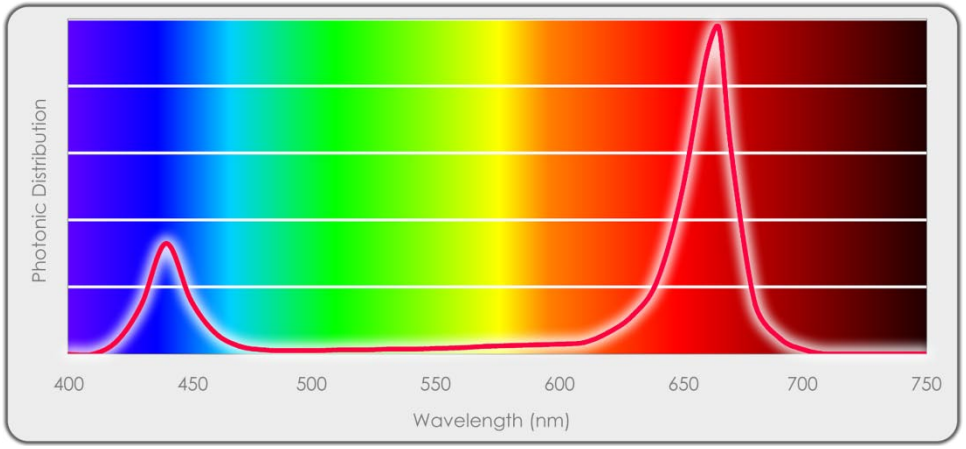
TotalGrow™ Broad Grow Spectrum



Blue Photons (400-499nm)	Green-Yellow Photons (500-599nm)	Orange-Red Photons (600-700nm)	Far Red Photons (701-750nm)
• Drive dense plant growth • Support plant health and appearance • Support root development and nutrient production • Stimulate chlorophyll production and gas exchange	• Provide the least amount of growth per photon • Provide the best penetration for subcanopy growth • Enable visual health assessment	• Most efficient at driving plant growth • Best chlorophyll absorption • Critical for flowering and day length control	• Support total plant function • Enhance the photosynthetic efficiency of other wavelengths • Enable day length control

Broad Spectrum: TotalGrow™ provides a broad spectrum of light in the wavelengths that plants need most for quick and healthy growth.

Typical Narrow LED Grow Light Spectrum

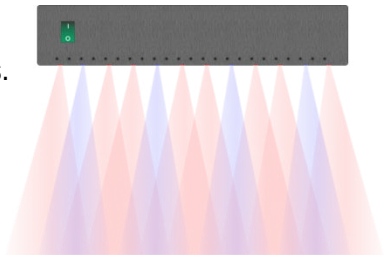


Broad Spectrum for Total Growth

- Like a healthy human diet requiring a diversity of foods in different proportions, healthy and efficient plant growth is the result of a "balanced diet" including an emphasis on red light, substantial blue light and small amounts of green and far red light in addition to the red light.
- LEDs have very narrow spectral bandwidths. The most efficient LEDs are red and blue. Typical LED grow lights can therefore only efficiently support a few key plant growth processes while ignoring the benefits of other light regions.

Uniform Light for Consistent, Efficient Growth

- TotalGrow™ Solid State Volumetric Lighting (SSVL) technology emits omnidirectional, fully mixed light that is easily guided by a reflector into patterns with exceptional uniformity over a grow area.
- LEDs emit very directional light with individual color point sources. Typical LED grow lights therefore produce inconsistent growth from hot and cold spots with potentially varying color spectra between plants.



Reliable Fixtures

- LED-based lights have uniquely long lifespans if heat generation is managed well. TotalGrow™ lights utilize highly engineered passive heat sinks for exceptional reliability.
- Many LED grow lights rely on fans with much shorter lives than the LEDs, resulting in premature light failures.
- Expertise behind TotalGrow™ lights includes electrical engineering, optical physics, biology and manufacturing process.

TotalGrow™ - The only grow light solution based completely on plant needs.

In Greater Detail:

Spectrum

- The goal of typical LED grow lights is to stimulate chlorophyll to drive photosynthesis using light at the wavelengths most efficiently absorbed by chlorophyll.
    - Typical LED grow light companies want this oversimplification of the lighting needs of a plant to be true because the most efficient LEDs are blue followed by red. Green, far red and other LEDs produce light at a disappointing fraction of the efficiencies of blues and reds, and incorporating more LED types significantly increases the cost and complexity of the product.
- TotalGrow™ Broad Spectrum Light makes efficient chlorophyll absorption a high priority as well, but it does so in the context of addressing the needs of the whole plant.
    - Intuitively, plants are complex and are adapted to broad spectrum sunlight. The radical shift to the narrow output regions of typical LED grow lights is not without risks and consequences.
    - TotalGrow™ Broad Spectrum Lights balance the opportunity of more efficient growth by maximizing the most needed wavelengths of light with the reality that other photoreceptors besides chlorophyll must be stimulated based on other action spectra. Research has shown the benefit of small amounts of the other light regions, including improved growth and health with up to 24% green,[1] and the enhancement effect of far red light to improve the efficiencies of other wavelengths due to more balanced photosystem stimulation.[2]

Uniformity

- Effective grow lighting is achieved by exposing every plant in the grow area to the same lighting intensity and spectrum.
- Lighting some plants more and others less means plants are finishing at different times or with different quality. Excessive output in hot spots generally yields little or no value and could even be harmful.
- LEDs output one very specific color of light in a highly directional manner.
    - Plants directly underneath a typical LED grow light fixture receive significantly more light than plants between fixtures, making a large portion of light output ineffective
    - Higher powered LED grow lights, e.g. 300-600W, exacerbate this problem and are increasingly wasteful.
    - Producing "dots" of red, blue or other light colors can result in differing spectra being received by different plants, increasing the non-uniformity of a growing area.
- TotalGrow™ lights are the only solution to use Solid State Volumetric Lighting (SSVL) technology with an omni-directional, incandescent-like output pattern.
    - TG15A fixtures and TG1A bulbs use diffuse reflectors to create ideal output patterns and generate uniformity in almost any grow area.
    - SSVL light packages immediately emit the light in the desired spectrum with no further mixing required.

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[1] Kim, Hyeon-Hye, Goins, Gregory D., Wheeler, Raymond M., and Sager, John C. "Green-light Supplementation for Enhanced Lettuce Growth under Red- and Blue-light-emitting Diodes." *HortScience* 39.7 (2004): 1617-1622.
http://hortsci.ashspublications.org/content/39/7/1617.full.pdf

[2] Hogewoning S.W. et al. found a 10% increase in photosynthetic quantum yield for sunlight spectra wavelengths in the presence of the far red of a shade spectrum and a 21% increase for shade spectra wavelengths in the presence of the lower wavelengths of a sunlight spectrum Hogewoning S.W., Wientjes E., Douwstra P., Trouwborst G., van Ieperen W., Croce R., Harbinson J. (2012). Photosynthetic quantum yield dynamics: From photosystems to leaves.Plant Cell 24: 1921–1935.