HYDRO 101

A 8 STEP GUIDE TO SUCCESSFUL INDOOR HYDRO GARDENING

The Right Environment

- Key components include relative humidity, temperature, CO2, and air circulation/exchange
- Ideal humidity is between 40%-60%
- Some plants like higher humidity, but that can lead to problems with fungus and disease
- Ideal temperature is between 68°-75° F
- Plants need CO2 to grow - with good air circulation and exchange, a room will naturally have between 300-400 PPM without supplemental CO2

Start With Good Water

- Water quality is essential to plant growth
- PPM (parts per million) or EC (electrical conductivity) measure salts in a solution
- Start off with a low PPM or EC and add nutrients specific to your plant variety requirements
- A Reverse Osmosis system can reduce PPM/EC
- pH (potential hydrogen) measures acidity or alkalinity in a solution on a scale of 0-14
- pH should range 5.8-6.2 in hydro and 6.0-6.8 in soil
- Nutrient "lockout" occurs in too high or low pH levels

Choose A Method

- Ebb & Flow gardens flood and drain a tray of plants with a nutrient solution at regular intervals
- Drip gardens provide a nutrient solution to each plant through tubes & emitters (drip stakes)
- Aeroponic gardens mist an oxygenated nutrient solution directly to the roots of its plants
- NFT (Nutrient Film Technique) gardens flow a slow moving nutrient solution over the plants roots
- Organics are possible using many methods, and are often grown in container gardens

Choose A Media

- Growing mediums act as the root anchor system
- Coco is made from the husks of a coconut, is pH stable, and provides moisture retention and aeration
- Expanded Clay pebbles provide moisture retention and aeration and are reusable if sterilized
- Rockwool stone is heated and spun into fibers then compressed, provides an excellent oxygen to water ratio, though flushing/conditioning is recommended
- Silica helps slow transpiration, provides moisture retention and aeration, and is reusable if sterilized
- Peat mixes can be altered to varying air/water ratios

Nutrients/Fertilizers

- Liquid/Dry nutrients can be organic or synthetic
- Over or under fertilizing can cause burning, curling or yellowing of plants
- Most nutrient bottles are labeled with N-P-K (Nitrogen, Phosphorus, and Potassium)
- Additives/supplements can bolster microbial activity at the root zone, strengthen plant cell walls, increase flower sites, shorten length to harvest, increase size, flavor and aroma of fruits and flowers and more
- When used together, nutrients and supplements will help you achieve maximum results

Grow Lighting

- MH (Metal Halide) and HPS (High Pressure Sodium) are types of HID lights used in grow rooms
- MH lamps = Blue spectrum for vegetative
- HPS lamps = Orange/Red spectrum for flowering
- T5 lamps are high-output fluorescents with low heat/energy consumption ideal for cuttings, mother plants, and short growth cycles
- DE (Double Ended) lighting is a full spectrum HID lamp with a higher par reading than a single ended
- Plants in vegetative stage need 15-18 hrs. of light
- Plants in bloom stage need 10-12 hrs. of light

Testing Equipment

- There are many meters available for testing solution pH, PPM, and EC
- Environmental controllers and meters are available to automate and more accurately control and maintain the temperature, humidity, CO2 and lights
- Testing equipment for the water-nutrient solution, light, room temperature and humidity, CO2, and air circulation is the key to a providing optimal conditions for a bountiful garden

Optional Accessories

- Grow/Garden room accessories are essential for optimized growth and harvest
- Atmosphere drive devices such as fans, blowers, CO2 emitters, and integrated timers are a grow rooms greatest accessory
- Trellising, stakes, supports, shears, and labels are useful when growing fruiting/flowering crops
- Pest and disease control may be needed and there are many organic options available
- For more information visit SunlightSupply.com!

hy•dro•pon•ics
noun: the science of growing or the production of plants in nutrient rich solutions or moist inert material, instead of soil.

Hydroponic crops can use up to 90% less water than soil grown crops, when in a recirculating system.

1/4 — You can plant 4 times the amount of hydroponic crops in the same area that soil crops need to grow.

x2 — Hydroponic crops can grow twice as fast.

Hydroponically grown crops can be grown organically and without the use of herbicides & pesticides.

Sunlight Supply, Inc.
National Garden Wholesale®
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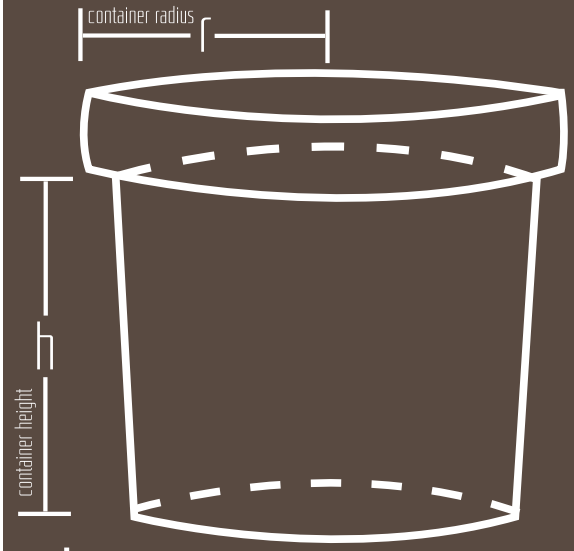
INDOOR SOIL GARDENING 101

A 7 STEP GUIDE TO SUCCESSFUL INDOOR ORGANIC GARDENING



Base: often peat or coco fiber or some combination

Aeration component: Perlite, vermiculite, lava rock, or rice hulls

Supplemental biological additive: compost or worm castings

Fertilizer: organic amendments like bone meal and kelp, or synthetic fertilizer

container volume estimate

$$V = \pi r^2 h$$

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National Garden Wholesale
sunlightsupply.com

Choose a Potting Mix/Mix Your Own

- Potting Mixes are typically peat-based mixes with perlite and other materials that unlike soil, are light weight and have great air/water holding properties
- Sphagnum Peat Moss is naturally acidic and often used with dolomite lime to raise pH
- Perlite is a coarse substrate derived from volcanic rock and used to improve drainage and aeration
- Coco is made from the husks of a coconut, is pH stable, and provides moisture retention and aeration
- Worm Castings and Composted Waste add beneficial biology that help plants access nutrients in the soil

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WHY USE SUPPLEMENTAL LIGHTING FOR INDOOR OR GREENHOUSE GARDENING?

High intensity discharge (H.I.D.) lighting has traditionally been used only by commercial growers in large scale greenhouses. These business savvy professionals have long understood the exceptional benefits of supplemental, artificial lighting for plant growth. From stronger, healthier seed starts, into faster maturing, vigorous plants that offer much higher yields and more spectacular flowering than can be achieved without supplemental lighting. H.I.D. lighting not only supplements sunlight, but can actually replace it during long winters where sunlight is in short supply. It is very energy efficient and the cost of operating one of our light systems is comparable to using one of your kitchen appliances.

Plants need light for proper growth. The light spectrum range produced by artificial light (particularly H.I.D. light) enhances the natural light derived from the sun by many times over. The result… when combined with proper nutrients… is nothing short of AMAZING! And the best news is… this technology once available only to the commercial market is now available to you. All this being said, what can supplemental lighting do for a home hobby grower?

- SIGNIFICANTLY INCREASE the health, strength, growth rate and yield of your plants.

- SUPPLEMENT NATURAL SUNLIGHT in your backyard greenhouse virtually eliminates seasonal & geographical restraints. In addition, by extending the "day length" with supplemental lighting, you will greatly enhance your growing success.

- CONTAINER PLANTS that are outdoors on decks and patios during the summer can be moved indoors during the winter under H.I.D. or high output fluorescent light allowing them to thrive year round.

- INDOOR GARDENING – Why settle for gardening just a few months of the year? By using one of our light fixtures as a primary light source indoors, you can enjoy the hobby of gardening all year long!

High Intensity Discharge lighting systems have revolutionized indoor gardening in the last two decades. They are the most energy efficient grow lights available, so they produce much more light for the amount of power consumed.

LINEAR FLUORESCENTS

Traditional T12 and T8 fluorescent lighting is simply not powerful enough to light an area more than 8-10 inches below the bulb. With the recent introduction of the highly efficient T5 technology, T5 linear fluorescent fixtures can now put out a respectable 92.6 lumens per watt. T12 lamps typically put out about 30 lumens per watt. T5 fixtures are excellent for starting seeds and cuttings, but are also able to produce enough light for full term growth. Because of their minimal heat output, they can be placed very close to the plant canopy to maximize the light output.

HIGH WATTAGE SELF BALLASTED GROW LAMPS

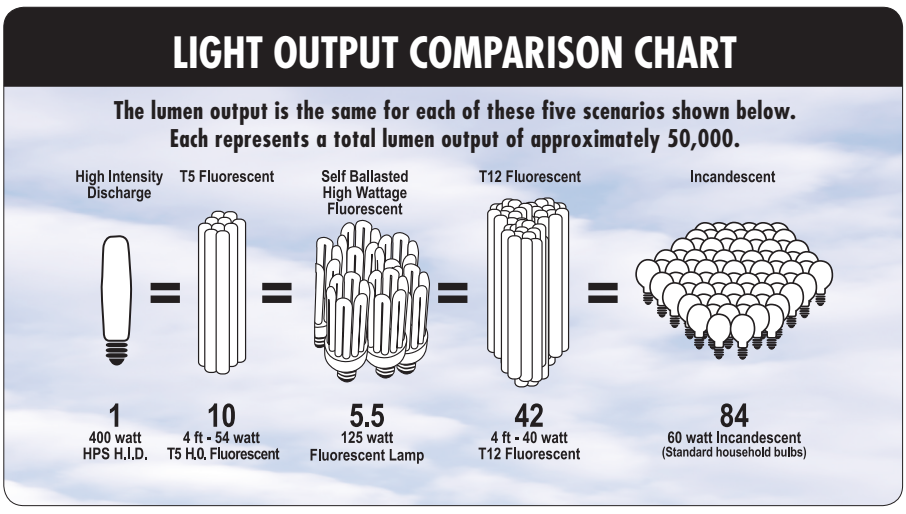
These lamps have become quite popular in the recent past. We offer Feliz brand mogul base fluorescent lamps that put out about 70 lumens per watt. They are excellent for starting seeds or to use over a small garden area.

INCANDESCENT LAMPS

These standard household bulbs do not emit enough light, or the proper spectrum to be used by serious gardening enthusiasts. They are not very efficient, using a considerable amount of power for the light they emit. They are typically only about 15 lumens per watt.

WHICH LIGHT IS RIGHT FOR YOU?

Most gardeners use at least 25 watts per square foot of garden space. You may need less if your light is used to supplement natural sunlight, or if you are growing a plant that does not require as much light (i.e. lettuce). However, many gardeners prefer to double or even triple the recommended wattage to achieve faster growth rates. There is really no such thing as too much light, but using a big light in a small space will sometimes result in high temperatures that are difficult to control. Keep in mind that plants need periods of darkness too. Most indoor gardeners use lighting from 12 - 18 hours per day.



HANGING HEIGHT

A general guideline for the proper hanging height of an H.I.D. lamp would be 12″ - 48″ depending on wattage (see below). Make sure to check for excessive heat at the top of your plants by placing your hand (palm down) over your plants. If the top of your hand is hot, you need to move your lamp up higher. If the light source is too close to your plants, you can burn them. Remember that as your plants grow you will need to adjust the height of your lamp. Please keep in mind that the latest air-cooled reflectors, like the Super Sun® 2 allow you to place higher wattage bulbs closer to plants than was possible in the past.

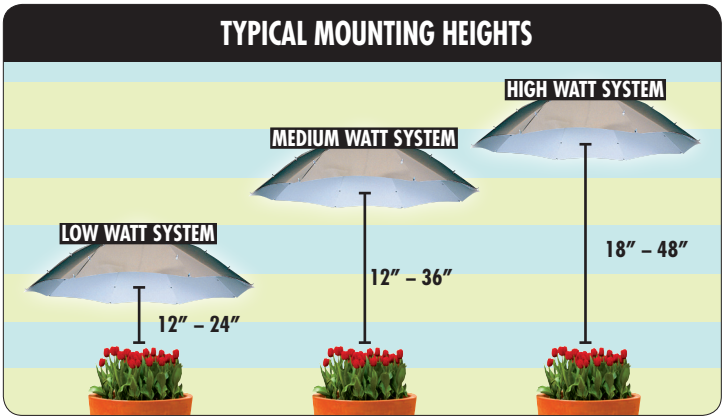
When you raise the light up & away from your plants, you need to be aware of the light levels at your plants will be significantly reduced.

As light moves away from its source (the lamp) it diminishes as follows:

1/Distance^2. For example: 1ft. = 1000 FC, 2ft. = 250 FC, 3ft. = 111 FC, 4ft. = 63 FC, 5ft. = 40 FC, & 6ft. = 28 FC.

COVERAGE AREA

A fluorescent fixture can be placed much closer to plants than an H.I.D. fixture because it produces very little heat. You should place your fluorescent lights as close to the tops of your plants as you can without excluding the outside perimeter of your garden.



H.I.D. AVERAGE COVERAGE AREA BY WATTAGE

150/175 watts covers approx 2′ x 2′ area
250 watts cover approx. 3′ x 3′ area
400 watts covers approx. 4′ x 4′ area
600 watts covers approx. 6.5′ x 6.5′ area
1000 watts covers approx. 8′ x 8′ area

NOTE: Coverage area may be reduced if this is your primary light source.

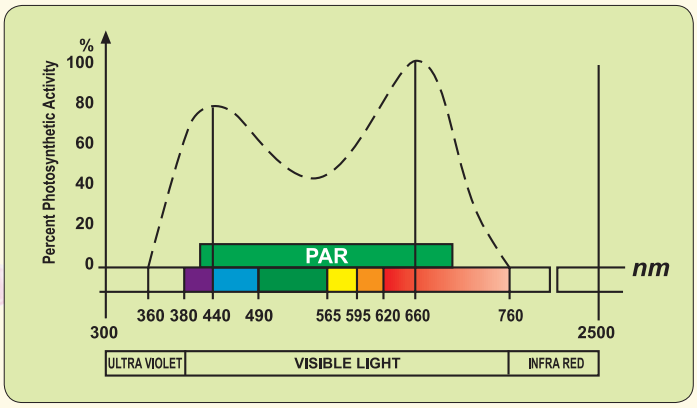
HIGH PRESSURE SODIUM (HPS) OR METAL HALIDE (MH)

If you choose H.I.D. as your source of lighting, you have another choice...HPS or MH. Sunlight Supply®, Inc. offers lights in MH and HPS. Metal Halide (MH) bulbs emit a light spectrum which appears blue-white to the human eye. This color spectrum is more conducive for vegetative growth, or starting seeds and cuttings. High Pressure Sodium (HPS) bulbs emit a spectrum which is more concentrated in red/orange light. This color is ideal for the fruiting and flowering stage of a plant's development. It is a good multi-purpose light as well.

Your style of gardening will determine which type of light is best for you. Whichever model you choose, you can be assured that your investment into the lighting technology used by the professional will be rewarded by increased, nutrition packed yields, lovelier flowers and healthier plants!

LIGHT REQUIRED FOR PHOTOSYNTHESIS

Only part of solar radiation is used by plants for photosynthesis. The photosynthetically active radiation (PAR) contains the wavelengths between 400 and 700 nanometers, and falls just within the so-called visible spectrum (380-770 nm). The total visible spectrum is perceived by us humans as white light, but with the aid of a prism, we see that the "white" light is actually separated into a spectrum of colors from violet to blue, to green, yellow, orange and red. Plants use the blue to red light as their energy source for photosynthesis.



FAQ - HORTICULTURAL LIGHTING

General Lighting Questions:

1) What is HID Lighting?

HID lighting stands for High Intensity Discharge, which is a special type of lighting that is much more intense (brighter) than other type of lighting available. An HID lighting system consists of a ballast, reflector, socket and lamp (light bulb). The ballast acts like the engine, converting and driving energy to illuminate the lamp. HID lighting options include High Pressure Sodium (HPS), Metal Halide (MH), Mercury Vapor and Low Pressure Sodium. The two typically used for plant growth are HPS and MH systems.

2) What is Color Rendering Index (CRI), Color Temperature (K) and Lumen?

Color Rendering Index is a subjective measurement of how well a lamp source renders colors. A measurement of the degree of color-shift an object undergoes when illuminated by a light source when compared to a reference source of comparable color temperature. Incandescent light is assumed to have a CRI of around 100 so it will render all colors correctly. MH only has a CRI of about 70, so only 70% of colors will be rendered correctly. HPS has a CRI of 22.

Color Temperature is not how hot the lamp is. Color temperature is the relative whiteness of a piece of tungsten steel heated to that temperature in degrees Kelvin. HPS has a warm (red) color temperature of around 2200ºK as compared to MH at 4200ºK, which has a cool (blue) color temperature. What is important to remember about these two terms is that CRI readings, of two sources, can only be compared if their color temperature is equal. You cannot compare the CRI of HPS (CRI=22) vs. Metal Halide (CRI=70) because the color temperatures are different (2200ºK vs. 4500ºK).

Lumen is a measurement of light output. It refers to the amount of light emitted by one candle that falls on one square foot of surface located at a distance of one foot from the candle. Traditionally, lumens have been the benchmark of a lamps ability to grow plants; meaning the brighter the lamp the better the plant. However, studies have shown that a broader color spectrum lamp will perform much better than a lamp with high lumen output, especially when it comes to plant growth.

3) What is the difference between MH and HPS with regards to plant growth?

MH lamps provide more of the blue/green spectrum, which is ideal for leafy crops, and/or plants that are in a vegetative (actively growing) stage. MH lamps provide a more natural appearance in color and are typically the choice for plants that have little to no natural light available. HPS lamps provide more yellow/orange/red spectrum, which is ideal for most plants that are actively fruiting and flowering. In addition, HPS lighting is the choice for growers looking to supplement natural sunlight. Ideally, the horticulturalist will use MH to grow their plants and HPS to fruit and flower their plants.

4) What is the difference between HID and Fluorescent lighting with regards to plant growth?

Traditionally, fluorescent lighting was used for seedlings, cuttings and plants with low light-level requirements and HID was used for established plants and plants with higher light-level requirements. Advances in fluorescent lighting technology, however, have provided more options for horticulturists. T5 fluorescent lighting is the latest in plant growth lighting. T5's high-light output combined with its low heat and energy consumption makes it an ideal light source to grow a broader array of plants.

5) What are the benefits of using T5 fluorescent lighting for plant growth?

T5 lamps provide the ideal spectrum for plant growth. Photosynthesis rates peak at 435 nm and 680 nm. A 6500K T5 lamp has a spectral distribution with relative intensity peaks at 435 nm and 615 nm. This equates to very little wasted light energy in terms of plant growth. T5 lamps promote incredible health and vigor of seedlings and cuttings. Root development is superior relative to other lighting sources. While T5 lighting is excellent for starting seeds and cuttings, it's also able to produce enough light for full term growth. Because of their minimal heat output, T5 lamps can be placed 6˝ – 8˝ above the plant canopy which maximizes photosynthetic response. Unlike conventional fluorescents, plants grown under T5 lamps do not have to be rotated to the center of the lamp. T5's slim diameter enables better photo-optic control of the emitted light, increasing efficiency in the form of even light distribution.

FAQ - HORTICULTURAL LIGHTING

Environmental Impacts of T5 (at a glance):

- T5 lamps have a diameter of 5/8" – smaller is better when it comes to manufacturing, transportation and disposal.
- Reduction in raw materials and components needed for manufacturing.
- Reduction in lamp and fixture packaging materials due to relative size.
- T5 are constructed of 40% less glass than T8.
- T5 contain 30% less phosphor than T8.
- T5 contain 3mg of mercury. 70% less than T8.
- Longer lamp life means reduced maintenance cost and less going to the landfill.

6) What are the major differences between HID ballasts and electronic ballasts?
Frequency output to the lamp and energy conversion from electricity to usable light are the biggest differences between HID ballasts and electronic ballasts. HID ballasts produce a frequency of 60 Hz. Electronic ballasts vary from manufacturer to manufacturer, but the frequency produced can be 400x that of an HID ballast. HID ballasts produce more heat than electronic ballasts, thus making electronic ballasts more energy efficient. You will not, however, save money on your electric bill by using electronic ballasts. HID lighting has been available for 60+ years, while electronic ballast (especially 400 watt and higher) is a relatively new technology.

7) Are electronic ballasts more energy efficient?
Electronic ballasts are more efficient at converting electricity into usable light. Since your power bill is based on kilowatt-hours and not efficiency, a 1000 watt electronic ballast will cost you about the same as a 1000 watt HID ballast to operate.

8) How much energy will my light use?
An average lighting system will increase your electricity cost about $8 to $20 per month. The exact amount depends on the wattage of the system and the number of hours operated. To calculate your cost, multiply the bulb wattage by the number of hours of operation and divide by 1000. This figure is the number of kilowatt-hours of electricity used. (Example: a 400 watt lamp running for 18 hours will use 7.2 kilowatt-hours). Check your power bill for the cost of each kilowatt-hour. Then multiply the number of kilowatt-hours used by the cost of a kilowatt-hour (K/hr) to figure the cost to run your light for that many hours.

9) Do I need special wiring in my house for my lighting system?
Lighting systems are available in a variety of voltages. The standard used by most gardeners is 120 volts / 60 Hz which plugs into a standard wall outlet. Other voltages may require special circuits and receptacles. Always contact a licensed electrician if the light you purchased has special voltage requirements and never exceed more than 75% of the rated ability of the fuse/breaker. (For example: use no more than 15 amps on a 20-amp circuit.)

10) What voltages are available for HID and Fluorescent lights?
HID systems are available in 120 volt, 208 volt, 240 volt, 277 volt and 480 volt. Fluorescent lighting varies, but most are available from 120 volt to 277 volt and 50 Hz or 60 Hz.

11) Will I save on my electric bill if I run my system with 240 volts?
No. Electric companies base your electrical bill on Wattage, not Voltage or Current. While ballasts wired for 240 volt will draw less current and run a little cooler than one wired for 120 volt, it will not save you money on your electric bill.

12) How often do I need to change my light bulb?
Most lamp manufacturers rate their lamps by "Average Life Hours" and usually claim 10,000 to 24,000 hours. These ratings are based on when the lamp will completely fail to come on. They do not factor in loss of intensity or loss of color. HID lamps lose intensity and color through normal use. This is OK if you are lighting a warehouse, but when it comes to plant growth, these losses can mean wasted electricity and poor plant performance. Serious horticulturalists recommend that you replace your lamps after 6000 hours of use. This equates to using your light 16 hours a day for one year

FAQ - HORTICULTURAL LIGHTING

13) How long should I run my lights?
This depends on the type of plants and whether you have natural sunlight available to your garden. As a general rule, when you are in a vegetative stage of plant growth and you have no natural sunlight, run your lights 14-18 hours a day. If you have natural sunlight, it will vary because the sunlight may or may not be direct. It will take a little experimenting to find the best length of time to run your lights. If you are actively fruiting and flowering, the rule is to run your lights 12 hours a day if you have no natural light.

14) How high do I need to hang my lights above my plants?
The higher the wattage the further away you want the light to be from your plants due to the amount of heat. HID lighting will be further away than a fluorescent fixture because of this. When mounting your lighting fixture take into account the type of plant and how tall the plant will grow. You want to keep the light as close as you can, but not so close to burn the plant. A simple rule is "if it is comfortable for the back of your hand, it will be a safe distance for your plants". Doing a little research on the type of plant and where it comes from will help in determining how much (or little) light your plants like. With fast growing plants, you may need to check the hanging height on a regular basis as plants that get too close to the lamp will be severely burned.

15) How big of an area will my light cover?
The size of the garden area will determine the wattage you need. If we assume that the plants will get no sunlight, a 1000 watt light will cover about 7 x 7 feet of growing area. A 600 watt will cover 6 x 6 feet, a 400 watt will cover 4 x 4 feet, and a 250 watt will cover 3 x 3 feet. These sized areas would be considered the "Primary Growing" areas. These lights will light-up larger areas, but plants placed outside of the Primary Growing area, will stretch and bend toward the light; a phenomenon called phototropism. Keep these areas of coverage in mind when using multiple fixtures. The best results occur when the areas of coverage overlap.

16) Why do I need glass to get the ETL Listing on a Metal Halide light?
Edison Testing Laboratories has stated that for a metal halide fixture to maintain its ETL Listing, that an additional tempered safety lens is required. The purpose of the glass is to prevent UV exposure in the event of an outer jacket failure.

17) Can I run a 1000 watt bulb in my 400 watt lighting system?
No! The internal components of the ballast are designed to send the correct voltage and current for the rated lamp. Mixing lamps and ballasts will result in premature failure and will void the manufacturers' warranty. Consider the size area you want your garden to be prior to making a lighting purchase. It is better to grow into a fixture than out of one.

18) Can I run a 430 watt bulb in a 400 watt lighting system?
Yes, the internal components of 400 watt and 430 watt ballasts are almost identical. You will only get 400 watts of light out of the 430 watt lamp, however.

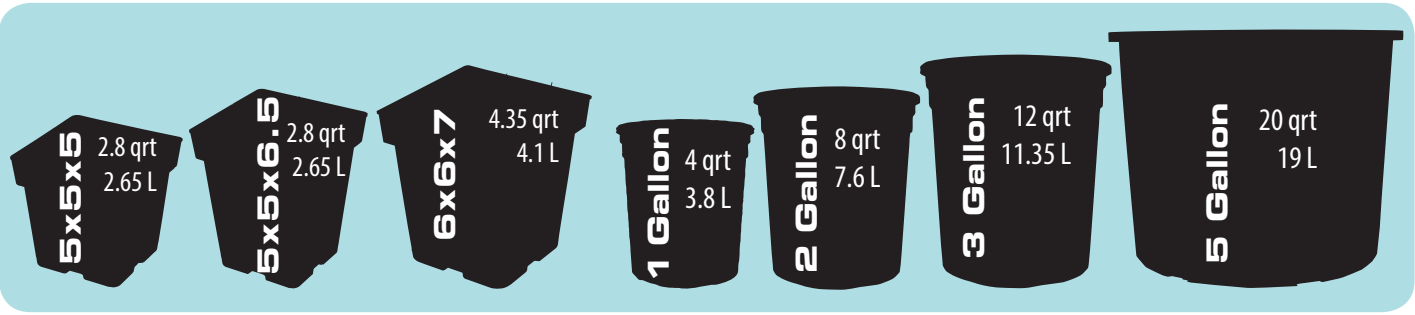
19) Do I need to wear gloves when handling an HID light bulb?
Manufacturers do not state that gloves are required when handling their lamps. It is recommended that your hands be thoroughly washed prior to handling HID lamps though.

20) What is a conversion bulb?
A lamp that operates on the opposite ballast it was originally designed for. For example, a 940 watt conversion lamp is an HPS lamp that runs on a 1000 watt Metal Halide Ballast. There are also MH lamps that are designed to operate on HPS ballasts. These bulbs allow the grower to purchase the ballast of their choice and offer the flexibility of growing a variety of plant types by simply changing the lamp they need.

21) How do I clean the inside of my Sun System® Reflector?
Warm water and mild dish soap are the best to clean and maintain the highly reflective finish. Avoid bleach, ammonia and other harsh or abrasive cleaners.

22) How do I set up a grow light?
Scan the QR code for the complete assembly of a grow light.

Container Capacities



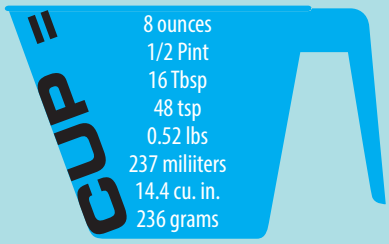
Common Size Conversion

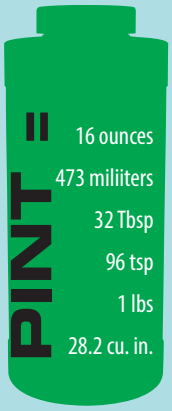
2 Tbsp = 1 fluid oz
4 Liter = 0.26 Gallons
10 Liter = 2.64 Gallons
6 Liter = 5.28 Gallons

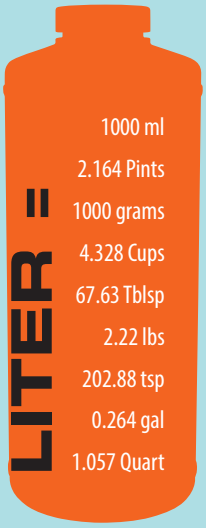
1 ml = 1/5 tsp
5 ml = 1 tsp
30 ml = 1 fluid oz
1 ml = 20 drops

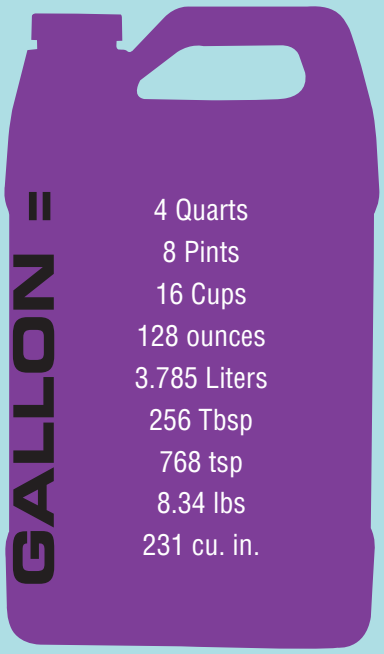
—	3.38 ounces	100 milliliter	0.1 Liter
1/2 Cup	4 ounces	118.3 milliliter	0.118 Liter
1/2 Pint	8 ounces	237 milliliter	0.237 Liter
2.5 Gallon	320 ounces	9464 milliliter	9.464 Liter
5 Gallon	640 ounces	18930 milliliter	18.93 Liter
6 Gallon	768 ounces	22710 milliliter	22.71 Liter

1/2 ounce 180 drops
15 ml 15 grams
3 tsp 0.663 cup

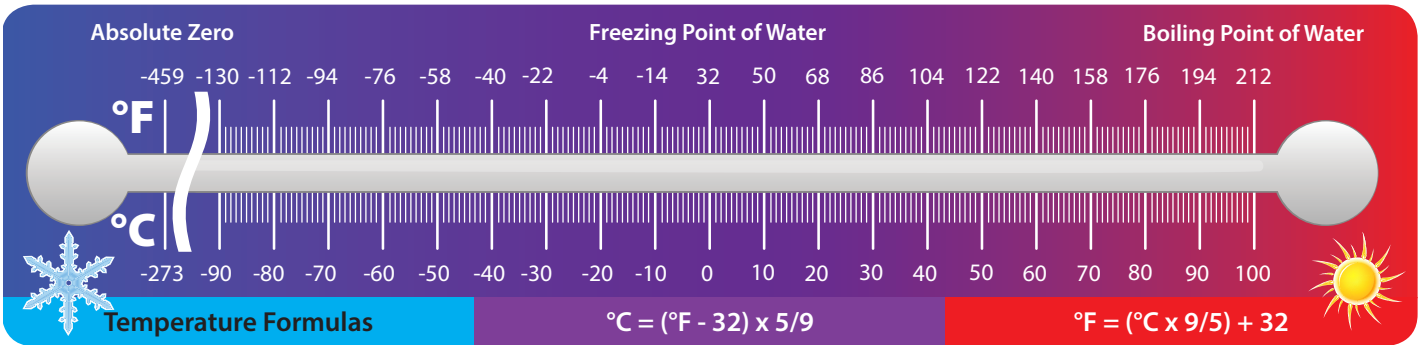








°F/°C Temperature Conversion



Beneficial Insects

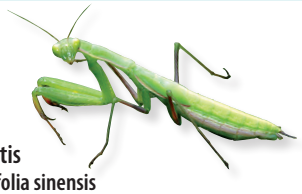

Aphid Predator
Aphidus sp.


Lacewing
Chrysoperla rufilabris


Lady Beetle
Hippodamia convergens


Mealybug Destroyer
Montrousieri Cryprolaemus


Minute Pirate
Bug Orius sp.


Praying Mantis
Tendora aridifolia sinensis


Predatory Mite
Phytoseiulus persimillis


Trichogramma
spp.


Whitefly Parasite
Encarsia formosa

Destructive Insects, Mites


Aphid


Aphid (winged)


Bagworm Larva


Billbug


Cucumber Beetle


Cyclamen Mite


Earwig


Fungus Gnat (Adult)


Fungus Gnat (Larva)


Lacebug


Mealybug


Rose Chafer


Sowbug


Spider Mite


Spittlebug


Thrips


White Fly


White Grub

Definitions & Abbreviations

PPM ➤ parts per million	mho ➤ conductivity	mS ➤ millisiemen	uS ➤ microsiemen
TDS ➤ total dissolved solids	EC ➤ electrical conductivity	pH ➤ potential hydrogen	1 Siemen ➤ 100mS
1 mS ➤ 1000 uS	1 mS ➤ 500 ppm (standard)	1 mS ➤ 650 ppm (horticultural)	1 mg/liter ➤ 1 ppm

C Carbon	Ca Calcium	Cl Chlorine	Cu Copper
Fe Iron	F Fluorine	H Hydrogen	K Potassium
MN Manganese	Mo Molybdenum	N Nitrogen	Na Sodium
O Oxygen	P Phosphorus	S Sulfur	Zn Zinc

Light & Power Formulas

Amps = Wattage ÷ Voltage

Voltage = Wattage ÷ Amps

AMPS are how many electrons flow past a certain point per second. VOLTAGE is a measure of how much force that each electron is under. WATTAGE is the electric power required by an appliance or device.

1 footcandle = lumen/ft^2

MEASUREMENT CONVERSION CHART

This measurement conversion chart, provided by Bluelab®, is a useful tool for all hydroponic growers. It allows you to convert between common units of measure when testing your nutrient solution.

Bluelab Measurement Conversion Chart

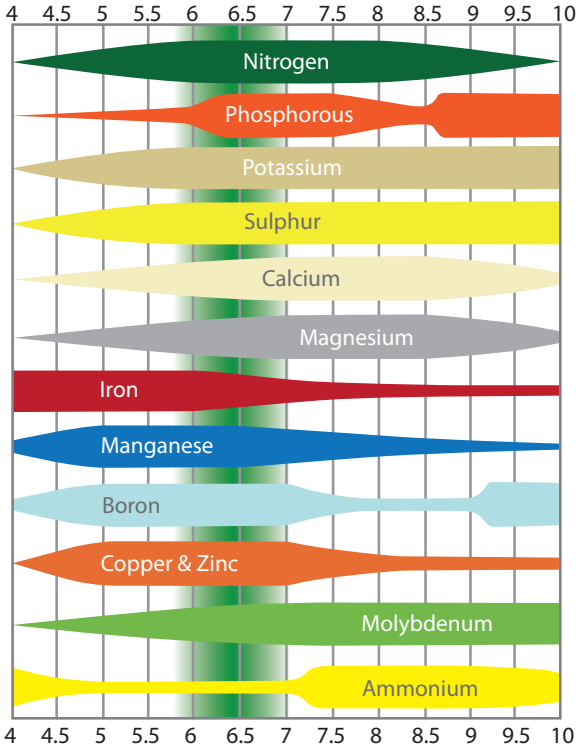
mS/cm² millisiemen per cm²	EC	CF	ppm 500 (TDS) (USA)	ppm 700 (UK, CA, AUST)
0.1	0.1	1	50	70
0.2	0.2	2	100	140
0.3	0.3	3	150	210
0.4	0.4	4	200	280
0.5	0.5	5	250	350
0.6	0.6	6	300	420
0.7	0.7	7	350	490
0.8	0.8	8	400	560
0.9	0.9	9	450	630
1.0	1.0	10	500	700
1.1	1.1	11	550	770
1.2	1.2	12	600	840
1.3	1.3	13	650	910
1.4	1.4	14	700	980
1.5	1.5	15	750	1050
1.6	1.6	16	800	1120
1.7	1.7	17	850	1190
1.8	1.8	18	900	1260
1.9	1.9	19	950	1330
2.0	2.0	20	1000	1400
2.1	2.1	21	1050	1470
2.2	2.2	22	1100	1540
2.3	2.3	23	1150	1610
2.4	2.4	24	1200	1680
2.5	2.5	25	1250	1750
2.6	2.6	26	1300	1820
2.7	2.7	27	1350	1890
2.8	2.8	28	1400	1960
2.9	2.9	29	1450	2030
3.0	3.0	30	1500	2100
3.1	3.1	31	1550	2170
3.2	3.2	32	1600	2240
3.3	3.3	33	1650	2310
3.4	3.4	34	1700	2380
3.5	3.5	35	1750	2450
3.6	3.6	36	1800	2520

pH - Why it's important

The pH scale, from 1 to 14, measures acid-to-alkaline balance. The number 1 is the most acidic, 7 is neutral, and 14 most alkaline. Every full-point change in pH signifies a ten-fold increase or decrease in acidity or alkalinity. For example, soil or water with a pH of 5 is ten times more acidic than water or soil with a pH of 6. Water with a pH of 5 is one hundred times more acidic than water with a pH of 7. With a ten-fold difference between each point on the scale, accurate measurement and control is essential to a strong, healthy garden.

Most plants grow best in soil with a pH from 6.5 to 7. Within this range plants can properly absorb and process available nutrients most efficiently. If the pH is too low (acidic), acid salts chemically bind nutrients, and the roots are unable to absorb them. An alkaline soil with a high pH causes nutrients to become unavailable. Toxic salt buildup that limits water intake by roots also becomes a problem. Hydroponic solutions perform best in a pH range a little lower than for soil. The ideal pH range for hydroponics is from 5.8 to 6.8. Some gardeners run the pH at lower levels and report no problems with nutrient uptake. The pH of organic soil mixes is very important because it dictates the ability of specific pH-sensitive bacteria.

Measure the pH with a soil test kit, litmus paper, or electronic pH tester, all of which are available at most nurseries. When testing pH, take two or three samples and follow instructions supplied by the manufacturer "to the letter". Soil test kits measure soil pH and primary nutrient content by mixing soil with a chemical solution and comparing the color of the solution to a chart. Most of these kits are difficult for novice gardeners to achieve accurate measurements. Comparing the color of the soil/chemical mix to the color of the chart is often confusing. If you use one of these kits, make sure to buy one with good, easy-to-understand directions, and ask the sales clerk for exact recommendations on using it.



This pH Chart (right) shows the Safe Zone is between 5.8 and 6.8.

The NPK's of Growing

(N) NITROGEN

Nitrogen is essential for plant growth. Nitrogen is a part of every living cell. The two forms of nitrogen which plants take up are in the ammonia (NH4) and nitrate (N03) ion forms. Most agronomic crops take up most of their nitrogen in the nitrate ion form. Plants will utilize N in the (NH4) ion form if present and available to the plant.

Lack of nitrogen and chlorophyll means that plants cannot utilize sunlight as an energy source to carry on essential functions such as nutrient uptake. Research has proven a foliar or leaf application of nitrogen is one form of application that can supplement a plant's nitrogen requirements during the growing cycle.

- Nitrogen is necessary for chlorophyll synthesis and as a part of the chlorophyll molecule involved in photosynthesis.
- Nitrogen is also a component of amino acids.
- Nitrogen is needed for growth of plants.

From the Greek words "nitron genes" meaning "nitre" and "forming" and the Latin word "nitrum". Discovered in Scotland by Daniel Rutherford in 1772.

(P) PHOSPHORUS

Phosphate is a very important plant nutrient (macro-nutrient) needed for the plant to complete its normal production cycle. The highest level of P in young plants is found in tissue at the growing stage. As plants mature most of the P moves into the flower and then to the seed or fruit.

- Phosphorus is needed for photosynthesis.
- Phosphorus is necessary for plant respiration.
- Phosphorus is essential for energy storage and transfer.
- Phosphorus is needed for cell division.
- Phosphorus is necessary for cell enlargement.
- Phosphorus is essential for several other plant processes.

From the Greek word "phosphoros" meaning "bringer of light" (an ancient name for the planet Venus?). Discovered in Germany by Hennig Brand in 1669.

(K) POTASSIUM

An important function of Potassium is it's influence in efficient water use. It helps in the process of opening and closing of plant leaf pores, called the stomata. Potassium is found in cell walls which surround stomata. Adequate amounts of Potassium can increase stress conditions on plants during drought conditions. Potassium is also responsible for producing quality crops.

- Potassium is essential for protein synthesis.
- Potassium is important in the breakdown of carbohydrates, providing energy for plants.
- Potassium helps to control ionic balance.
- Potassium is important in the translocation of minerals.
- Potassium helps plants to overcome effects of disease.
- Potassium is essential in the fruit formation stage.
- Potassium helps improve shelf life of fruits and vegetables.
- Potassium is involved in the activation of more than 60 enzymes which regulate the rates of major plant growth reactions.

From the English word "potash" and the Arabic word "qali" meaning alkali ("K" comes from the Latin word "kalium"). Discovered in England by Sir Humphrey Davy in 1807.

GLOSSARY

Alternating Current (AC): An electric current that reverses its direction at regular occurring intervals. Homes have AC.

Acid: An acid or sour substance has a pH below 7.

Aeration: Supplying soil and roots with air or oxygen.

Aeroponics: Growing plants by misting roots suspended in air.

Alkaline: Refers to a substance with high pH; Any pH over 7 is considered alkaline.

All-Purpose (General-Purpose) Fertilizer: A balanced blend of N-P-K; All purpose fertilizer is used by most growers.

Amendment: Fortifying soil by adding organic or mineral substances in order to improve texture, nutrient content or biological activity.

Ampere (Amp): The unit used to measure the strength of an electric current.

Annual: A plant that normally completes it entire life cycle in one year or less. Tomatoes are examples of annual plants.

ANSI: American National Standards Institute requires a specific code be printed on the lamp and on the corresponding ballast. These codes must match in order for the system to operate properly.

Arc: Luminous discharge of electricity (light) between two electrodes.

Arc Tube: A quartz container for luminous gases also houses the arc in HID lights.

Auxin: Classification of plant hormones; Auxins are responsible for foliage and root elongation.

Bacteria: Very small, one-celled organisms.

Beneficial Insect: A good insect that eats bad flower and vegetable munching insects.

Biodegradable: Able to decompose or break down through natural bacterial or fungal action, substances made of organic matter are biodegradable.

Bolt: Term used to describe a plant that has gone to seed prematurely.

Bonsai: A very short or dwarfed plant.

Breaker Box: Electrical circuit box having on/off switches rather than fuses.

Breathe: Roots draw in or breathe oxygen, stomata draw in or breathe carbon dioxide.

British Thermal Unit (BTU): Amount of heat energy required to raise the temperature of one pound of water by one degree Fahrenheit.

Bud Blight: A withering condition that attacks flower buds.

Buffering: The ability of a substance to reduce shock and cushion against pH fluctuations.

Bulb: The outer glass envelope or jacket that protects the arc tube of an HID lamp.

Bulbs: Common are tulips and daffodils planted in the fall for spring blooms, or forced indoors for winter blooms.

Calyx: The pod harboring female ovule and two protruding pistils, seed pod.

Carbon Dioxide: (CO_2) A colorless, odorless, tasteless gas in the air necessary for plant life and biomass accumulation.

Carbohydrate: Neutral compound of carbon, hydrogen and oxygen. Sugar, starch and cellulose are carbohydrates.

Caustic: Capable of destroying, killing or eating away by chemical activity.

Cell: The base structural unit that plants are made of; cells contain a nucleus, that houses it's DNA.

Cellulose: A complex carbohydrate that stiffens a plants tissue.

CFM: Cubic feet per minute.

Chelate: Combining nutrients in an atomic ring that is easy for plants to absorb.

Chlorine: Chemical used to purify water.

Chloroplast: Containing chlorophyll.

Chlorosis: The condition of a sick plant with yellowing leaves due to inadequate formation of chlorophyll. Chlorosis is caused by nutrient deficiency, usually iron or imbalanced pH.

Clay: Soil made of very fine organic mineral particles. Clay is not suitable for container gardening.

Climate: The average condition of the weather in a garden room or outdoors.

Color Spectrum: The band of colors (measured in nm) emitted by a light source.

Color Temperature: The relative whiteness of a piece of tungsten steel heated to that temperature in degrees kelvin.

Color Tracer: A coloring agent added to many commercial fertilizers, so the horticulturist knows there is fertilizer in the solution.

Compaction: Soil condition that results from tightly packing soil; compacted soil allows for only marginal aeration and root penetration.

Companion Planting: Planting garlic, marigolds, etc., along with other plants to discourage insect infestation.

Compost: A mixture of decayed organic matter.

Core: The transformer in the ballast is referred to as the core in HID lighting systems.

Corms, Rhizomes and Tubers: Dormant stems planted in the fall for spring blooms, or forced indoors for winter blooms. Common varieties are dahlias and irises.

Cotyledon: Energy storage components of a seed that feed the plant before the emergence of its first true leaves.

Cross-Pollinate: Pollinating two plants having different ancestry.

Cubic Foot: Volume measurement in feet: L" x W" x H" ÷ 1728" = Cu. Ft.

Cutting: (1) Growing tip cut from a parent plant for asexual propagation (2) Clone.

Damping-Off: Disease that attacks young seedlings and cuttings causing stem to rot at base.

Direct Current (DC): An electric current that flows in only one direction.

Deplete: Exhaust soil of nutrients, making it infertile.

Desiccate: Cause to dry up. Insecticidal soap desiccates its victims.

Dioecious: Having distinct male and female organs on different plants within the same species.

Dome: The part of the HID outer bulb opposite the neck and threads.

Dome Support: The spring like brackets that mount the arc tube within the outer envelope.

Drainage: Way to empty soil of excess water: with good drainage, water passes through soil evenly.

Drip Line: A line around a plant directly under its outermost branch tips: Roots seldom grow beyond the drip line.

Drip System: A very efficient watering system that employs a main hose with small water emitters.

Dry Ice: A cold, white substance formed when carbon dioxide is compressed and cooled; dry ice changes into CO_2 gas at room temperature.

Electrode: A conductor used to establish electrical arc or contact with non-metallic part of circuit.

Elongate: Growth in length.

Envelope: Outer protective bulb or jacket of a lamp.

Equinox: The point at which the sun crosses the equator and day and night are each 12 hours long; the equinox occurs twice a year, in spring and fall.

Feed: Deliver nutrient to the plant via roots or foliage.

Female: Pistillate, ovule, seed-producing.

Ferreting: To fertilize and irrigate at the same time.

Fertilizer Burn: Over fertilization: first leaf tips burn (turn brown) then the leaves curl.

Flat: Shallow (three inch) deep container, often 18 by 24 or 10 by 20 inches with good drainage, used to start seedlings or cuttings.

Fluorescent Lamp: Electric lamp using a tube filled with fluorescent material, which has a low heat output.

Foliage: The leaves or more generally, the green part of a plant.

Foliar Feeding: Misting fertilizer solution which is absorbed by the foliage. Best to do when first turning on your lights.

Foot-Candle: The unit is defined as the amount of illumination that the surface of an imaginary 1-foot radius sphere would be receiving if there were a uniform point source of one candle in the exact center of the sphere. The foot-candle is equal to one lumen per square foot. Foot-candle is a derived unit of illuminance from Lux. One foot-candle is equal to 10.76 lux.

GLOSSARY

Fungistat: A product that inhibits fungus keeping it in check.

Fungus: A lower plant lacking chlorophyll which may attack green plants; mold, rust, mildew.

Fuse: Electrical safety device consisting of a metal that melts and interrupts the circuit when circuit is overloaded.

Fuse Box: A box containing fuses that control electric circuits.

GPM: Gallons per minute.

Gene: Part of a chromosome that influences the development of plant; genes are inherited through sexual propagation.

Genetic Make Up: The set of genes inherited from parent plants.

Halide: Binary compound of a (halogens) with an electropositive elements.

Hermaphrodite: One plant having both male and female organs; the breeding of hermaphrodites is hard to control.

Hertz (hz): A unit of frequency that cycles one time each second: a home with 60 Hertz AC current cycles 60 times per second.

HID: High Intensity Discharge.

Honey Dew: A sticky, honey like substance secreted into foliage by aphids, scale and mealy bugs.

Hood: Lighting reflector.

HOR: The abbreviation stamped on some HID bulbs meaning they must be burned in a horizontal position.

Horizontal: Parallel to the horizon, ground or floor.

Hormone: Chemical substance that controls the growth and development of a plant. Root-inducing hormones help cuttings root.

Humidity: (relative): Ratio between the amount of moisture in the air and the greatest amount of moisture the air could hold at the same temperature.

Humus: Dark, fertile, partially decomposed plant or animal matter; humus forms the organic portion of the soil.

Hybrid: An offspring from two plants of different breeds, variety or genetic make up.

Hydrated Lime: Instantly soluble lime, used to raise pH or sweeten soil.

Hydrogen: Light or colorless, odorless gas; hydrogen combines with oxygen to form water.

Hygrometer: Instrument for measuring relative humidity in the atmosphere.

Inbred: (True Breed) Offspring of plants of the same breed or ancestry.

Inert: Chemically non-reactive; inert growing mediums make it easy to control the chemistry of the nutrient solution.

Intensity: The magnitude of the light energy per unit; intensity diminishes the farther away from the source.

Jacket: Protective outer bulb or envelope of lamp.

Kilowatt Hour: Measure of electricity used per hour; a 1000-watt HID uses one kilowatt in one hour.

Lacewing: Beneficial insects that preys on aphids.

Leach: Dissolve or wash out soluble components of soil by heavy watering.

Leaf Curl: Leaf malformation due to over-watering, over fertilization, lack of magnesium, insect or fungus damage or negative tropism.

Leaflet: Small immature leaf.

Leaves: The external part of a plant attached to branches and stems for the purpose of taking in light from the sun's energy. They do this with chloroplasts in the cells which contain chlorophyll.

LEC (Light Emitting Ceramic) metal halide: Ceramic metal halide high intensity discharge lighting is the next generation of the traditional metal halide lighting, offering longer life, improved lumen characteristics and energy savings.

LED: Light-Emitting Diode: a semiconductor diode that emits light when conducting current and is used in electronic equipment, especially for displaying readings on digital watches, calculators, lights, etc.

Leggy: Abnormally tall internode space, with sparse foliage. Leggyness of a plant is usually caused by lack of blue light or CO2. Too much nitrogen can also cause this.

LEP (Light Emitting Plasma): Plasma, the fourth state of matter is a type of compact, long life lighting source powered by a radio frequency.

Life Cycle: A series of growth stages through which a plant must pass in Its natural lifetime; the stages for an annual plant are seed, seedling, vegetative and floral.

Light Mover: A device that moves a lamp back and forth or in a circle across the ceiling of a garden room to provide more even distribution of light.

Lime: Used in the form of dolomite or hydrated lime to raise and stabilize soil pH.

Litmus Paper: Chemically sensitive paper used for testing pH.

Loam: Organic soil mixture of crumbly clay, silt and sand.

Lumen: Measurement of light output: one lumen is equal to the intensity of light emitted by one candle that falls on one square foot of surface located one foot away from one candle.

Macro Nutrient: One or all of the primary nutrients N-P-K or the secondary nutrients magnesium and calcium.

Mean: Average throughout life; HID's are rated in mean lumens.

Meristem: Tip of plants growth.

Micromol: µmol. A unit of measurement for PAR photosynthetic active radiation (a specific wavelength of light spectrum).

Micro Nutrient: Also referred to as trace elements, including S, Fe, Mn, B, Mo, Zn, and Cu.

Millimeter: Thousandth of a meter approximately .04 inch.

Moisture Meter: An electronic device that measures the exact moisture content of soil at any given point.

Monochromatic: Producing only one color; LP sodium lamps are monochromatic.

Mother Plant: The original source plant that clones or cuttings are taken from.

Mulch: A protective covering of organic compost, leaves, etc.; indoors, mulch keeps soil too moist and possible fungus could result.

Nanometer: .000000001 Meter, nm is used as a scale to measure wave lengths of light; color and light spectrums are expressed in nanometers (nm).

Necrosis: Localized death of a plant part.

Neck: Tubular glass end of the HID bulb, attached to the threads.

Nutrient: Plant food, essential elements N-P-K, secondary and trace elements fundamental to plant life.

Ohm's Power Law: A law that expresses the strength of an electric current; volts times amperes equals watts.

Organic: Made of, or derived from or related to living organisms. In agriculture organic means "natural". In chemistry organic means "a molecule or substance that contains carbon".

Ovule: A plant's egg found within the calyx, it contains all the female genes; when fertilized, an ovule will grow into a seed.

Oxygen: Tasteless, colorless element, necessary in soil to sustain plant life as well as animal life.

Parasite: Organism that lives on or in another host organism; fungus is a parasite.

Peat: Partially decomposed vegetation (usually moss) with slow decay due to extreme moisture and cold.

Perennial: A plant, such as a tree or shrub, which completes its life cycle over several years.

pH: A scale from 1 to 14 that measures the acid to alkaline balance of a growing medium (or anything); in general plants grow best in a range of 5.5 to 6.8 pH.

pH Tester: Electronic instrument or chemical used to find where soil or sater is on the pH scale.

Photometrics: The study of light, especially color.

Phosphor Coating: Internal bulb coating that diffuses light and is responsible for variations in color outputs.

Photoperiod: The relationship between the length of light and dark in a 24 hour period.

GLOSSARY

Photosynthesis: The building of chemical compounds (carbohydrates) from light energy, water and carbon dioxide.

Phototropism: The specific movement of a plant part towards a light source.

Pigment: The substance in paint or anything that absorbs light, producing (reflecting) the same color.

Pollen: Fine, dust like micro-spores containing male genes.

Power Surge: Interruption or change in intensity of electricity.

Primary Nutrients: N-P-K

Propagate: (1) Sexual: Produce a seed by breeding different male and female flowers (2) Asexual: To produce a plant by taking cuttings.

Prune: Alter the shape and growth pattern of a plant by cutting stems and shoots.

PVC Pipe: Plastic (polyvinyl chloride) pipe that is easy to work with, readily available and used to pipe water into a garden room.

Pyrethrum: Natural insecticide made from the blossoms of various chrysanthemums.

Root Bound: Roots stifled or inhibited from normal growth, by the confines of a container.

Roots: Their purpose is to anchor a plant and provide a means in which to feed and hydrate a plant.

Rejuvenate: Restore youth; a mature plant, having completed its life cycle (flowering), may be stimulated by a new 18 hour photo period, to rejuvenate or produce new vegetative growth.

Salt: Crystalline compound that results from improper pH or toxic buildup of fertilizer. Salt will burn plants, preventing them from absorbing nutrients.

Secondary Nutrients: Calcium (ca) and Magnesium (mg).

Seed Pod: A dry calyx containing a mature or maturing seed.

Short Circuit: Condition that results when wires cross and form a circuit. A short circuit will blow fuses.

Socket: Threaded, wired receptacle for a bulb.

Soluble: Able to be dissolved in water.

Spore: Seed like offspring of a fungus.

Sprout: (1) A recently germinated seed (2) Small new growth of a leaf or stem.

Square Feet (Sq Ft): Length (in feet) times width equals square feet.

Stamen: Male, pollen-producing.

Starch: Complex carbohydrate; starch is manufactured and stored in food.

Sterilize: Make sterile (super clean) by removing dirt, germs and bacteria.

Stroboscopic Effect: A quick pulsating or flashing of a lamp.

Stress: A physical or chemical factor that causes extra exertion by plants; a stressed plant will not grow as well as a non stressed plant.

Stomata: Small mouth like or nose like openings (pores) on leaf underside, responsible for transpiration and many other life functions; the millions of stomata, must be kept very clean to function properly.

Sugar: Food product of plant. Carbohydrates that contain hydrocarbon chain.

Synthesis: Production of a substance, such as chlorophyll, by uniting light energy and elements or chemical compounds.

Tap Root: The main or primary root that grows from the seed; lateral roots will branch off the tap root.

Tepid: Warm 70 to 80 degrees F (21 to 27 degrees C); always use tepid water around plants to facilitate chemical processes and ease shock.

Terminal Bud: Bud at the growing end of the main stem.

Thin: Cull or weed out weak, slow growing seedlings.

Transformer: A device in the ballast that transforms electric power from one voltage to another.

Transpire: Give off water vapor and bi-products via stomata and carbon dioxide intake at the leaves.

Trellis: Frame or netting (lattice) that trains or supports plants.

Tungsten: A heavy, hard metal with high melting point which conducts electricity well; tungsten is used for a filament in tungsten halogen and incandescent lamps.

Ultraviolet: Light with very short wave lengths, out of the visible spectrum, past the blue-violet.

Variety: Strain, phenotype.

Vent: Opening such as a window or door that allows the circulation of fresh air.

Ventilation: Circulation of fresh air, fundamental to a healthy indoor garden, an exhaust fan creates excellent ventilation.

Vertical: Up and down perpendicular to the horizontal.

Voltage: An electromotive force or potential difference expressed in volts.

Wattage: A measure of electrical power expressed in watts.

Wetting Agent: Compound that reduces the droplet size and lowers the surface tension of the water, making it wetter.

Wick: Part of a passive hydroponic system using a wick suspended in the nutrient solution, the nutrients pass up the wick and are absorbed by the medium and roots.

POWER COST ESTIMATION GUIDE Use this handy guide to figure out the cost of using various watt fixtures

POWER CONSUMPTION

On average a light system will increase your electricity cost from $8 to $20 per month—the exact amount depends on the size of the system and the number of hours operated. However, since these grow lights are so energy efficient, you are getting huge amounts of light (and growing power) for your money! Make sure your grow room's power circuit can handle the power draw. For safety reasons, do not exceed 75% of the rated ability of the fuse/breaker (for example: use no more than 15 amps on a 20-amp circuit). To calculate your cost, multiply the bulb wattage X hours of operation and divide by 1000. This figure is the number of kilowatt hours of electricity consumed. (Example: a 400 watt bulb running for 18 hours will use 7.2 kilowatt hours). Check your power bill for the cost of each kilowatt hour. Then multiply the number of kilowatt hours by the cost of a kilowatt hour (K/hr) to arrive at the cost per month to run the light in your area.

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 48 WATT LIGHTING FIXTURE

COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 52 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ .37											
6 HRS X 30 DAYS	$0.37	$0.56	$0.75	$0.94	$1.12	$1.31	$1.50	$1.68	$1.87	$2.06	$2.25	$2.43
8 HRS X 30 DAYS	$0.50	$0.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.25	$2.50	$2.75	$3.00	$3.24
10 HRS X 30 DAYS	$0.62	$0.94	$1.25	$1.56	$1.87	$2.18	$2.50	$2.81	$3.12	$3.43	$3.74	$4.06
12 HRS X 30 DAYS	$0.75	$1.12	$1.50	$1.87	$2.25	$2.62	$3.00	$3.37	$3.74	$4.12	$4.49	$4.87
14 HRS X 30 DAYS	$0.87	$1.31	$1.75	$2.18	$2.62	$3.06	$3.49	$3.93	$4.37	$4.80	$5.24	$5.68
16 HRS X 30 DAYS	$1.00	$1.50	$2.00	$2.50	$3.00	$3.49	$3.99	$4.49	$4.99	$5.49	$5.99	$6.49
18 HRS X 30 DAYS	$1.12	$1.68	$2.25	$2.81	$3.37	$3.93	$4.49	$5.05	$5.62	$6.18	$6.74	$7.30

*** A 48 watt lighting fixture uses 52 watts per hour. For use with the Sun Blaze® 22.**

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 96 WATT LIGHTING FIXTURE

COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 104 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ .75											
6 HRS X 30 DAYS	$0.75	$1.12	$1.50	$1.87	$2.25	$2.62	$3.00	$3.37	$3.74	$4.12	$4.49	$4.87
8 HRS X 30 DAYS	$1.00	$1.50	$2.00	$2.50	$3.00	$3.49	$3.99	$4.49	$4.99	$5.49	$5.99	$6.49
10 HRS X 30 DAYS	$1.25	$1.87	$2.50	$3.12	$3.74	$4.37	$4.99	$5.62	$6.24	$6.86	$7.49	$8.11
12 HRS X 30 DAYS	$1.50	$2.25	$3.00	$3.74	$4.49	$5.24	$5.99	$6.74	$7.49	$8.24	$8.99	$9.73
14 HRS X 30 DAYS	$1.75	$2.62	$3.49	$4.37	$5.24	$6.12	$6.99	$7.86	$8.74	$9.61	$10.48	$11.36
16 HRS X 30 DAYS	$2.00	$3.00	$3.99	$4.99	$5.99	$6.99	$7.99	$8.99	$9.98	$10.98	$11.98	$12.98
18 HRS X 30 DAYS	$2.25	$3.37	$4.49	$5.62	$6.74	$7.86	$8.99	$10.11	$11.23	$12.36	$13.48	$14.60

*** A 96 watt lighting fixture uses 104 watts per hour. For use with the Sun Blaze® 24.**

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 108 WATT LIGHTING FIXTURE

COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 117 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ .84											
6 HRS X 30 DAYS	$0.84	$1.26	$1.68	$2.11	$2.53	$2.95	$3.37	$3.79	$4.21	$4.63	$5.05	$5.48
8 HRS X 30 DAYS	$1.12	$1.68	$2.25	$2.81	$3.37	$3.93	$4.49	$5.05	$5.62	$6.18	$6.74	$7.30
10 HRS X 30 DAYS	$1.40	$2.11	$2.81	$3.51	$4.21	$4.91	$5.62	$6.32	$7.02	$7.72	$8.42	$9.13
12 HRS X 30 DAYS	$1.68	$2.53	$3.37	$4.21	$5.05	$5.90	$6.74	$7.58	$8.42	$9.27	$10.11	$10.95
14 HRS X 30 DAYS	$1.97	$2.95	$3.93	$4.91	$5.90	$6.88	$7.86	$8.85	$9.83	$10.81	$11.79	$12.78
16 HRS X 30 DAYS	$2.25	$3.37	$4.49	$5.62	$6.74	$7.86	$8.99	$10.11	$11.23	$12.36	$13.48	$14.60
18 HRS X 30 DAYS	$2.53	$3.79	$5.05	$6.32	$7.58	$8.85	$10.11	$11.37	$12.64	$13.90	$15.16	$16.43

*** A 108 watt lighting fixture uses 117 watts per hour. For use with the Sun Blaze®42.**

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 150 WATT LIGHTING FIXTURE												
COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 165 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 1.19											
6 HRS X 30 DAYS	$1.19	$1.78	$2.38	$2.97	$3.56	$4.16	$4.75	$5.35	$5.94	$6.53	$7.13	$7.72
8 HRS X 30 DAYS	$1.58	$2.38	$3.17	$3.96	$4.75	$5.54	$6.34	$7.13	$7.92	$8.71	$9.50	$10.30
10 HRS X 30 DAYS	$1.98	$2.97	$3.96	$4.95	$5.94	$6.93	$7.92	$8.91	$9.90	$10.89	$11.88	$12.87
12 HRS X 30 DAYS	$2.38	$3.56	$4.75	$5.94	$7.13	$8.32	$9.50	$10.69	$11.88	$13.07	$14.26	$15.44
14 HRS X 30 DAYS	$2.77	$4.16	$5.54	$6.93	$8.32	$9.70	$11.09	$12.47	$13.86	$15.25	$16.63	$18.02
16 HRS X 30 DAYS	$3.17	$4.75	$6.34	$7.92	$9.50	$11.09	$12.67	$14.26	$15.84	$17.42	$19.01	$20.59
18 HRS X 30 DAYS	$3.56	$5.35	$7.13	$8.91	$10.69	$12.47	$14.26	$16.04	$17.82	$19.60	$21.38	$23.17
* A 150 watt lighting fixture uses 165 watts per hour. For use with the Sun System® HPS 150.												

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 216 WATT LIGHTING FIXTURE												
COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 234 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 1.68											
6 HRS X 30 DAYS	$1.68	$2.53	$3.37	$4.21	$5.05	$5.90	$6.74	$7.58	$8.42	$9.27	$10.11	$10.95
8 HRS X 30 DAYS	$2.25	$3.37	$4.49	$5.62	$6.74	$7.86	$8.99	$10.11	$11.23	$12.36	$13.48	$14.60
10 HRS X 30 DAYS	$2.81	$4.21	$5.62	$7.02	$8.42	$9.83	$11.23	$12.64	$14.04	$15.44	$16.85	$18.25
12 HRS X 30 DAYS	$3.37	$5.05	$6.74	$8.42	$10.11	$11.79	$13.48	$15.16	$16.85	$18.53	$20.22	$21.90
14 HRS X 30 DAYS	$3.93	$5.90	$7.86	$9.83	$11.79	$13.76	$15.72	$17.69	$19.66	$21.62	$23.59	$25.55
16 HRS X 30 DAYS	$4.49	$6.74	$8.99	$11.23	$13.48	$15.72	$17.97	$20.22	$22.46	$24.71	$26.96	$29.20
18 HRS X 30 DAYS	$5.05	$7.58	$10.11	$12.64	$15.16	$17.69	$20.22	$22.74	$25.27	$27.80	$30.33	$32.85
* A 216 watt lighting fixture uses 234 watts per hour. For use with Sun Blaze® 44.												

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 250 WATT LIGHTING FIXTURE												
COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 275 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 1.98											
6 HRS X 30 DAYS	$1.98	$2.97	$3.96	$4.95	$5.94	$6.93	$7.92	$8.91	$9.90	$10.89	$11.88	$12.87
8 HRS X 30 DAYS	$2.64	$3.96	$5.28	$6.60	$7.92	$9.24	$10.56	$11.88	$13.20	$14.52	$15.84	$17.16
10 HRS X 30 DAYS	$3.30	$4.95	$6.60	$8.25	$9.90	$11.55	$13.20	$14.85	$16.50	$18.15	$19.80	$21.45
12 HRS X 30 DAYS	$3.96	$5.94	$7.92	$9.90	$11.88	$13.86	$15.84	$17.82	$19.80	$21.78	$23.76	$25.74
14 HRS X 30 DAYS	$4.62	$6.93	$9.24	$11.55	$13.86	$16.17	$18.48	$20.79	$23.10	$25.41	$27.72	$30.03
16 HRS X 30 DAYS	$5.28	$7.92	$10.56	$13.20	$15.84	$18.48	$21.12	$23.76	$26.40	$29.04	$31.68	$34.32
18 HRS X 30 DAYS	$5.94	$8.91	$11.88	$14.85	$17.82	$20.79	$23.76	$26.73	$29.70	$32.67	$35.64	$38.61
* A 250 watt lighting fixture uses 275 watts per hour. For use with Sun System® Digital.												

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH) — 400 WATT LIGHTING FIXTURE												
COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 460 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 3.31											
6 HRS X 30 DAYS	$3.31	$4.97	$6.62	$8.28	$9.94	$11.59	$13.25	$14.90	$16.56	$18.22	$19.87	$21.53
8 HRS X 30 DAYS	$4.42	$6.62	$8.83	$11.04	$13.25	$15.46	$17.66	$19.87	$22.08	$24.29	$26.50	$28.70
10 HRS X 30 DAYS	$5.52	$8.28	$11.04	$13.80	$16.56	$19.32	$22.08	$24.84	$27.60	$30.36	$33.12	$35.88
12 HRS X 30 DAYS	$6.62	$9.94	$13.25	$16.56	$19.87	$23.18	$26.50	$29.81	$33.12	$36.43	$39.74	$43.06
14 HRS X 30 DAYS	$7.73	$11.59	$15.46	$19.32	$23.18	$27.05	$30.91	$34.78	$38.64	$42.50	$46.37	$50.23
16 HRS X 30 DAYS	$8.83	$13.25	$17.66	$22.08	$26.50	$30.91	$35.33	$39.74	$44.16	$48.58	$52.99	$57.41
18 HRS X 30 DAYS	$9.94	$14.90	$19.87	$24.84	$29.81	$34.78	$39.74	$44.71	$49.68	$54.65	$59.62	$64.58
* A 400 watt lighting fixture uses 460 watts per hour. For use with Sun System® Digital, Harvest Pro®												

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH)

432 WATT LIGHTING FIXTURE

COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 468 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 3.37											
6 HRS X 30 DAYS	$3.37	$5.05	$6.74	$8.42	$10.11	$11.79	$13.48	$15.16	$16.85	$18.53	$20.22	$21.90
8 HRS X 30 DAYS	$4.49	$6.74	$8.99	$11.23	$13.48	$15.72	$17.97	$20.22	$22.46	$24.71	$26.96	$29.20
10 HRS X 30 DAYS	$5.62	$8.42	$11.23	$14.04	$16.85	$19.66	$22.46	$25.27	$28.08	$30.89	$33.70	$36.50
12 HRS X 30 DAYS	$6.74	$10.11	$13.48	$16.85	$20.22	$23.59	$26.96	$30.33	$33.70	$37.07	$40.44	$43.80
14 HRS X 30 DAYS	$7.86	$11.79	$15.72	$19.66	$23.59	$27.52	$31.45	$35.38	$39.31	$43.24	$47.17	$51.11
16 HRS X 30 DAYS	$8.99	$13.48	$17.97	$22.46	$26.96	$31.45	$35.94	$40.44	$44.93	$49.42	$53.91	$58.41
18 HRS X 30 DAYS	$10.11	$15.16	$20.22	$25.27	$30.33	$35.38	$40.44	$45.49	$50.54	$55.60	$60.65	$65.71

*** A 432 watt lighting fixture uses 468 watts per hour. For use with Sun Blaze® 48.**

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH)

600 WATT LIGHTING FIXTURE

COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 680 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 4.90											
6 HRS X 30 DAYS	$4.90	$7.34	$9.79	$12.24	$14.69	$17.14	$19.58	$22.03	$24.48	$26.93	$29.38	$31.82
8 HRS X 30 DAYS	$6.53	$9.79	$13.06	$16.32	$19.58	$22.85	$26.11	$29.38	$32.64	$35.90	$39.17	$42.43
10 HRS X 30 DAYS	$8.16	$12.24	$16.32	$20.40	$24.48	$28.56	$32.64	$36.72	$40.80	$44.88	$48.96	$53.04
12 HRS X 30 DAYS	$9.79	$14.69	$19.58	$24.48	$29.38	$34.27	$39.17	$44.06	$48.96	$53.86	$58.75	$63.65
14 HRS X 30 DAYS	$11.42	$17.14	$22.85	$28.56	$34.27	$39.98	$45.70	$51.41	$57.12	$62.83	$68.54	$74.26
16 HRS X 30 DAYS	$13.06	$19.58	$26.11	$32.64	$39.17	$45.70	$52.22	$58.75	$65.28	$71.81	$78.34	$84.86
18 HRS X 30 DAYS	$14.69	$22.03	$29.38	$36.72	$44.06	$51.41	$58.75	$66.10	$73.44	$80.78	$88.13	$95.47

*** A 600 watt lighting fixture uses 680 watts per hour. For use with Harvest Pro®, Hard Core, Galaxy® Digital Logic, Galaxy® Legacy.**

POWER COST ESTIMATION GUIDE PER MONTH (ASSUMES 30 DAY MONTH)

1000 WATT LIGHTING FIXTURE

COST PER KW/HR	4¢	6¢	8¢	10¢	12¢	14¢	16¢	18¢	20¢	22¢	24¢	26¢
HRS. PER DAY X 30 DAYS	EXAMPLE: 6 HRS X 1100 WATTS* ÷ 1000 X $ .04 PER KWH X 30 DAYS = $ 7.92											
6 HRS X 30 DAYS	$7.92	$11.88	$15.84	$19.80	$23.76	$27.72	$31.68	$35.64	$39.60	$43.56	$47.52	$51.48
8 HRS X 30 DAYS	$10.56	$15.84	$21.12	$26.40	$31.68	$36.96	$42.24	$47.52	$52.80	$58.08	$63.36	$68.64
10 HRS X 30 DAYS	$13.20	$19.80	$26.40	$33.00	$39.60	$46.20	$52.80	$59.40	$66.00	$72.60	$79.20	$85.80
12 HRS X 30 DAYS	$15.84	$23.76	$31.68	$39.60	$47.52	$55.44	$63.36	$71.28	$79.20	$87.12	$95.04	$102.96
14 HRS X 30 DAYS	$18.48	$27.72	$36.96	$46.20	$55.44	$64.68	$73.92	$83.16	$92.40	$101.64	$110.88	$120.12
16 HRS X 30 DAYS	$21.12	$31.68	$42.24	$52.80	$63.36	$73.92	$84.48	$95.04	$105.60	$116.16	$126.72	$137.28
18 HRS X 30 DAYS	$23.76	$35.64	$47.52	$59.40	$71.28	$83.16	$95.04	$106.92	$118.80	$130.68	$142.56	$154.44

*** A 1000 watt lighting fixture uses 1100 watts per hour. For use with Harvest Pro®, Hard Core, Galaxy® Digital Logic, Galaxy® Legacy & Grow Amp.**