A Good Straightforward Guide to LED Grow Lights

http://www.kulekat.com/led-home-lighting/do-led-grow-lights-work.html

Understanding LED Grow Lights

There are a number of reasons why LEDs are proving popular as grow lights, but to properly understand these it's helpful to first recap the qualities that are most desirable in a grow light, and also to examine the characteristics intrinsic to LEDs. It's also worth understanding why there has been more heat than light generated around this subject, with some folk adamantly claiming that LED grow lights don't really work and others insisting instead that they do in fact work very well. Both sides are right; they're just comparing apples with oranges, in other words not talking about the same products, as will become apparent.

Understandably, many folk are seduced by the idea of a "bargain" but the fact is that those who pick up a cheap grow panel on eBay (typically incorporating 225 lamps and using "only" 14 watts or so) are set for a bad experience (and then likely blame the technology). Quality LED grow lights are realistically priced, save a fortune in running costs and pretty much live up to their performance claims.

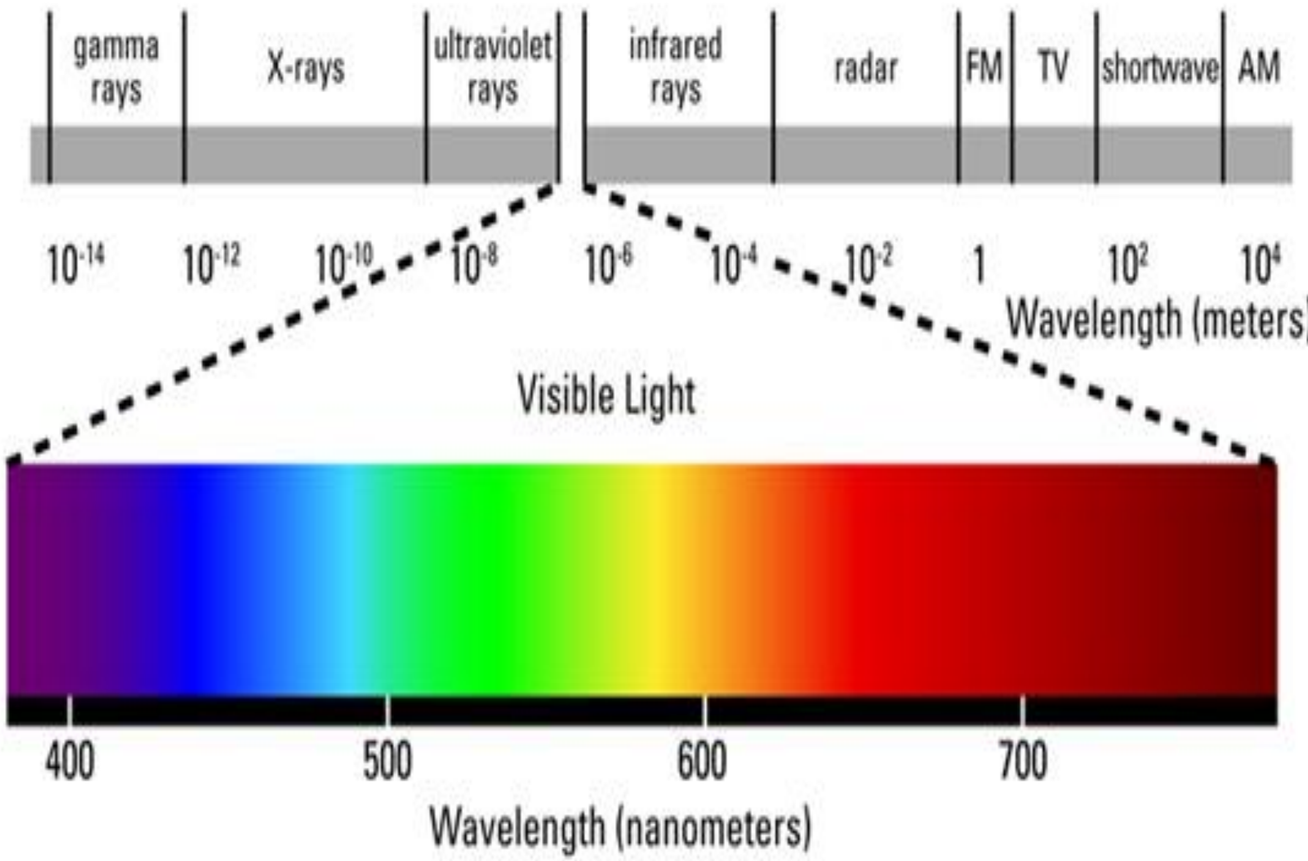
But back to the introduction… the purpose of a grow light is evident in the name itself – to help plants grow. Usually the intention is to be able to grow plants indoors (i.e. in the absence of sunlight) and/or to also better control the rate of growth, size and other characteristics. The advantage of an indoor growing environment is that you can very precisely control the factors crucial to plant growth and tailor them for specific types of plant. All plants require warmth, water and nutrients (absorbed from the soil or using a hydroponic system where the plant sits in nutrient rich water). But most crucially, they need light and, as we shall see, not just any old light either.

How Plants Use Light To Grow

The way that all plants grow is by photosynthesis, the process whereby carbon dioxide (CO_2) is converted into the organic material that makes up the plant (carbon, proteins, sugars and so on) using energy derived from sunlight. This energy is absorbed through special proteins containing chlorophyll molecules that reside in photosynthetic cell membranes called chloroplasts.

Now the point about chlorophyll is that it only absorbs light from particular parts of the spectrum, mostly the blue and red parts. It is especially poor at absorbing light from the green part of the spectrum which is why chlorophyll itself and anything containing it (such as plant leaves, grass and so on) appears green, since that area of sunlight is reflected rather than absorbed. In fact, chlorophyll is so effective at absorbing light outside the green part of the spectrum that these colors are only revealed when the chlorophyll decays – hence the reason we have to wait till Autumn to see the reds, browns and yellows that are present in leaves but masked by the chlorophyll.

There are in fact two types of chlorophyll, rather unimaginatively termed Chlorophyll a and Chlorophyll b (note the lower case designation). These differ slightly in chemical composition and their absorption peaks. So type “a” has a wider gap between its peaks, which sit in the violet and red portions of the spectrum, whereas type “b” has its peaks closer together in the blue and yellow zones. Both of course avoid the trough of green that sits in the middle between blue and yellow, and by targeting adjacent areas (violet/blue and yellow/red) they extend the range of useable light, with absorption in the violet/blue region being especially beneficial in low light conditions. If you're not familiar with the layout of the spectrum, this graphic should help clear things up….



Photosynthetically Available Radiation (also called Photosynthetically Active Radiation and abbreviated to PAR) defines the spectral band between 400 and 700 nanometres (nm) as illustrated above where plants find light suitable for photosynthesis. The standard unit of measure for PAR is µmol (micromoles) per square meter per second which gives the photosynthetic photon flux density (PPF or PPFD) – essentially how much light is hitting a given area. Where lumens per watt are used to determine the efficacy of regular lighting (i.e. intended for humans), PPF holds sway in horticulture.

How much light do plants need?

Now generally speaking, the more light the better where plants are concerned; however there is a distinct point beyond which they are unable to make further use of extra light. This is rather boringly called the Light Saturation Point and for your average plant this is around about 500 µmol/m^2. For comparison, the maximum amount of PAR available on a clear summer day is 2000 µmol/m^2.

Subjecting plants to light in excess of their particular saturation point (this obviously varies for individual species) is not only wasteful but in fact counter productive as they will actually grow less well. An easy way to adjust the PAR is to simply alter the height of the lights above the plants. For example, the saturation point for lettuce is about 300 $\mu mol/m^2$ and a typical 130w LED grow light can deliver between 200-1400 $\mu mol/m^2$ as the distance is varied from 3 feet to 6 inches. The optimum height for growing lettuce would thus be at about 2 feet.

To sum up then, what plants require for healthy growth is light that radiates at four specific wavelengths (two types of chlorophyll times two absorption peaks each). To be technical, chlorophyll “a” absorption peaks are at 430 nm and 662 nm, and chlorophyll “b” sits within “a” at 453 nm and 642 nm. As we shall discover, understanding these basic principles can prove useful when evaluating the efficacy of different types of grow light.

However, that’s not quite the end of the science lesson. Plants don’t use both parts of the spectrum adjacent to the green portion at the same time. Generally speaking, the blue end is utilized more during early growth and the red end later during blooming. To complicate matters, sunlight is, by comparison to what most electric light bulbs can produce, very very bright.

A further difficulty is that light is governed by the Inverse Square Law which put simply means that every time you double the distance from a light source the amount of light received reduces not by 2, but by 2 squared i.e. 4. So any effective grow light has to allow for these various factors.

An Overview Of Grow Light Technologies

Pretty much every type of lighting technology ever developed has been tried for the purpose of growing plants. This covers conventional incandescent light bulbs, fluorescent tubes, the present market leaders which are high intensity discharge lamps (HIDs) including high pressure sodium (HPS) and metal halide (MH) lamps, and of course most recently LEDs.

Discounting regular incandescent and fluorescent lights, since these are not particularly effective for growing plants indoors, an interesting feature of MH lamps is that they produce light in the blue part of the spectrum while HPS lamps are characteristically yellow (street lighting has used sodium lamps for many years now). Between them they cover both sets of chlorophyll absorption peaks, but obviously you need both types of lamp in order to optimise both the early development and maturation phases of plants.

For this reason, some manufacturers have devised combination and switchable versions. It’s worth noting however that although HID lamps are extremely bright (they’re commonly also used as car headlight bulbs) they also get very hot and emit infra red (IR) and particularly in the case of MH lamps ultra violet (UV) radiation. While being potentially harmful in excess (or too close), both IR and UV light can of course significantly benefit many types of plants.

LED grow lamps use four separate LEDs (or LED clusters) each designed to emit light at one of the four chlorophyll absorption peaks. The main advantages of LED technology are not only very precise targeting of the key wavelengths of light, but that they are reasonably inexpensive, very bright, out last every other form of lighting bar none by a considerable margin, draw very little power, give off hardly any heat, and can be switched and programmed to produce whatever levels and mixes of light might be required at any given stage of growth. Don't forget though that plants, like animals, also need regular down time with the lights switched off – as a rule don't exceed eighteen hours per day.

LED Grow Lights

Light emitting diodes (LEDs) have come a long way from their humble origins as indicator lamps found in electronic equipment display panels. These days they pop up all over the place: in LED garden lights, replacements for halogen lamps in conventional 12v lighting circuits and as LED home lighting in general. It was only a matter of time before LED technology staked out yet more territory in areas such as, for example, stage lighting and recently of course, grow lights.

Like many other early applications of LED technology, the first LED grow lights struggled to attain sufficiently high levels of light, reliant as they were on clusters of first generation 1W to 2W LEDs (each equivalent to about a 25W incandescent bulb). Current versions use high powered LED modules of the type found in car lamps and contemporary kitchen lighting that can genuinely compete with most HID grow lights, but without the drawbacks (cost to purchase, maintain and power, high heat output, air conditioning requirements and inflexibility).

But be aware that not all LEDs are created equal, so check the power rating and stated luminous flux but also look for quality branding with regard o the diodes themselves – you generally won't get burned (pun intended) with names such as Cree, Philips, Epistar, Seoul Semiconductor and Osram for example. Like most consumer LED lighting applications, the initial cost is invariably well above the established alternatives, but don't be fooled. The payback from LEDs in terms of vastly lower ongoing running costs means that most folk should expect to recoup their investment within a year or two at most.

For professionals and serious amateurs it's an absolute no-brainer – the costs associated with operating regular electric lighting are frankly horrendous when you consider how much of the electricity bill (about 90% as it happens) goes towards producing unwanted waste heat which you then have to pay more money to dissipate with cooling systems. Future generations will doubtless look back at such practices with disbelief at the sheer lunacy of it.

And did anyone mention the maintenance? No need to – there isn't much to speak of, since LED grow light panels should last well over 50,000 hours (some claim 100,000, but let's keep expectations at a conservative level). By most estimates that works out at about ten years continuous use. It has to be pointed out though that the 50,000 hours mark is typically the point at which the performance of the LEDs has dropped to about 70% of their original and are thus considered to be at the end of their “useful” life span (they will likely continue shining for twice as long but with ever decreasing efficacy).

The main benefits though aren’t simply cost savings and reduced heat loss. Both fluorescent and HID lamps use noisy, very high voltage ballasts and require much sturdier mounting than lightweight, robust, low-voltage LED panels. Many people though are easily led astray by the fact that HID lamps “appear” to be very much brighter than LED equivalents.

Light intensity versus brightness

One of the biggest causes of confusion and disagreement in the world of grow lighting is the word “brightness”. The problem is that we constantly use the word colloquially to describe how things “appear” to us – it’s a bright sunny day, that bulb is a bit bright, etc. It is no way a scientific definition of light intensity – the number of photons hitting a specific area over time – and ignores wavelengths of light that humans are less sensitive to.

Take as an example an X ray light source. Is this bright? Well you can’t see it and you wouldn’t be able to read a book using X rays. But when you consider that a very short burst from an X ray machine can pass straight through you onto a film plate, casting shadows only where your bones got in the way, you have to conclude that maybe brightness and intensity aren’t one and the same thing after all.

Likewise, because LEDs accurately target the wavelengths preferred by plants they both don't need to be and in fact don't seem so bright to us, even though they are actually delivering a greater amount of "useful" light. That perception is further bolstered by the fact that HIDs emit a lot of light in the green/yellow part of the spectrum which increases their perceived intensity to the human eye (unlike plants we favor light around the 550 nm mark). But the fact is that they are just wasting all this additional light since it is of little benefit to plant life.

If we take a 400w HID as an example, about 260 watts of that will actually be completely outside the Photosynthetically Available Range (PAR) so at least 65% of the light (and the energy used to produce it) is completely wasted. So with less than 40% of the light generated by HPS and MH lamps being absorbed by plants, and barely 10% of

the electricity you pay to run them being actually converted into light in the first place this is not looking promising for conventional lighting. On these figure about 4% of the input energy ends up doing some good for the plant (it's not quite that bad to be honest, but it's fun to push the data around to draw extreme conclusions).
Some LED grow light systems do indeed include additional wavelengths, simply to enhance the visual appearance of the plants since foliage often looks black when lit purely by blue and red light. But there is no getting away from the fact that plants benefit enormously from the capability with LED lamps to smoothly vary the balance between blue and red exactly as needed.

Seedlings do better with the balance in favor of blue light, while crop yields can be significantly boosted by switching over to red towards the end of the growing cycle. In this way you can simply replace MH lamps for early growth and HPS lamps used later in the cycle with a single, dynamically variable solution that reduces running costs and maintenance issues at the same time.

Light intensity and distance

It's worth also reiterating here that because LED lights have a very low heat output, the Inverse Square Law of light (mentioned above) plays to their advantage. Let's say you have a set of grow lights positioned two feet from your plants that delivers, for the sake of argument, 400 lux (the intensity of light per square metre). If you halve that distance to one foot then the light delivered will be equivalent instead to 1600 lux – a massive increase in light density without any additional expenditure.
The problem for most conventional and especially HID grow lights is that at such distances there is a serious risk of scorching foliage and otherwise disrupting the plants' environment. With LED panels you can reduce the distance between plants and their light source to just a few inches, thereby gaining maximum light density and by the same token reducing the cost.

With LED grow light technology you can not only put money back in your pocket, but also feel comfortable about your carbon footprint. It's probably only a matter of time anyway before authorities start to monitor (and tax) waste heat. And speaking of the authorities, many serious indoor plant growers are all too well aware that their electricity usage profile can attract unwelcome attention – there tend to be assumptions made about what exactly is being grown (did someone mention cannabis?).

Another great benefit of switching to LED lighting is that you can realistically expect to run it using domestic solar power systems. Virtually all LED lamps require a low voltage input (typically 12 volts) that is well within the capacity of a standard home solar panel and battery. A whole new meaning to the term "green fingers"?

Things To Consider Before Buying Or Installing LED Grow Lights

If you've ever tried searching for an unbiased and informative LED grow light review to figure out what to look for, or even whether to consider buying an LED grow light at all, you'll be quite familiar with how frustrating this can be. Many "reviews" are little more than marketing for specific products and attempting to glean any understanding from forums and such like is a fool's errand. For every person who says they've had good results, there's another only too willing to argue that they're talking rubbish.

So what’s with this quasi religious debate? Well it has to do with the early days when LED was in its infancy and far more was claimed for it than was realistically possible. As discussed above, plants fundamentally need two things from light: specific wavelengths and amplitude (intensity). The reason that LED technology entered the fray in the first place was the realization that LED lights can be fine tuned to specific wavelengths. However the first attempts simply couldn’t back this up with enough power, and there wasn’t exactly much in the way of honesty about this particular shortcoming.

Needless to say, LED grow lights quickly got a poor reputation thanks to, let’s be clear about this, poor products. The problem though is that, once they take root, these kinds of prejudices can fester for a very long time and there are many who not only continue to base their opinions on them to this very day, but do not see any reason to re-examine the evidence. Which is unfortunate since modern LED systems compete head-on with HID in terms of performance and leave them standing when it comes to cost of ownership.

However, people still seem wedded to the principle of comparing oranges with apples. Yes, it is completely true that HID based systems are more “powerful” and “brighter” – but that’s because they have to be in order to compensate for the vast amount of power and light that they waste. And this is precisely where LED undermines them, because all that waste has a cost. Chucking out colossal quantities of heat and generating huge amounts of light that is outside the PAR (and therefore of no damn use) requires one heck of a lot more electricity than simply delivering exactly the right kind of light in just the right amount.

So, the first question most people want properly answered is: do LED grow lights work? The answer is unequivocal and affirmative. They really do work and very well, but there are a lot of products on the market that are frankly scams or, to be charitable, borderline fraudulent in even labeling themselves as LED grow lights.

Avoiding the sharks

The situation with LED grow lights is is some respects not unlike the world of double glazing, which at one point became a form of shorthand for sharp practices and sleazy sales techniques. There is nothing whatsoever wrong with well made and installed double glazing, and to comply with modern building regulations you are now compelled to install it anyway. The dodgy reputation came about thanks to the cowboys and crooks that jumped on the bandwagon and sold substandard products to make a quick buck.

Whenever something new comes along, the sharks are never circling far behind. So how do you protect yourself and avoid being ripped off for rubbish that wouldn’t grow anything? Well, as already mentioned above, don’t even bother with a product that has no-name components. Manufacturers of quality LED grow lights are only too keen to name-drop with regard to their LED supplier; in sharp contrast to the pile ‘em high sell ‘em cheap merchants who are pointedly silent on the subject. In fact if it’s wholesale, an import or cheap then avoid.

Good quality LEDs of any type are NOT cheap to buy – they do save a lot of money down the line, but the initial purchase price is always pretty steep. This is easily demonstrated with LED spotlights which cost anywhere from 10 times as much as conventional halogen lamps, but which nevertheless last 20 times longer and use 1/10th as much electricity.

Simple math tells you that it's worth spending 10 times more than you're used to spending next time you replace a spotlight, but… then you see that some LED spots cost much, much less. The trouble is that the supplier is coy about just how powerful they are and only when you've parted with your money do you discover that the "bargain" you bought is about as bright as a night light and effectively useless.

Another way to both protect yourself and help sift the gems from the dross is to look for suppliers who offer realistic trial periods and solid refund policies. You need to satisfy yourself that the product lives up to the claims and the only effective way to do that is to grow something using it – and that takes time. It also tells you that the supplier has complete faith in the quality of their product and is prepared to put their reputation behind it.

Be sure to check the quoted power figures. LED grow light panels for example are made up of clusters of individual LED modules, but the overall rating is less important than the power per LED and both of these ratings take second place to either lumens or PPF. Now prepare to be thoroughly confused, because some of this may appear counter intuitive (and also underpins some of the shady practices that have gotten this topic a bad name of late).

Light intensity versus light coverage

To be at all effective, each individual LED should consume at least one watt of power. Below this level there is insufficient penetrative power. There is a balance to be maintained between overall light coverage and individual light intensity. Consider for example replacing a 50w halogen lamp with 10 x 5w lamps – the intensity is simply not there.

So if (to use an example that may be familiar to some) a panel is rated at 13.8 watts using 225 LEDs then you can easily calculate that each one is 0.061 watts – about 16 times below the minimum threshold, or equivalent to using a 6w light bulb in place of a 100w one. It simply won't function at all, but because it is being sold as an "LED grow light panel" it's all too obvious where the mud will stick when folk find this out for themselves.

But there's more to it than that. What you should look for are high intensity or high brightness 1w LEDs that are specifically 10mm (rather than say 5mm or smaller) and are current generation, not the things used in Christmas lights and novelty toys. This is easier said than done because everyone calls their LEDs "hi intensity" irrespective of the truth of the matter since there is no agreed definition of the term. But you can compare what is used in any given product with a respected standard such as this Edison High Power 1w LED. Note that this lists luminous flux for LEDs emitting light at different wavelengths, so we can easily see that at 620~630nm we get 50 lumens (per watt, obviously since this is a 1 watt lamp).

Total lumens versus lumens per watt

However, things get even more complicated with LED lights. With conventional HID lamps, the higher the input wattage the higher both the total lumens and the lumens per watt, and so a 100w bulb is roughly twice as powerful as a 50w one.

This isn't so with LED lamps. At higher input power levels, each individual LED is certainly brighter but they are less efficient (fewer lumens per watt). There is also no effective difference in penetrative power for horticultural purposes between a 1W LED and a 3W LED. This is a fundamental difference between traditional and LED grow light systems. The former use a small number of very high power lights whereas the latter use many low powered light sources.

To go back to our Edison 1W LED by way of example, the same Edixeon S in the form of a 3w bulb is indeed brighter at a total of 85 lumens, but the lumens per watt figure is one third that at just over 28lm/w. Put another way, 3 x 1w LEDs gives a total of 150lm (3*50lm)which is a lot more light than 1 x 3w LED outputting 85lm. The same effect is observed as the wattage increase through 5 and 7 watt LEDs.

There's nothing inherently wrong in using higher wattage LEDs – they are genuinely much brighter, if less efficient – just don't compare apples with oranges. A board containing 90 x 1W LEDs will be both more powerful and more efficient than one containing 30 x 3W LEDs – you can't simply compare the wattages in the same way you're used to doing with HID systems.

There are also two further twists, the first of which is that in many cases the manufacturer will state the maximum power consumption of either each individual LED or the whole unit (so 3 watts or 150 watts for a unit with 50 LEDs), yet they don't actually drive them at the maximum. For 3 watt LEDs it is not uncommon to discover that, depending on which part of the spectrum they are targeting, they get limited to between 2.2 and 2.8 watts.

The reason is to coax the optimum luminous efficiency, heat loss and hence lifespan from each diode. For example, Epistar LEDs targeting 660nm are most efficient at 2.2 watts. Needless to say, the LEDs targeting other wavelengths will almost certainly be limited to their own specific optimum band and so you often cannot easily figure out the true consumption of the LEDs unless the manufacturer cares to state it.

Which leads to the second twist when evaluating LED grow lights, and one which is best explained by example. This 135W LED UFO uses 24 separate high power Epistar 5W LEDs of varying colors. Now 24 lots of 5 watts only comes to 120 watts total, and since we now know that most (or indeed all) of these LEDs will be running at some level below their rated maximum of 5 watts (probably about 4.6 on average), that leaves somewhere in the region of 25 watts that's "missing".
Where it's gone of course is in running the LED drivers and fans and out through the heat sinks as heat loss. So this 135 watt unit is in reality delivering about 110 watts of LED light. But then the exact same issues apply to a conventional HID only arguably much, much worse.

LED Grow Light Options

As regards specific types of LED grow lighting systems, there are numerous configurations with choices between UFO grow lights (so named because, well, they look like UFOs), grow light panels and single spot lamps. Then there is the color balance to consider. Typically the ratio varies between 4:1 and 8:1 red:blue and these days the balance can also be varied. When reviewing the red to blue light balance, be sure that specific wavelengths are stated (somewhere in the region of 660nm for red and 460nm for blue). Just "appearing" to be red or blue is not good enough.

Many 1st generation LED grow lamps were bi-band (just red and blue) which experience has shown to be insufficient for most plants. Although these two wavelengths satisfy the bulk of a plant's needs, most still require trace amounts of light from other portions of the spectrum. However, many growers reported good results even with these early models; here's an independent test from 2008 of the Cree Procyon 100 which was considered state of the art way back then, and yet still the subject of heated debate – plus ça change…

More modern (so-called 2nd generation) system are tri-band and incorporate an orange component and there are now 5 band lights that match both chlorophyll absorption peaks in the red and blue zones plus orange, a good example being the Illuminator Series of LED Grow Lights (the suppliers of which are also responsible for the video below).

You should be looking for anything above 90 watts, so an LED grow light 120 watts or more should suffice depending of course on your specific requirements and situation. The reason incidentally that it is common to find LED grow lights 120w advertised online is that this is approximately equivalent to most standard 400w HPS setups (in much the same way that in the world of domestic energy saving light bulbs a 6w LED is shorthand equivalence for a 50w halogen lamp).

Finally, the lighting system you choose should be guided by the type of plants you aim to grow (are they tall, bushy, especially leafy, etc) and the physical space. For example, is it a greenhouse or completely indoors, what are the clearances, is it for a grow tent? One aspect of LED grow lights in particular, namely the fact that they run cool means that instead of providing ventilation and ducting to dissipate excess heat, you may need to consider instead providing *additional heating*. Not only do LEDs give off very little heat anyway, but many systems have built-in ventilation fans which further cool things down. Many of the larger grow tents for example provide for a powered ventilation system to cope with the heat from an HID lamp. Obviously this is going to be way too much for indoor growing using LED grow lamps.

LED grow lights – the final verdict

So is the buzz about LED grow lights all hype or are they for real? Well, don't trust to "professional" grow light reviews (which not infrequently are written or commissioned by a supplier as a marketing tool) – simply check out what regular folk who just want to grow plants indoors have to say about their own real life purchases and experiences courtesy of the entirely open Amazon reviews. Sure, there's the occasional professional curmudgeon for a reviewer and the odd rotten product, but by and large LED grow lights completely live up to the claims, especially in the demanding domestic consumer market. And knowing what plants need and how LED lights work, now you know why.

Still not convinced? Have you ever considered gardening in space? Well, probably not, but NASA have since it's the only possible way to feed the crew on a trip to Mars. This is a seriously demanding environment with zero usable natural light available plus massive constraints on weight, spare parts, heat loss and power consumption. LED grow lights tick the boxes on every score and especially because of the ability to target only the spectral wavelengths required and save further energy by avoiding producing unusable light. And the results? Apparently the scientists ate the results and pronounced them delicious!

Finally, keep in mind that at the end of the day, what counts most with grow lighting is both light intensity (not to be confused with brightness) and accurate spectral calibration. One without the other is of little use and this simple fact underpins why LED technology is the way forward for horticulture lighting.

Find out more at: http://www.kulekat.com/led-home-lighting/do-led-grow-lights-work.html#ixzz1zmCCje9j