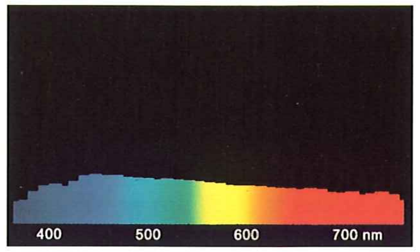
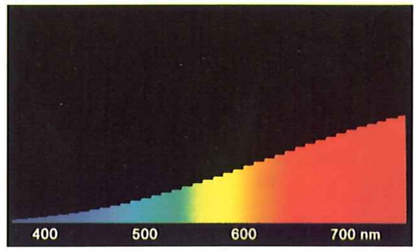
Spectral power distribution

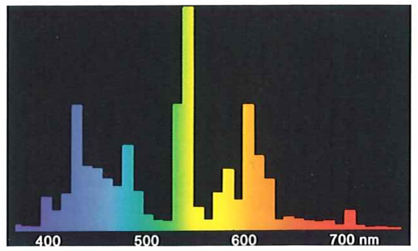


Daylight (D65)

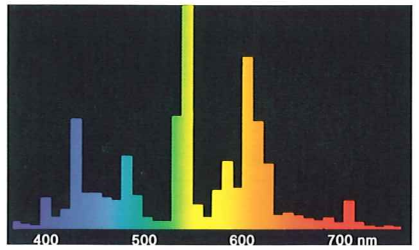


Filament lamps

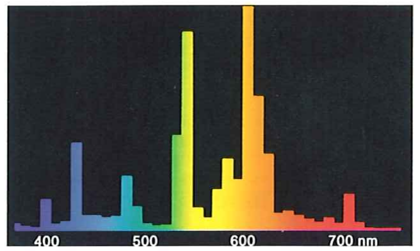
Fluorescent tubes



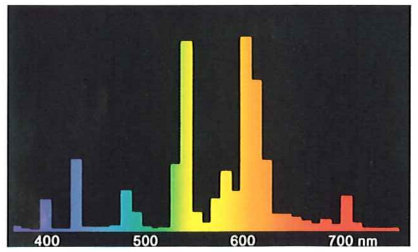
Colour appearence 11, LUMILUX® Daylight



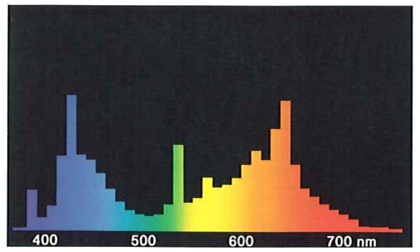
Colour appearence 21, LUMILUX® White



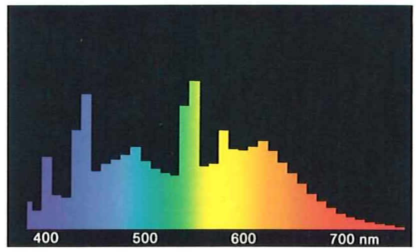
Colour appearence 31, LUMILUX® Warm-white



Colour appearence 41, LUMILUX® INTERNA®

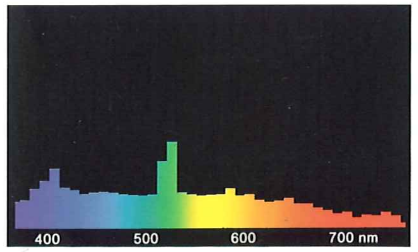


Colour appearence, 77 FLUORA®

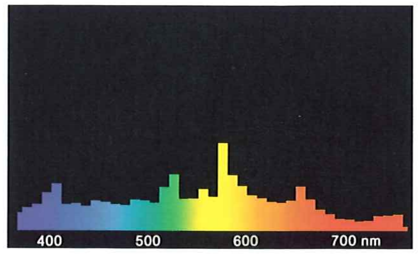


BIOLUX®

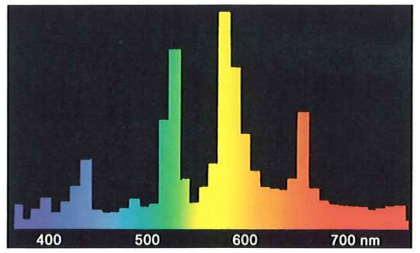
Discharge lamps



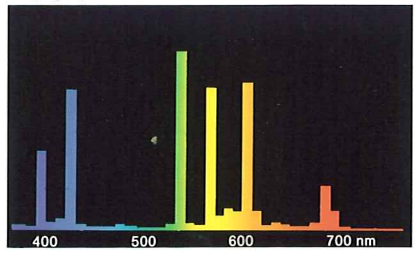
POWERSTAR® HQI® .../D
(Daylight)



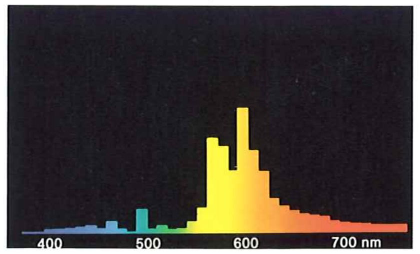
POWERSTAR® HQI® .../NDL
(Neutral-white DE LUXE)



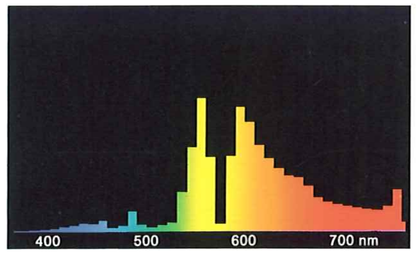
POWERSTAR® HQI® .../WDL
(Warm-white DE LUXE)



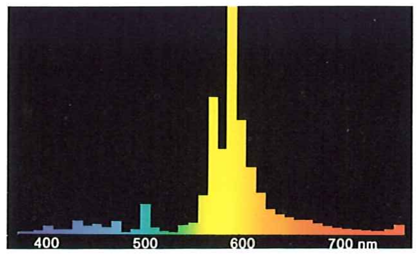
HQL DE LUXE



VIALOX® NAV SUPER & NAV Standard



VIALOX® NAV DE LUXE



VIALOX® PLANTA

Description	vertical scale
Daylight	$\frac{200\ \text{mW}}{\text{m}^2 \cdot 1000\ \text{lx} \cdot 10\ \text{nm}}$
Filament lamps	$\frac{200\ \text{mW}}{1000\ \text{lm} \cdot 10\ \text{nm}}$
Fluorescent tubes and discharge lamps	$\frac{200\ \text{mW}}{1000\ \text{lm} \cdot 10\ \text{nm}}$

Assessment methods for commercial installations

There are various methods that are used for assessing the effect of light on plant growth. Without a knowledge of the specific requirements it is impossible to say which of these methods provides the most accurate information for the various applications of light in horticulture. It is best to consult the relevant literature and based rely on empirical data.

The following tables (pages 28 and 29) show the most important variables to help you select the right level of light energy to promote healthy growth for your particular application.

Photosynthesis

Photosynthesis is the principal means in which light energy is transformed into chemical energy in plants. The photosynthesis curve is characterised by high sensitivity in the blue and red sectors and low sensitivity in the green sector (see Fig. 1, page 22). Despite differences in the photosynthesis curves of individual species of plant, the common features are so strong that a standard photosynthesis curve has been agreed (DIN 5031 Part 10). The effect of photosynthesis is calculated, as in photometry in general, using the convolution integral of the spectral radiated energy distribution with the efficiency curve.
The advantage of this method is that is relates to an actual characteristic of plants. This sets it apart from other evaluation methods.

Column 1
Photosynthetic effect of the lamps (analogous to luminous flux)

Column 2
Efficacy of photosynthetic active radiation, referred to the electric system power consumed (analogous to luminous efficacy)

Column 3
Photosynthetic irradiance at an illuminance of 1000 lux

PAR values

Column 4
Abbreviation for photosynthetic active radiation

The PAR range is from 400 to 700 nm.

Column 4 indicates the unweighted radiation at an illuminance of 1000 lux.

Einstein or mol values

Number of photons in the impinging radiation. Photons are the energy-carrying particles in radiation (e.g. visible light). Their energy can be calculated by multiplying their frequency by an universal constant known as Planck's constant. If the spectral power distribution of a light source is known, it can be used to calculate the number of photons that strike a body (part of a plant) within an unit period of time. The number of photons varies depending on whether the light comes from the sun or from an artificial light source since their spectral power distributions are different.

In biology, it is now accepted that $6.02 \cdot 10^{23}$ photons is equivalent to 1 μ Einstein or 1 "mol" of photons. (This number corresponds to the number of molecules in 1 mol of a substance.)
If 1 Einstein of radiation is active on 1 mol of a substance, then statistically speaking, each molecule will be hit by a photon each second.
1 μ Einstein = $\frac{1}{1{,}000{,}000}$ of an Einstein.
The weighted spectral range must always be specified.

Column 5
Einstein values for the 400–700 nm range
Column 6
Einstein values for the 350–500 nm range
Column 7
Einstein values for the 600–700 nm range

referred in each case to an illuminance of 1000 lux

The Einstein values Ep in an installation can therefore be calculated from a measurement of the illuminance E.

$$Ep = \frac{Ep\ (1000\ \text{lx}) \cdot E}{1000}$$

Solar photosynthesis factor SPF

Column 8
SPF indicates how much more effective a light source is than natural daylight of the same illuminance.

$$SPF = \frac{\text{Photosynthetic effect (system)}}{\text{Photosynthetic effect (sun)}} \text{ for } E = 1000\ \text{lx}$$

For data for 1 to 8, see tables on pages 28/29.