Application Note AN111

Grow Lights: Separating Fact From Fiction

Hundreds of companies make grow lights. from 50 to 1,000 watts, with High Pressure Sodium (HPS), fluorescent and LED light sources…. With many kinds of light: full spectrum white light or multiband "pink/purple" light. The main objective is to economically duplicate—indoors--the full spectrum sunlight which has been growing every kind of plant, fruit, vegetable and flower for thousands of years.

Sunlight has one great advantage. All the light reaching grow area is almost 100% uniform. In other words, the light reaching all areas of a very small garden or a very large farm is very uniform (evenly distributed) everywhere). That perfect light distribution is possible only because all of the light rays coming from the sun 93 million miles away are perfectly parallel.

That uniform distribution is very hard for even the best grow lights to duplicate --and impossible for most.

What does this really mean? **It means that no matter what the specified watts or PPF/J rating of the grow-light are… or what the spectrum is…. It only matters how much of that emitted light actually reaches every part of grow bed in a uniform, evenly distributed way.**

Let us stop for minute to mention a very important definition: Footprint. The *footprint* of a grow light means its shape and size ---length X width. The *footprint* of a grow bed is also defined by length and width. 95% of all grow lights have a footprint much smaller than the footprint of the grow-bed.

That means it is impossible to have uniform distribution. The result is that the emitted light is used very poorly and unevenly, with the plant in middle getting adequate light but plants at the sides having poor or unpredictable growth.

With existing grow-light products –where grow- light footprint is much smaller than the grow-bed footprint-- there are only two ways to solve this problem.

1---Use many grow lights arranged in a grid, with overlapping patterns, to fill in the "weak spots". This is typically possible only in very large facilities with perfect facility layout. Not possible where a grower wants to use what is called "supplemental" lighting for a regular greenhouse.

2. A grow-light with a very large footprint—as large as the grow-bed itself. This can put almost perfectly even light on every spot on the grow-bed. Such large-footprint lights are expensive and heavy. They are typically useful only for very large, expensive, carefully designed facilities. They cannot easily be used for supplemental light in a regular greenhouse.

To explain problem of regular grow light in simple way---- Most of light is directed straight ahead but drops off quickly in directions to the sides. If distance to plants is made less, more light goes to center but even weaker to the sides---not good. If distance made greater, light is more even everywhere but weaker everywhere—also not good . Impossible get all the light where wanted.

It is like trying to water a lawn by aiming a single hose only at center of the lawn and expecting the grass to grow evenly everywhere. So does not really matter exactly how much light or how much water if spread out poorly;

HPS Grow lights…-Not what they seem to be

One of the most misunderstood areas of grow lighting is with high pressure sodium (HPS) grow lights. These lights, which are inexpensive, have lumens-per-watt specified at above 150 and can have PPF/j above 2.0.but those numbers are possible only under special laboratory conditions- impossible to duplicate in grow light application.

All horticultural publications tell us how much light is recommended for various plants. The amount of light is not exact. The truth is that almost all plants will grow without having perfect light (like noontime clear-sky sunlight) Growth might be slower or plant/vegetable/flower characteristic might not be perfect but will be "acceptable"

That is why the thousands of growers who have used HPS grow lights for the past 30 years have had acceptable results—maybe not the best but "acceptable".

HPS lights put out much light—which creates high numbers on light meters but it is well known that much of it is not most useful for plants—too much orange red, and infrared and not enough blue/green.

But let's look at the biggest weakness of the HPS—where we get fooled because the HPS grow-light specification methods are created in perfect laboratory conditions which do not exist in a real application above an actual grow bed.

HPS Reflectors .

HPS lamps are efficient as light emitters. They have poor color accuracy but they are available very high wattages, and with low cost

However, just because the lamp seems to be creating so much light at low cost does not mean all the light is getting to where we want it. See Figure 1

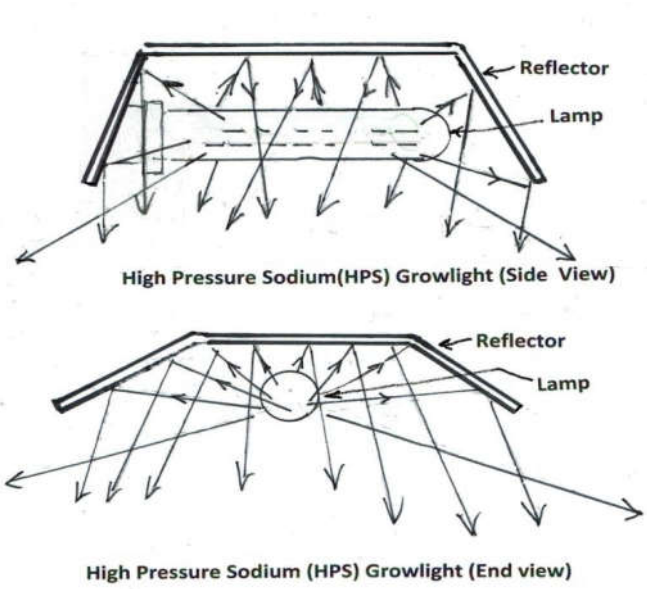


Figure 1 **Emission pattern of HPS Grow light**

Light is emitted from a long glass tube and goes in every direction-- almost 360-degree light emission. Only about 30% of the light actually goes in the direction we want. So we need a reflector to collect all that light and redirect to where we want.

There is a precise mathematical relationship between size and location of a light source and the shape and size of a reflector. Typically, a reflector needs to be 10-12 times the size of the light source to be efficient.

In a precision incandescent or halogen reflector---as in a PAR spotlight lamp we buy at hardware store, the tiny filament wire is very much smaller than the reflector. However, in the HPS unit used as grow-light the reflector is only twice the size of the bulb itself-- not large enough to have that mathematical precision. It would have to be much greater size and weight—and far more expensive--- maybe 36 inches in diameter--- to perform as well as an incandescent par lamp.

All this means that 100% of HPS grow-lights (all of them have built-in reflectors) collect and focus the light poorly. Not much better than no reflector at all. They do have good light uniformity across the grow bed. Unlike most LED grow lights, they do not have "hot spots" (i.e. excessive light) in the center and poor light around the sides. *But they achieve that uniformity by wasting a very significant amount of light sent off to the sides.*

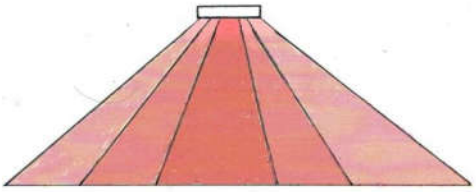
UNIFORMITY OF LIGHT DISTRIBUTION

***The official definition of Uniformity*= *Average* light across the grow bed divided by the *Minimum*.**

For example, if we have extreme brightness in the exact middle of the grow bed but very poor light at the sides and corners, that would be very poor uniformity. We would get very poor or unpredictable growth in various part of the grow bed. For grow lights, uniformity needs to be better than 2:1 to be considered good.

Almost all grow lights with a footprint much smaller than the footprint of the grow-bed have poor uniformity --- typically 4: 1 or worse. Figure 2 shows the side view of such a regular LED grow light -bright in the middle and a sharp drop-off at the sides.

Figure 2



Many large growing facilities achieve good uniformity by having many lights at substantial heights with inter-unit spacing so that adjacent light patterns overlap as in Figure 3. The overlap fills in the "weak spots"

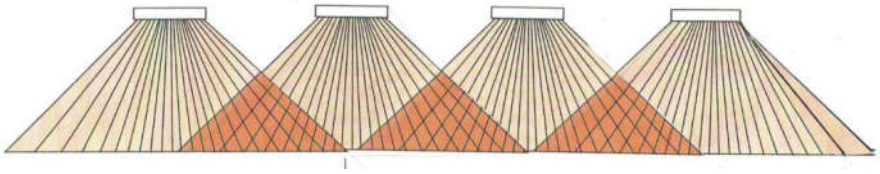


Figure 3 Overlapping patterns with many LED light fixtures

But that is not always possible –and does not solve the problem for the user who needs to position a single fixture.

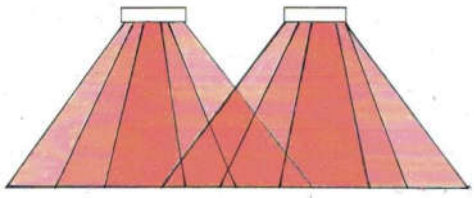
Typically, it is only possible to achieve best uniformity in a single light fixture, as noted earlier. by using a very large unit with an area (footprint) about the same as he grow-bed itself. In other words, if the grow-bed is 48 inches X 48 inches then the lighting array needs to be the same. Figure 4 shows such a unit, (all using many "light bars") made by some US and China firms. They are all heavy, expensive and expensive to ship. Also, they require assembly after shipment

Figure 4 **Large LED grow light array using many light bars—Typically 48 inch X 48 inch or one I.5 m X 1.5 m**

PowerGROW **Technology**

With the *PowerGROW* method, there is a combination of a careful selection of lamp beam angle---wider than a typical LED spot or floodlight--- but narrower than the inherent 120-degree angle of an LED without optics. In this case we choose 60-70 degrees.

But the really important feature is that instead of having -all LEDs aiming in the same direction—as in 99% of all LED grow lights- we separate light emission into multiple beams parts, each aimed an average of 35-40 degrees away from an adjacent beam. The result similar to the use of many grow lights arranged in a large overlapping grid pattern (like Figure 3) except here we do it in a single compact, lightweight unit.



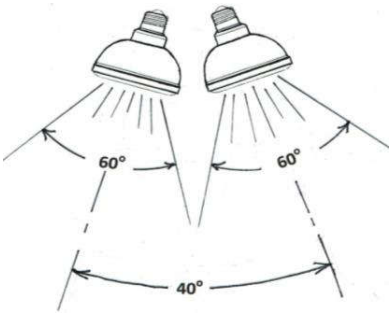


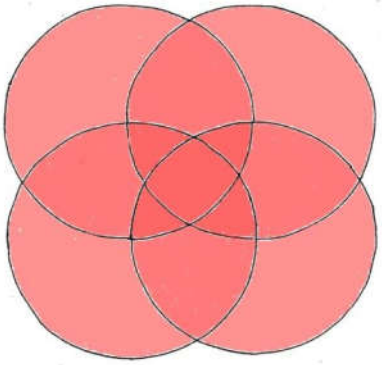
Figure 5 **Figure 6**

Figures 5 shows a simplified side view of that improved light pattern. Figure 6 shows how adjacent lamps are directed in slightly different direction--- about 40 degrees apart) The result is a floodlight which magnifies the light sent to the grow bed but with much better uniformity than of a single standard floodlight or spotlight. The wasted light off to the side is minimized. The increase uniformity and reduction of wasted light has the same positive effect on grow-bed bed productivity as an additional10-20% of grow-light watt.

Figure 7 shows a top view of the four overlapping light distribution patterns appearing on the surface. This is a simplified view but it does show how, instead of a single circle, very bright in the center and dim at edges, there are four circle center each of lower brightness, But now, instead of a single very bright "center" there are four overlapping "centers" is now spread out to wider area. In the 16- lamp 640 watt SH-640 unit, there are 16 such overlapping beam circles.

Figure 7

Overlapping beam patterns, Top view of the Illuminated Surface



What is also unique here is that each beam can be individually manually adjusted in direction to keep each circle of received light in the same place (or where we want it) regardless of hanging distance or grow bed shape.

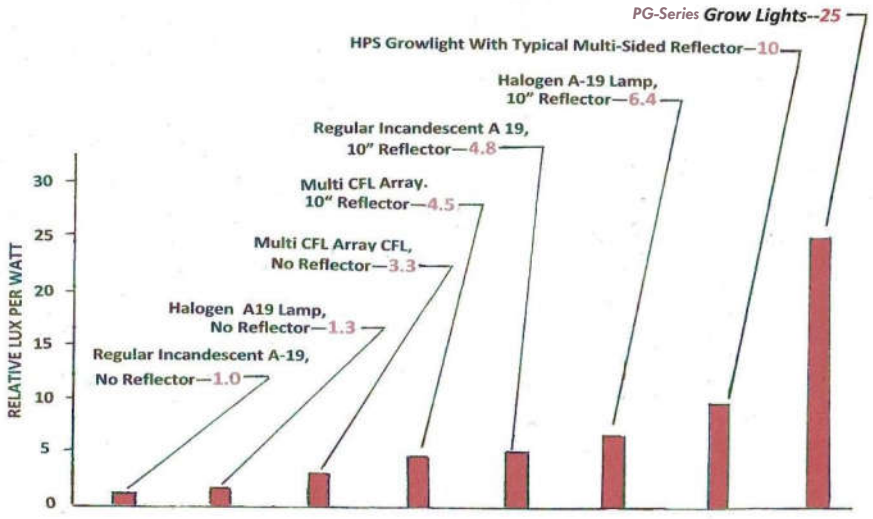


Figure 8 Comparison of High Wattage Lighting Methods