PATENT CLAIMS

1. A dark cavity housing a horticultural lighting fixture comprising at least one LED and/or quantum dot having

a) first spectral characteristics including a peak in the wavelength range from 600 to 700 nm and arranged to exhibit a full width ~~of~~ at half maximum of at least 50 nm or more;

b) second spectral characteristics with a maximum of 50 nm full width ~~of~~ at half maximum and arranged to exhibit a peak wavelength in the range from 440 to 500 nm.

c) the emission at wavelengths of 500–600 nm arranged to be reduced below the intensity in 400-500 nm band and below the intensity in 600-700 nm band.

~~2. A horticultural lighting fixture in a dark cavity comprising at least one LED and/or quantum dot having~~

~~a) first spectral characteristics including a peak in the wavelength range from 600 to 700 nm and arranged to exhibit a full width of half maximum of at least 50 nm or more;~~

~~b) second spectral characteristics with a maximum of 50 nm full width of half maximum and arranged to exhibit a peak wavelength in the range from 440 to 500 nm, and~~

~~c) the emission at wavelengths of 500–600 nm is arranged to be reduced below the intensity in 400-500 nm band and below the intensity in 600-700 nm band.~~

~~3. The lighting fixture of claim 1, wherein at least a part or the whole of the emission at wavelengths of 500–600 nm is arranged to be reduced below the intensity in 400-500 nm band and below the intensity in 600-700 nm band.~~

42. The lighting fixture of claim 1, ~~2 and/or 3,~~ wherein the LED and/or quantum dot has a spectral characteristics with a freely adjustable peak in the wavelength range from 500 to 800 nm and arranged to exhibit at least 30 nm full width of half maximum.

~~53~~. The lighting fixture of claim 1~~,~~and/or 2,~~ 3 and/or 4,~~ wherein the emission intensities of the first, second and optional third spectral characteristics of the LED and/or quantum dot are arranged to be adjustable.

~~64~~. The lighting fixture of any of claims 1 to ~~53~~, comprising a second LED and/or quantum dot with at least one spectral characteristics with maximum 50 nm full width of half maximum and a peak wavelength in the range of 400 to 500 nm and optionally second and third spectral characteristics arranged to have a freely adjustable peak wavelengths in the range from 450 nm to 800 nm.

~~75~~. The lighting fixture of any of claims 1 to ~~64~~, wherein the PPF value of the fixture per Watt is 0.35 μmol s^{-1} m^{-2} or higher.

~~86~~. The lighting fixture of any of claims 1 to ~~75~~, wherein the spectral emission characteristics; intensity, peak wavelength and full width of half maximum are controlled with size, number and species of quantum dots.

~~97~~. The lighting fixture of any of claims 1 to ~~86~~, wherein
a) the first LED and/or quantum dot has first spectral characteristics comprising a peak wavelength in the wavelength range of 600 to 700 nm and is arranged to exhibit at least a full width of half maximum of at least 50 nm;
b) the first LED and/or quantum dot further having second spectral characteristics comprising a peak in the wavelength range of 440 to 500 nm; and
c) the first LED and/or quantum dot optionally having third spectral characteristics of a freely adjustable peak wavelength in the range of 500 nm to 800 nm range arranged to exhibit at least 30 nm full width at half maximum;
d) emission intensities of the first, second and optional third spectral characteristics being adjustable in any ratio.

~~108~~. The lighting fixture of claim ~~97~~, comprising second LED and/or quantum dot with at least one spectral characteristics with maximum 50 nm full width at half maximum

and peak wavelength in the range of 400 to 500 nm and optional second and third spectral characteristics having freely adjustable peak wavelengths in the range of 450 nm to 800 nm.

~~11~~9. A lighting ~~device~~ fixture for plant cultivation as claimed in claim 1 ~~or 2~~, wherein, said lighting device ~~(100)~~ comprises a plurality of quantum dots ~~(110, 120, 130, 140, 150, 160)~~ of different size.

~~12~~10. A lighting ~~device~~ fixture as claimed in claim 1, ~~2~~ and/or ~~11~~9, wherein, at least one LED and/or the size distribution of said plurality of quantum ~~(110, 120, 130, 140, 150, 160)~~ dots is arranged to produce an aggregate emission spectrum similar to photosynthetically active radiation (PAR) spectrum except that the emission spectrum omits or provides a very low intensity in the green yellow (500-600) nm and comprises a high intensity spectral feature in the far red 700-800 nm band.

~~13~~11. A lighting ~~device~~ fixture as claimed in claim ~~11~~9, wherein, the size of at least one said quantum dot is chosen so that it/they emit photons in a band or in various bands with preset relative intensities in the photon spectrum with a certain photomorphogenetic effect in plants.

~~14~~12. A lighting ~~device~~ fixture as claimed in claim ~~13~~11, wherein, the said photomorphogenetic variable effected is any of the following biological parameters: weight, leaf number, root mass, stem height, chemical composition (such as vitamin, mineral, and/or nutrient content and/or concentration) of the plant at different time points or at harvesting maturity.

~~15~~13. A lighting ~~device~~ fixture as claimed in claim ~~11~~9, wherein, at least one of said quantum dots ~~(110, 120, 130, 140, 150, 160)~~ is made of any of the following alloys: cadmium selenide, cadmium sulphide, indium arsenide, indium phosphide and/or cadmium selenide sulphide.

~~16~~14. A lighting ~~device~~ fixture as claimed in claim ~~1~~9, wherein, the said size distribution of quantum dots ~~(110, 120, 130, 140, 150, 160)~~ comprises quantum dots of different sizes within the range of 2 nm - 200 nm.

~~17~~15. A lighting ~~device~~ fixture as claimed in claim ~~1~~9, wherein, at least one said quantum dot ~~(110, 120, 130, 140, 150, 160)~~ is produced by colloidal synthesis.

~~18~~16. A lighting ~~device~~ fixture as claimed in claim 1~~, 2~~ and/or ~~1~~9, wherein, the LED and/or size of at least one quantum dot ~~(110, 120, 130, 140, 150, 160)~~ is arranged so that it emits in the far red 700-800 nm band.

~~19~~17. A greenhouse and/or growth chamber light ~~device~~ fixture as claimed in claim 1 ~~or 2~~, wherein, said light ~~device~~ fixture comprises at least one quantum dot ~~(110, 120, 130, 140, 150, 160)~~.

~~20~~18. A light emitting component of a horticultural light in a dark cavity, comprising;

- a light emitting diode (LED) semiconductor chip; and
- a light wavelength up-conversion quantum dot or phosphor which is deposited in direct proximity of the LED semiconductor chip;

said component being capable of emitting two characteristic light emission peaks, and the emission at wavelengths of 500–600 nm is arranged to be reduced below the intensity in 400-500 nm band and below the intensity in 600-700 nm band, wherein the emission at wavelengths of 500-600 nm is arranged to be reduced below the intensity in 600-700 nm band.

~~21~~19. The light emitting component of claim ~~20~~18, wherein the light wavelength up-conversion quantum dot or phosphor is deposited directly on the surface of the LED chip or spaced out with other optical material.

~~22~~20. The light emitting component of any of claims ~~20~~-18 or ~~21~~19, wherein the light emitting diode LED semiconductor chip has a peak emission range of 440 to 500 nm.

~~23~~21. The light emitting component of any of claims ~~20~~ 18 to ~~22~~20, wherein the wavelength up-conversion quantum dot or phosphor is arranged to convert part of the light emission energy emitted by the LED semiconductor chip to the high wavelength of 600 to 700 nm.

~~24~~22. The light emitting component of any of claims ~~20~~ 18 to ~~23~~21, wherein the two characteristics light emission peaks are at 440 nm–500 nm and 600–700 nm, respectively.

~~25~~23. The light emitting component of any of claims ~~20~~ 18 to ~~24~~22, wherein the two characteristic light emission peaks omit spectral characteristics one at least 50 nm full width at half maximum and another maximum of 50 nm full width at half maximum and both at different wavelength ranges.

~~26~~24. Use of the lighting device or fixture of claim 1 ~~and/or 2~~ in providing light for at least one plant with the said at least one plant in a dark cavity with said lighting device or fixture as the sole source of light.

~~27~~25. Use of the light emitting component of claim ~~20~~ 18 in providing light for at least one plant with the said at least one plant in a dark cavity with said lighting device or fixture as the sole source of light.

~~28~~26. A method for enhancing plant growth wherein at least one lighting device or fixture of claim 1 ~~or 2~~ emits light to at least one plant with the said at least one plant in a dark cavity with said lighting device or fixture as the sole source of light.

~~29~~27. A method for enhancing plant growth wherein at least one light emitting component of claim ~~20~~ 18 emits light to at least one plant with the said at least one plant in a dark cavity with said lighting device or fixture as the sole source of light.

~~30~~28. A light emitting device, fixture and/or component as claimed in any of the claims 1~~, 18, 19~~ and/or ~~20~~ 18 wherein said light emitting device, fixture and/or component is surrounded by a cavity which may optionally be closed with a lid.

~~31~~29. A light emitting device, fixture and/or component as claimed in any of the claims 1~~, 18, 19~~ and/or ~~20~~ 18 wherein all or part of the emission at a frequency of 600–800 nm is generated using a whole or partial wavelength up-conversion of the LED and/or quantum dot chip radiation power and/or by another electrically powered quantum dot.