GENERAL INFO **ON LIGHTING**

Light is the most important factor in any indoor growing environment. It is also the limiting factor in any indoor growing environment. Without good and plentiful light, a plant will not be able to perform photosynthesis, the nitty-gritty process that occurs when a plant converts food into energy. Fortunately, plants are able to use artificial light, as long as there is plenty of it and it is of the correct growing spectrum.

Photosynthesis

Of the many light-absorbing pigments within a plant's leaf structure, the most active is chlorophyll. Chlorophyll absorbs light from the blue and red wavelengths of the visual spectrum, turning plants into that stunning green our eyes have come to know and love. The absorbed radiant energy is used to convert ingested carbon dioxide, water, and nutrients to make carbohydrates which nourish the plants and promote new cell growth. This allows for strong, vigorous tissue production and the release of oxygen. Correct lighting will result in healthy, happy plants that are resistant to infections or colonizing hordes of insect pests.

Light Spectrum

Plants are under the spell of the seasons and subject to seasonal changes in light. The blue end of the spectrum is associated with spring and longer days, promoting vegetative growth and a short, stocky stature. The red end of the light spectrum is reminiscent of autumn, with shortened days and long harvest sunsets. Autumn usually prompts plants to finish up, creating flowers and seeds. It also gives plants a sweet, poetic aroma, like the feeling one gets upon seeing a beautiful sunset. We are not making this light spectrum stuff up. Ask any plant!

Light Particles

Inexperienced growers often make the mistake of cramming too many plants under insufficient light. Without enough light particles to go around, plants will not have enough energy to grow. Plant growth will be spindly and weak, leaving the grower disappointed and confused. To avoid this happening to you, we suggest the use of a light meter to monitor exactly how much light your plants are receiving. A light meter uses a photo-sensitive cell that creates an electric current when it detects light particles and measures a reading in foot candles. From there, you can figure out if your plants are getting the optimum amount of light they need. Different plants require different amounts of light. Lettuce and herbs will need far less light than peppers or tomatoes, which must flower to produce their fruit. Plants that require hot, sunny days to grow well, will need quite a lot of artificial light to produce satisfactory results when grown indoors—don't starve them!

Lighting Cycles

One of the most important jobs of the indoor grower is reproducing the daily and seasonal flow of light. For vegetative growth—in addition to a bluer light spectrum—plants are exposed to long growing days that mimic spring and early summer. Plants that are meant to produce veggies, fruits, or flowers are encouraged to begin the budding process by a change in the light cycle and optimally, a change of the light spectrum. In general, 18 hours of light is best for vegetative growth and 12 hours of light is the best stimulus for flowering (although, some plants will prefer the exact opposite schedule).

Just about all plants need a regular period of light and dark. During the light stage plants absorb energy. In the dark stage plants build organic molecules from this absorbed energy. As you reproduce the cycle of nature, **consistency is very important**. Plants love a dependable pattern of light and will get stressed if the pattern becomes erratic. A good light-timer should be used in order to create regular intervals of lights-on and -off. These intervals can be scheduled conveniently as long as plants receive light and dark at the same time every day. The general range is 6-12 hours of darkness every day. It is important to not disturb plants during the dark period, so be careful about visits that may disrupt with light to the room during this time.

WHICH LIGHT **IS RIGHT FOR ME?**

Many lights on the market simply aren't suitable for really growing plants. Incandescent lighting (ordinary light bulbs, spot lights, "plant lights," etc.) shouldn't be considered. They're inefficient, not bright enough and have an incorrect color spectrum. If you want to grow plants using artificial light, there are two kinds of lights to be aware of: High-Intensity Discharge (HID) lights and fluorescent lights.

HID Grow Lights

High-Intensity Discharge (HID) lights come as close to natural light as technology allows. However, they're not so sophisticated as to completely reproduce the full spectrum. Consequently, two types of HIDs have been created to blend into a cohesive spectrum—the Metal Halide and the High Pressure Sodium. These lamps produce four to six times as many lumens as any incandescent light of the same wattage—and they last much longer. As close to natural sunlight as possible and even safer than a star? We guarantee these lights will never burst into a supernova or collapse in on their own gravity becoming a black hole and destroying the Earth. Nope. Never ever.

An HID lighting system includes a ballast that runs a light socket, powering a bulb. A reflective hood sits around the bulb and focuses light onto plants that would otherwise be lost. Reflectors are either painted white inside or plated with a highly reflective aluminum or brilliant chrome. Some reflectors allow for air cooling, which exhausts hot air out from the bulb and out of the room.

Metal Halide (MH)

These lamps bathe plants in light from the blue end of the spectrum. They are commonly used in the early vegetative stages of blooming plants' growth to create a strong plant which has large leaves and a thick stems to feed the fruit. One of the major benefits of MH lamps is that they promote tight internodal spacing between branches, keeping plants from stretching. MH light is used for plants that are expected to grow many leaves and become bushy, such as lettuce, spinach, cabbage and herbs. Recent strides in lighting technology have begun to produce MH bulbs that will reproduce a deeper more balanced "Blue" spectrum . The **Hortilux Blue** is an amazing "Full Spectrum" bulb with a CRI rating of 90+.

High Pressure Sodium (HPS)

HPS bulbs reproduce light from the red/orange end of the spectrum. Plants use this light in reproductive processes, which means that HPS bulbs help your plants to produce more fruits and flowers. Exposing plants solely to a red spectrum light tends to make them stretch, lose their color and start to look downright unnatural. New HPS bulbs are available to include blue light to promote better vegetative growth. Our personal favorite is **Ushio Opti-Red.** If you're only going to use one lamp, we recommend an balanced spectrum HPS, especially for plants that flower.

Fluorescents

For most of plant growing history, fluorescents have best been used during early plant stages - when using a larger wattage light would be a bit like frying an egg on the sidewalk. They are mainly used to sprout seedlings and initiate rooting in cuttings. They cover a wide spectrum, but until recently they were not capable of growing healthy plants full term.

WHICH LIGHT **IS RIGHT FOR ME?**

LEDs

LED grow lights can operate up to 40% more efficiently than a comparable HPS light. LEDs not only serve as a full spectrum of light—ideal for both veg & flower—on many of these fixtures, but also run more efficiently and produce less heat in the grow room. They offer great savings compared to DE light systems due to the efficiency in operation and little to no maintenance costs. LEDs come in a variety of modular designs and provide better uniformity across your plants as they are more intense while simultaneously dispersing light more evenly, and deeper into the plant.

Light fixture types range from LED panels to LED bars and light strips and LED Light bulbs. LED bars are slightly less expensive than panels and are a single row of diodes that come in different spectrums. These are typically used as supplemental light sources, and you will generally need more than one bar to light a grow room, so multi-bar fixtures like the **Gavita Pro 1700e** are a great solution. The **Gavita Pro 1700e** produces almost no heat. The open bar design passively cools the system. This fixture consists of 8 LED light bars, and this open design prevents heat build-up over the canopy. This allows you to place it closer to your canopy than other lights, cut down cooling costs, and maintain a perfect grow environment.

LED panels are the most common and allow growers either a full spectrum or the ability to switch between spectrums. These include heatsinks and a driver and often come with a warranty. We recommend the **Gavita CT 1930e** as it is the industry's first and only LED that is a 1:1 HPS replacement. It provides a wide, even light distribution that matches HPS light throw while improving coverage for plants on the periphery and is compatible with wiring and electrical requirements for most indoor growing environments. This compact toplight is able to dramatically limit the cost and downtime required to convert a facility of 20 and even 10,000 lights.

Double-Ended (DE) Digital Light Systems

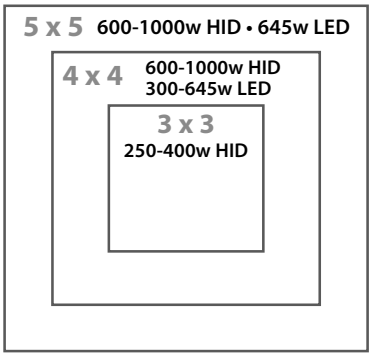
Along with being capable of up to 1150 watts of output (compared to the 1050 watts for a standard HPS bulb), the DE lamp reduces harmonic distortion (vibration), resulting in less physical wear on the lamp and its internal components. DE lamps also run at a higher frequency, which allows for a more complete spectrum. This all adds up to the most usable (PAR) light for the plants. The **Gavita SL2** and **Luxx DE** are great options when it comes to complete DE systems. Make sure you pair your DE bulb with a high frequency ballast.

High Output (T5) Fluorescents

High output (T5) fluorescents put off twice the amount of light when compared to normal (T12) fluorescents for the same electrical costs. An example would be a standard, two-foot T12 fluorescent bulb, which gives off 1000 lumens compared to a T5 two-foot bulb which gives off 2000 lumens—both use the same wattage. High output fluorescents, like compact fluorescents do really well with vegetative growing plants or keeping parent plants healthy. They can spread the light out over a square area (as in the the two-foot, 8-bulb fixture, taking up 2 ft. x 2 ft. of space) or over rectangular areas (as in the four-foot. 4-bulb or the four-foot. 8-bulb light fixtures) very well. High output fluorescents put off very little heat compared to the great amount of light that they produce. Not recommended for fruiting or flowering. These T5s need to be run in specific fixtures with special electronic ballasts that can power their output such as the **SunBlaze** units.

HOW MANY LIGHTS **IS RIGHT FOR ME?**

This is an age-old question that we feel needs some special attention. Of course no one can fully answer how many lights is right for any one grower. But, what we can offer is some useful information that will help you come to a decision that is right for you. The more light you add into a grow space, the more fruit / flowers you will produce. Light is directly proportional to yield (up to a point of full saturation). You cannot produce more light than what the sun would produce on its brightest day. So how do we decide what too much light is? Or how much light is enough for a given grow space? Below, we have gathered information that you can utilize to make your decision.

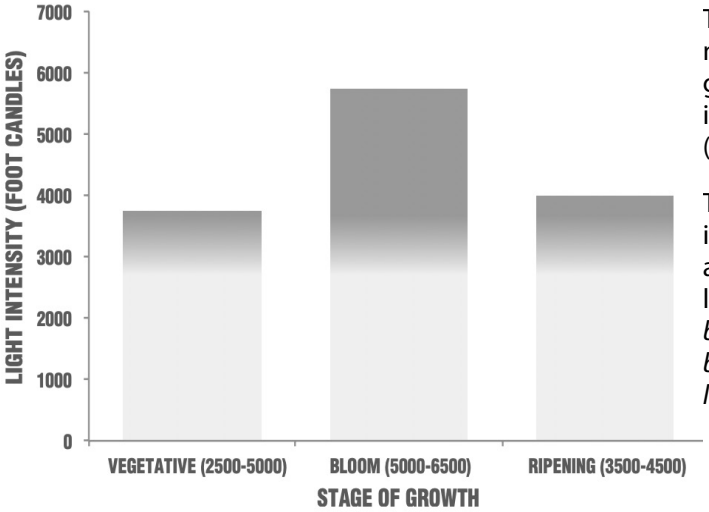


The diagram on the left indicates effective coverage areas for various light wattages. A 1000w HPS light will blanket a 4x4 area with light; even up to a 5 x5 or larger depending on the reflector and the stage of growth a plant is in. A 600w HPS light can cover anywhere between a 3x3 and 4x4 area of light depending on the reflector and the stage of growth a plant is in. A 400w light can spread up to a 3x3 area (even a 4x4 for plants in veg. growth). A 250w light can also cover up to a 3x3 area. From these simple measurments one can effectively decide how many lights are needed to light up any given grow space.

If you are planning on using LED grow lights, there are a few things you need to know about calculating your grow light coverage. For example, if your 5' x 5' growing space requires 320-480 watts of grow lighting, and you choose the LED route, an LED fixture at 645 watts will suffice. Most multi bar LED fixtures require a 5' x5' footprint (4' x 4' minimum).

Light Requirements for the Major Stages of Plant Growth

Different light levels are required for each stage of plant growth. A general rule of thumb is that 1/4-1/3 of the wattage used in the bloom stage is necessary for use in the vegetative stage. For example, lets say 41,000w lights are used in the bloom stage, then anywhere from two 400w lights to three 600w lights should be used for the vegetative stage. Beyond this, it is also important to spread the available light as evenly as possible. This depends on incorporating the layout diagram (above) with the use of a good reflector. Please see our info sheet on reflectors for more information on how to pick the best reflector for you.



To the left is a graph with foot candle/lux measurements to help dial in your system. As the graph shows, using 55-60,000 lux or 5500 foot candles is suggested for optimum growth in the main part (usually weeks 1-6 of the bloom [fruit/flower] stage).

The max sunlight on Earth's surface is 90,000 lux and is not good for plant growth. Generally speaking, anything over 70,000 lumens is beyond the optimum level of light for photosynthesis to occur. *Don't become a grower that over does their lighting. Just because it is "cool," doesn't mean it is not too intensely lit.*

LIGHTING QUESTIONS **ANSWERED**

What is the difference between HPS and MH?

Although high pressure sodium (HPS) and metal halide (MH) are types of high intensity discharge (HID) lights, they emit a different color spectrum. HPS bulbs emit very bright light that is concentrated in the red to yellow side of the spectrum and are weak on the blue-violet end. In contrast, MH bulbs emit a very balanced light containing all the energy peaks of the visible light spectrum, leaning more towards the blue end. Another difference is the lumens per watt of both bulbs. Lumens is the measurement for the efficiency of the bulb or how much light is produced for the amount electricity used. Sodium bulbs are the brightest and are more efficient, producing between 97 and 150 lumens per watt. Halide lights produce 65-115 lumens per watt.

Why do people use MH light for vegetative growth and HPS light for flowering?

HPS bulbs can make some plants grow "leggy" and stretched out due to the high yellow to red spectrum of light they emit. MH bulbs tend to keep plants "tighter" with less space between internodes. Consequently, some will use MH lights during vegetative stage to keep the structural growth of the plant nice and tight, but will switch to HPS during the flowering stage when plants need more light. Although HPS bulbs don't have as balanced a spectrum as MH bulbs, the intensity of light they provide promotes flower and fruit development. HPS bulbs will give you about 30-35% more yield in the bloom phase when compared to MH lights. If you are going to use only one light, we suggest an HPS bulb with increased blue spectrum capacity like the **Hortilux** or **Ushio**.

What size light do I need?

What is the size of the plant area that you need to cover? To find out, multiply length x width to get the square footage. To achieve the optimum level of lumens, you need between 20 (minimum) and 60 (maximum) watts per sq ft. For example, if you have a 4'x4' area (equals 16 sq ft) multiplied by 30 watts you get 480 watts. This means you need at least a 400 watt light, but would do much better with a 600 or 1000 watt grow light. Keep in mind the actual amount of light you'll need depends on the requirements of the type of plants you are growing. There may be several different arrangements that will offer optimum light energy. For example, to achieve a total of 2400 watts, you could use one 400 and two 1000 watt lights or four 600 watt lights, etc.

Because LED grow lights operate so efficiently, manufacturers will display a wattage equivalent to HPS. It is often best to reference the PPFD or lux measurement because wattage can vary from LEDs to HPS with close to the same strength of light. A multi-bar LED light can cover a 4' x 4' to 5' x 5' area at 645 watts. High bay LED lights can reach up to 6' x 6' coverage in a single fixture.

When designing a room with multiple lights consult with one of our sales associates to find the appropriate layout. Let us help map it out for you!

What is the difference between 120-volt and 240-volt lights?

Both 120-volt and 240-volt lights operate with the same 100% output and use roughly the same amount of electricity. A 600 watt light uses the same amount of current in 120-volts as in a 240-volts light. The standard household outlet is 120-volts. You may want to get a 240-volt outlet if you plan on running several lights off of one circuit breaker. The maximum wattage on a 120-volt circuit is 1500 watts, per the National Electric Code. With proper wiring, 240-volt circuits can carry up to 5760 watts. This means that you can plug several high powered lights into a lighting timer that will power them all on and off on the same circuit. 240-volts is also considered to be more *stable* because it uses half the amps. To calculate, use the equation, amps x volts = watts. You can achieve some savings using 240-volts because there is less amperage, thus there is less heat and less conductivity. This begins to add up as more power is consumed.

What is the life cycle of HID bulbs?

MH bulbs should be changed at least every 6-12 months if you're burning them 18 hours per day. We recommend changing most HPS bulbs every 6-9 months because the available lumens begin to decrease after that point.

LIGHTING QUESTIONS **ANSWERED**

How long should I leave my HID light off before I turn it on again?

When MH bulbs are turned off they should be left to cool for 20 minutes before restarting. Turning a MH bulb on when it is already hot severely shortens the life of the bulb and can affect the intensity of the light. MH lights should be replaced after a year of heavy use. HPS bulbs can be restarted after being shut off for only two or three minutes. HPS bulbs should be replaced every 6-9 months.

How much does it cost to run a HID lamp?

To calculate how much it will cost to run different HID lamp wattages you will need to determine how much you pay for electricity per kilowatt hour. (Refer to your electric bill—it is usually anywhere from .20 to .40 cents per kilowatt hour). A 400 watt light running for 12 hours a day costs between $40 to $60 per month. A 1000 watt light running for 12 hours a day costs anywhere from $100 to $150 per month. It all depends on how much you pay for electricity. One light is not a large drain on your electricity bill.

What precautions should I take with my light?

Keep remote ballasts elevated on a cinder block or shelf in case you end up with a lot of water on the floor. Do not use extension cords with 250, 400, or 1000 watt light systems and be sure to use a three-pronged ground timer. To protect your investment from power surges and spikes, use a surge suppressor. It is not advisable to run your lamp on extension cords. Young plants are more prone to heat damage from your light system. Keep lights at least three feet away and even farther for larger lights. As plants get older they can handle the extra heat and the plant-to-light distance can be decreased.

Why is everyone switching to LED lights? Is it really worth the investment?

LEDs produce far less heat, partly due to their efficiency, partly due to the technology itself. These heat reductions are further complimented when you factor in the modern-day design of LED's—the open bar styles help heat dissipate above the fixture rather than below. They are built with LED diodes, which can have a lifespan of over 50,000 hours! This all results to saving money in labor, replacement bulbs, and energy costs.

What LED lights do you recommend?

The **Gavita CT 1930e** is our preferred choice for high bay LED fixtures as it is a 1:1 HPS replacement and has one of the highest ambient temperature ratings on the market, as high as 55° C. Its IP66 wet rating means that each fixture is protected against dust, oil, and even streams of water. This gives you the power to easily combat sulfur and other residue build-ups with jet sprayers while keeping people and your equipment safe. Install wherever you grow—in low rooms, on vertical racks, over rolling benches, or even in tents.

For those interested in trying out multi-bar LEDs, but not quite ready to invest in a **Gavita Pro 1700e** system, we highly recommend **Luxx Lighting LED Pro 645w** and **Growers Choice ROI-E720** Full-Spectrum LED fixtures. The Luxx Pro plug-and-play design ships ready to run, straight out of the box. Its design removes clutter from mounting by easily attaching to uni-strut and allows you to adapt light movers to their room, removing the need for rope ratchets and extra wires in the grow room. This unique LED can be hung from either 2 or 4 contact points. The ROI-E720 was engineered with greater dimensions to provide more versatility and better canopy coverage, and delivers the entire spectrum of light to your plants, giving them exactly what they need to grow big and beautiful.

The most affordable recommendation is the **EcoGrow 630w LED** multi-bar light which is well made and comes with a 5yr warranty. With only 630 watts pulled from the wall, the **EcoGrow** series grow light provides a complete full spectrum ideal for the vegetative stage through the flowering phase, resulting in increased crop quality and yields over similar wattage LEDs on the market. The design of these fixtures allows light to be spread throughout the entire footprint more evenly, reducing hot spots and delivering uniform levels of photosynthesis flux density, or PPFD.