LED Grow Lights

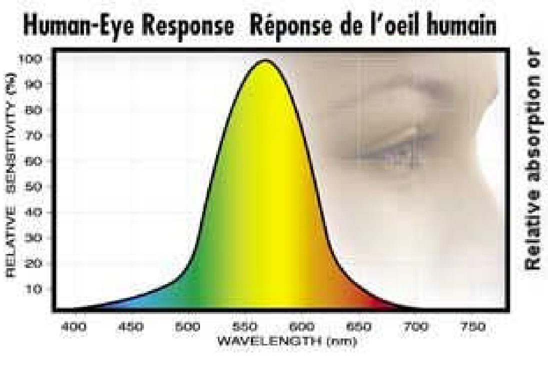
In this document we will endeavour to give an overview of terminology in relationship to growing plants under LED lights, we will do some comparisons between different products and show the range of products that we offer.

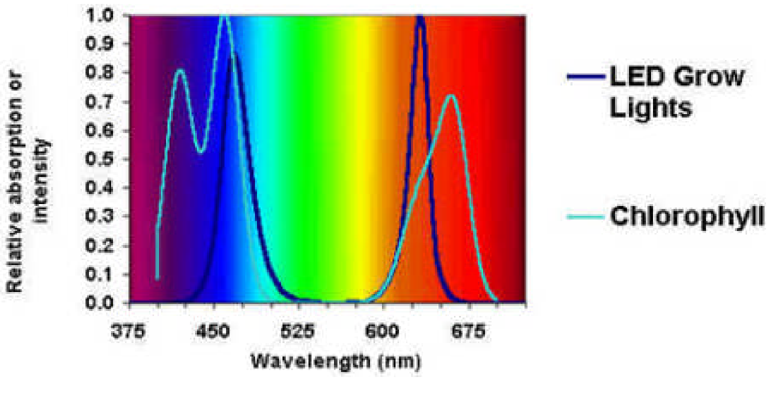
The nature of light

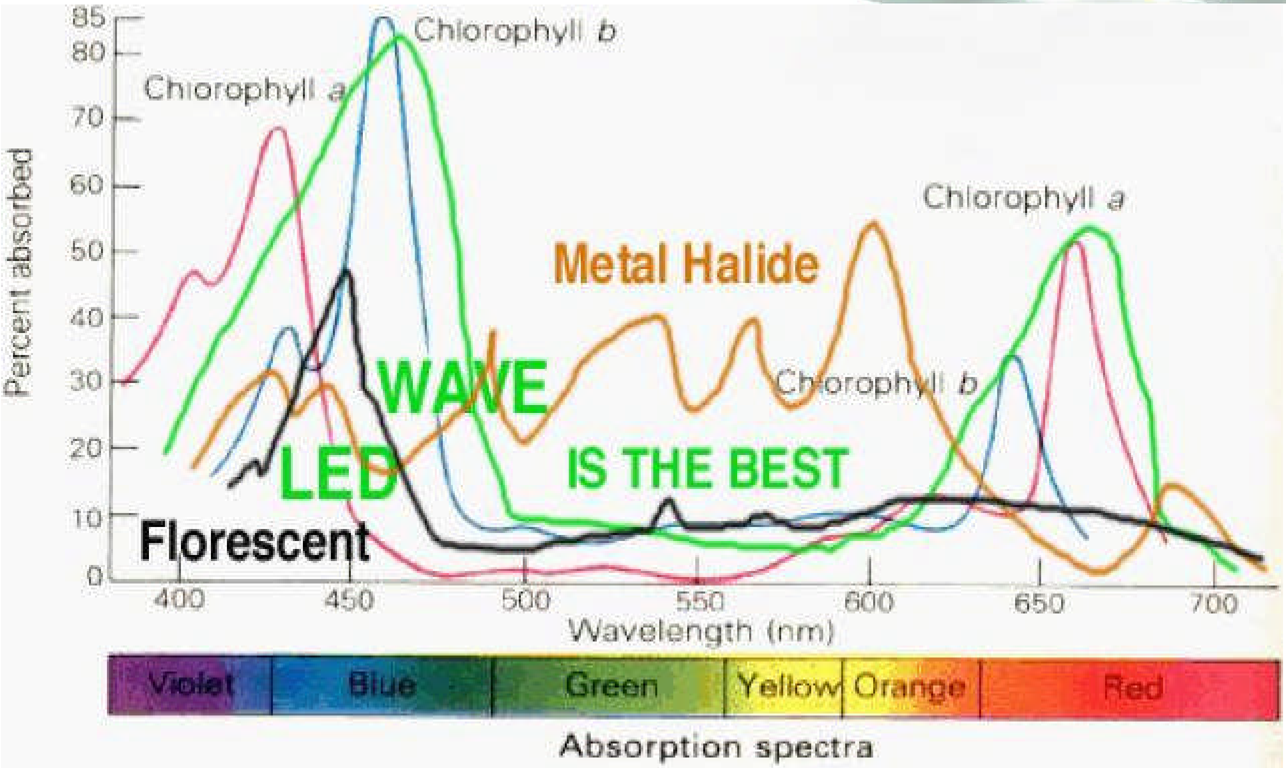
The energy produced by the sun reaches the earth as electromagnetic radiation. Light and other forms of electromagnetic radiation are considered to have both a wave nature and a particle nature. Particles or packets of light (its particle nature) are known as photons(the smallest divisible unit) light depends on the number of photons absorbed per unit time. Each photon carries a fixed amount of energy which determines the amount that the photon vibrates. The distance moved by a photon during one of its vibrations is referred to as its wavelength and is measured in nanometres. Electromagnetic radiation spans a broad range of wavelengths. At the one end of the spectrum of electromagnetic radiation there are gamma rays which have a wavelength of 10 nm and at the other end, radio waves which have a wavelength of 1012nm. A very small part of this spectrum can be seen by the human eye i.e. between the wavelengths 380 and 750 nm. This part of the electromagnetic spectrum is called visible light. Almost all life depends ultimately on this part of the spectrum for its energy. Humans perceive the different wavelengths of visible light as different colours. Within the spectrum the longer the wavelength of the radiation, the slower the vibration of the photons and the less energy each photon contains. Thus photons of ultraviolet light, at the blue end of the visible spectrum, have shorter wavelengths and contain more energy than red light and infrared radiation. Sunlight contains 4% ultraviolet radiation, 52% infrared radiation and 44% visible light. Why is only visible light used by plants?

Light and photosynthesis

Chlorophyll does not absorb all the wavelengths of visible light equally. Chlorophyll a, the most important light-absorbing pigment in plants, does not absorb light in the green part of the spectrum. Light in this range of wavelengths is reflected. This is the reason why chlorophyll is green and also why plants (which contain a lot of chlorophyll) are also green. Note in the graph below that the absorption of light by chlorophyll a is at a maximum at two points on the graph 430 and 662 nm. The rate of photosynthesis at the different wavelengths of visible light also show two peaks which roughly correspond to the absorption peaks of chlorophyll a. Plants do not depend only on chlorophyll a in their light harvesting machinery but also have other pigments (accessory pigments) which absorb light of different wavelengths.



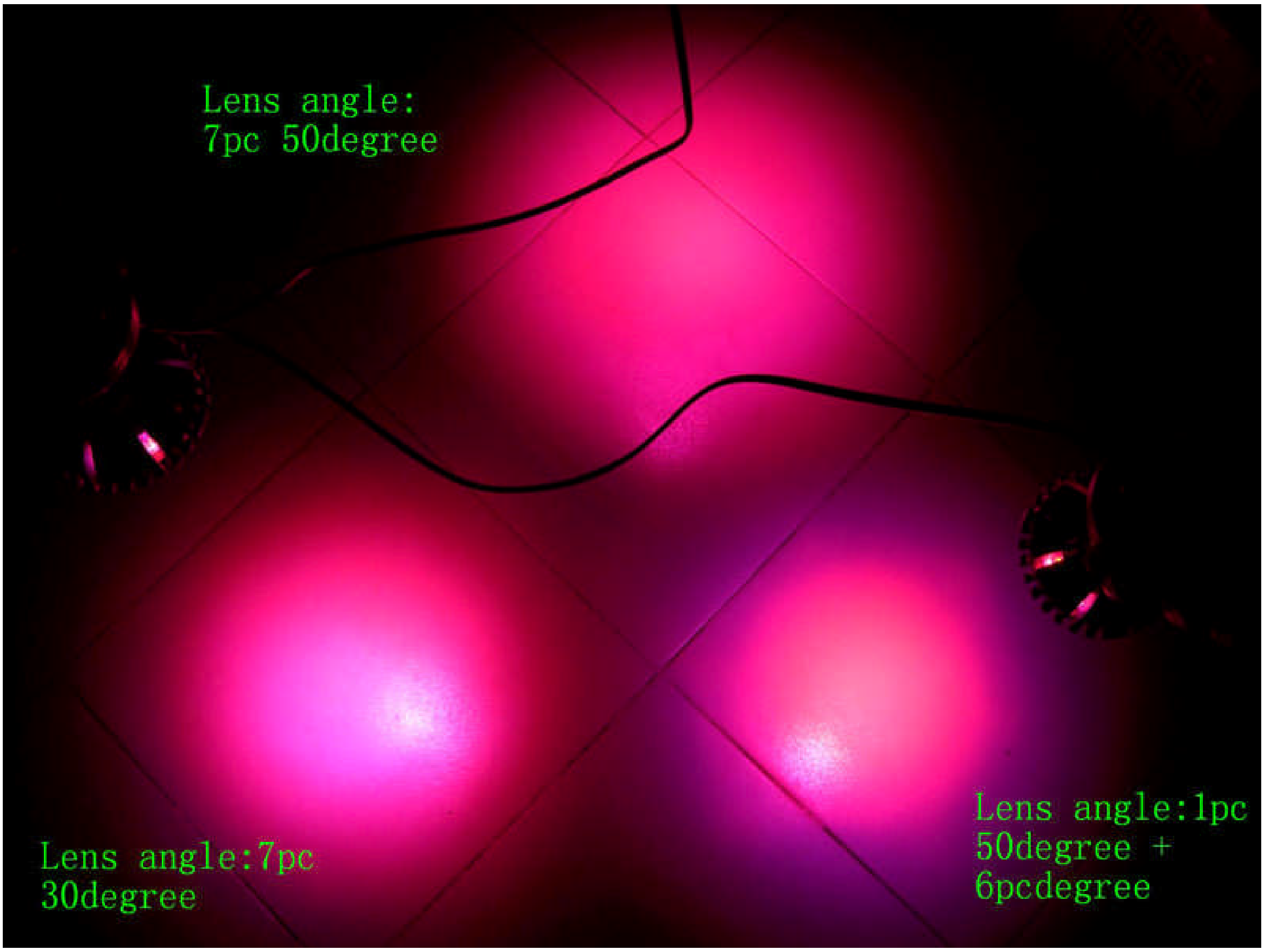




One of the first questions we are asked is "**how bright are the LED lights that you sell?"** and what is their measure in lumens.
Firstly you need to remember that Lux meters (lumens) are designed to measure brightness in relationship to the human eye, i.e. designed for use mainly with cameras etc, so it is described as a subjective measure, which is not really of great concern to a plant, there are other meters that measure the actual photons as they reach the plant and their relevance to the photosynthetic reaction, but this gets all very complicated, for instance even though blue light registers far less in brightness on a Lux metre when it comes to photons absorbed by the plant blue actually has more energy then the red spectrum. These type of measurements are therefore much more accurate when comparing the energy required from light by plants, however they are still not accurate because they still give value to the wavelengths of light that the plant may not be using. Unfortunately everybody needs to use the same units for these comparisons to be of any use, at the moment most people use Lux meters which still have some value as long as you are comparing similar things, ie two LED lights with the same ratio of blue to red LEDs or if you are comparing two HIDs, but not really relevant if you are trying to compare a red and blue LED lamp with an HID.
Also we must remember that we are only talking about the new high power LEDs that run at 1 W or greater not the smaller LEDs that flooded the market over the last year or so, which will be fine for growing seedlings but do not really have enough power ie intensity, for a plant to go into flower and fruit stages successfully.

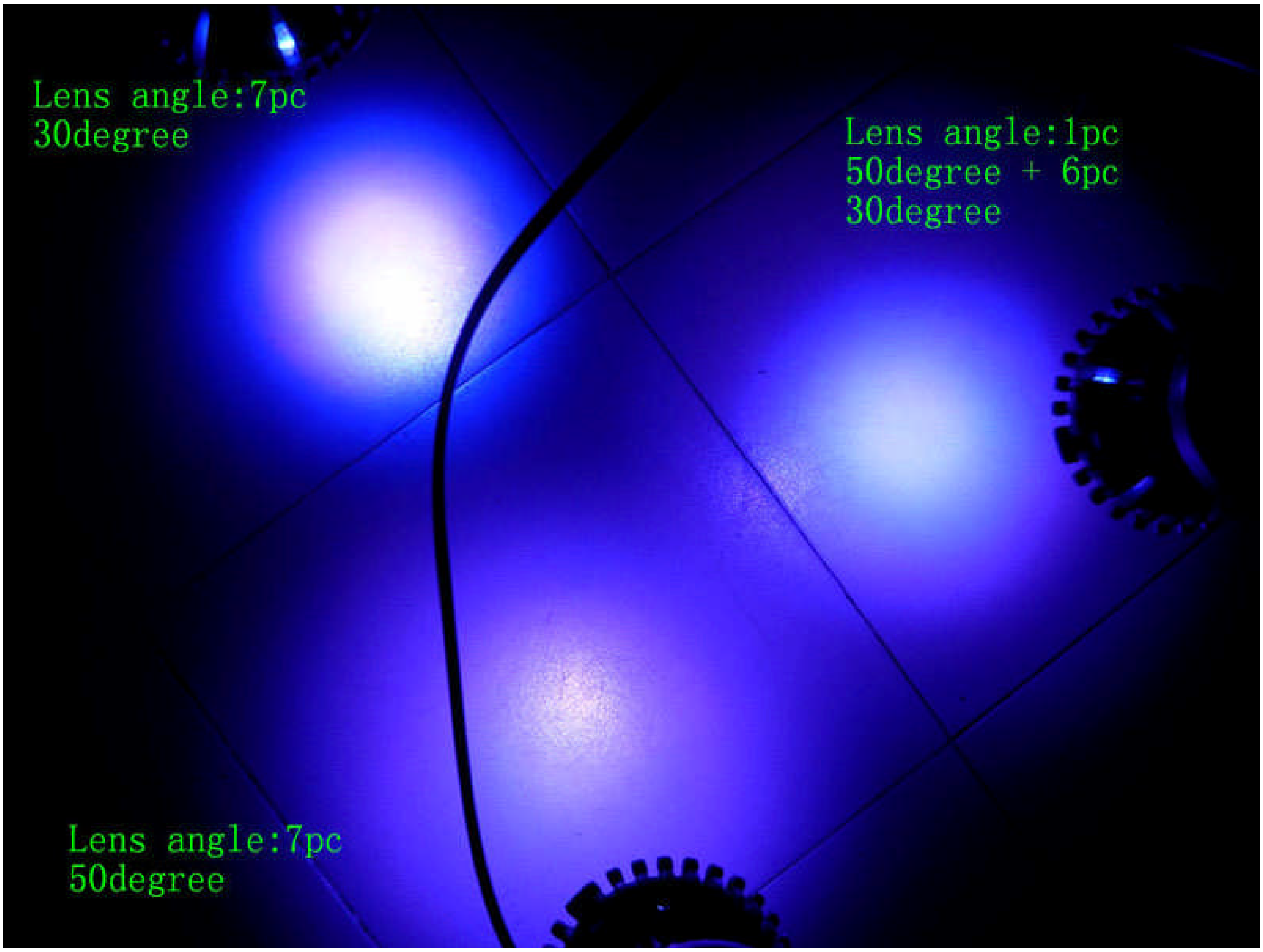
Probably the best and most expensive LED light on the market at the moment is an American device called the Procyon see a grow test between a 400 watt high pressure sodium bulb HPS and a Procyon 100 at http://www.homegrownlights.com/testing.html
At this site http://www.greenpinelane.com/hgl_procyon_test.aspx you will see where tomatoes have been grown to flower and fruit using this device, they have also done Lux measurements (scroll to the bottom of the page) over a 3' x 2' or 0.9 m x 0.6 m, roughly half a square metre, you see that the intensity decreases towards the edges but if you take the highest measurement in the centre at say 18 inches above the test meter, the highest reading is 7820. Below we have done some similar measurements using our 7 W (1B6R) with 30° lenses LED light and at 18 inches the greatest measurement is 11470 and the 7 W (6B1R) 30° lenses LED light and at 18 inches the greatest measurement is 4420, the lights on the Procyon use a ratio 2Red to 1Blue so combining our lights gives a reading of 9120. The Procyon users 56 LEDs

without lenses, they run their LEDs at just under 2Watts giving slightly higher brightness than the ones that we use, that are run at 1W, however the LEDs that we use will last slightly longer (because they are not running as hot), and as can be seen by the brightness tests below, by using lenses you can achieve the greater brightness levels and, this is even more so when you add extra lights together as you do not get the drop off at the edges e.g. in the Procyon at the edge of the 2 foot square rectangle the measurements are down to around 2000.
You will see below where the 3x7W (6R1B) LED lights have been placed in a row you see that it covers the same length as the Procyon without the diminished brightness at either end, being focused it does not cover quite as much width, but we would suggest using 3x12W (8R4B) LED lights, which would give you a similar spread, and higher intensities over a more uniform area, and the same ratio of red to blue LEDs ie 2:1.
The other advantage of using these smaller lights is that not only do they work out cheaper as we have demonstrated, using lenses gives you higher intensities, but you also have the flexibility of changing the lenses to suit your particular application, you can even remove the lenses for widespread closer applications.



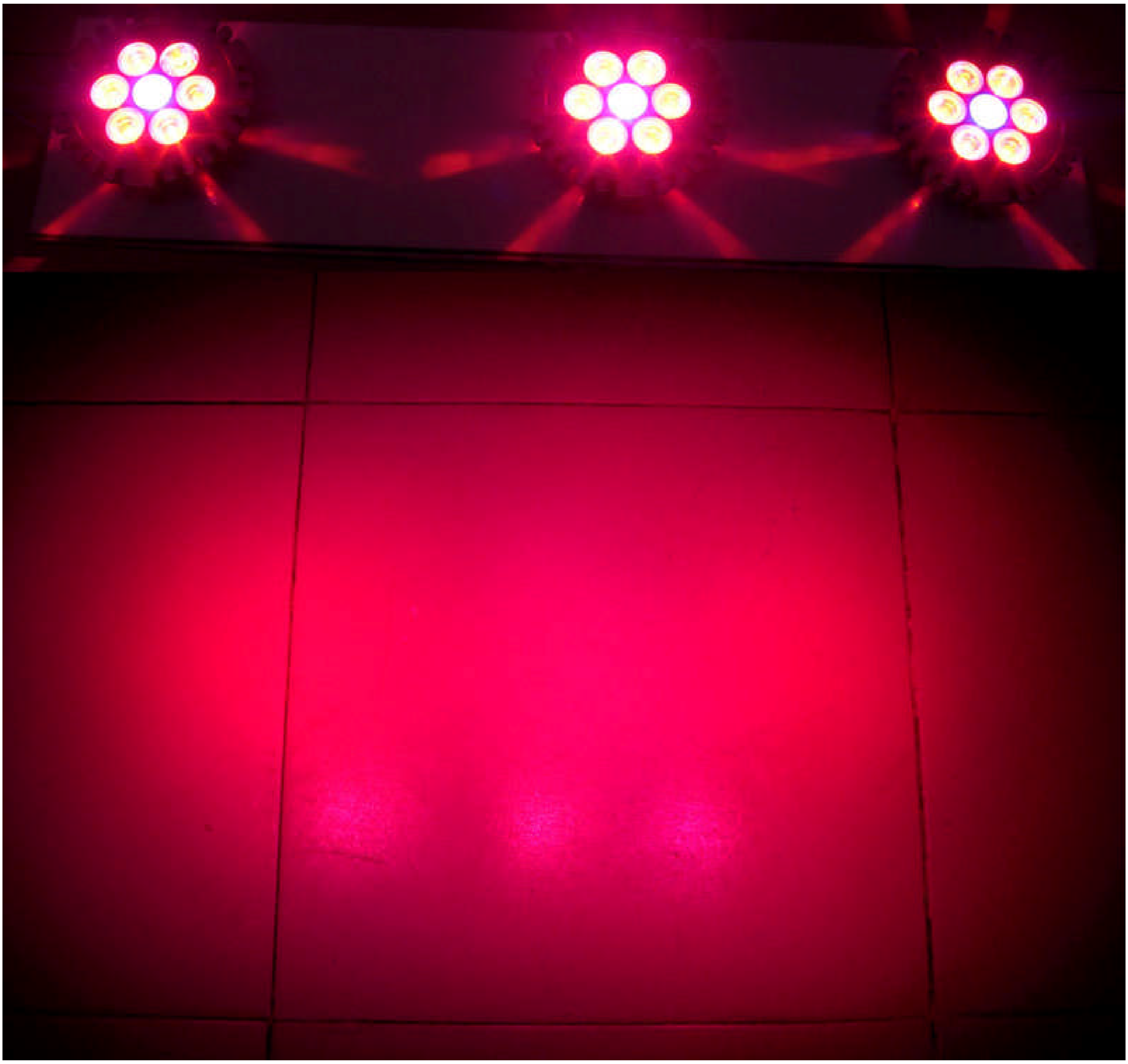
7Watt (6Red1Blue):- Mix of light with 3 different lens angles

Angle / Height	7pc 50° LUMEN(LX) Intensity	7pc 30° LUMEN(LX) Intensity	1pc 50° + 6pc 30° LUMEN(LX) Intensity
24inch	4340	7370	7020
18inch	7170	11470	10640



7Watt (1Red6Blue):- Mix of light with 3 different lens angles

Angle Height	7pc 50° LUMEN(LX) Intensity	7pc 30° LUMEN(LX) Intensity	1pc 50° + 6pc 30° LUMEN(LX) Intensity
24inch	720	2200	1450
18inch	1490	4420	2500



3x7Watt (6Red1Blue):- The coverage of 3 lights

Coverage Height	Length(mm)	Width(mm)
24inch	900	550
18inch	800	350