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 at half maximum of at least 50 nm or more;

b) second spectral characteristics with a maximum of 50 nm full width 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. The lighting fixture of claim 1, 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.

3. The lighting fixture of claim 1and/or 2, 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.

4. The lighting fixture of any of claims 1 to 3, 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.

5. The lighting fixture of any of claims 1 to 4, wherein the PPF value of the fixture per Watt is 0.35 $\mu mol\ s^{-1}\ m^{-2}$ or higher.

6. The lighting fixture of any of claims 1 to 5, wherein the spectral emission characteristics; intensity, peak wavelength and full width of half maximum are controlled with size, number and species of quantum dots.

7. The lighting fixture of any of claims 1 to 6, 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.

8. The lighting fixture of claim 7, 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.

9. A lighting fixture for plant cultivation as claimed in claim 1, wherein, said lighting device comprises a plurality of quantum dots of different size.

10. A lighting fixture as claimed in claim 1and/or 9, wherein, at least one LED and/or the size distribution of said plurality of quantum 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.

11. A lighting fixture as claimed in claim 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.

12. A lighting fixture as claimed in claim 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.

13. A lighting fixture as claimed in claim 9, wherein, at least one of said quantum dots is made of any of the following alloys: cadmium selenide, cadmium sulphide, indium arsenide, indium phosphide and/or cadmium selenide sulphide.

14. A lighting fixture as claimed in claim 9, wherein, the said size distribution of quantum dots comprises quantum dots of different sizes within the range of 2 nm - 200 nm.

15. A lighting fixture as claimed in claim 9, wherein, at least one said quantum dot is produced by colloidal synthesis.

16. A lighting fixture as claimed in claim 1 and/or 9, wherein, the LED and/or size of at least one quantum dot is arranged so that it emits in the far red 700-800 nm band.

17. A greenhouse and/or growth chamber light fixture as claimed in claim 1, wherein, said light fixture comprises at least one quantum dot.

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.

19. The light emitting component of claim 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.

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

21. The light emitting component of any of claims 18 to 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.

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

23. The light emitting component of any of claims 18 to 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.

24. Use of the lighting device or fixture of claim 1 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.

25. Use of the light emitting component of claim 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.

26. A method for enhancing plant growth wherein at least one lighting device or fixture of claim 1 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.

27. A method for enhancing plant growth wherein at least one light emitting component of claim 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.

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

29. A light emitting device, fixture and/or component as claimed in any of the claims 1and/or 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.

CLAIMS:

1. A dark room, enclosure or container housing a horticultural lighting fixture, comprising:

at least one first light emitting diode (LED) and/or quantum dot having

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

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

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 at half maximum of at least 50 nm or more,

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

wherein the lighting fixture is configured to reduce a light emission at wavelengths of 500-600 nm is below the intensity in the 400-500 nm band and below the intensity in the 600-700 nm band.

3. The lighting fixture of claim 1, wherein at least a part or the whole of an 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.

4. The lighting fixture of claim 1, wherein the LED and/or quantum dot has additional 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 at half maximum.

5. The lighting fixture of claim 1, wherein emission intensities of the first spectral characteristics, the second spectral characteristics, and optional third spectral characteristics of the first LED and/or quantum dot are arranged to be adjustable, at least the emission intensities of the first and

second spectral characteristics that are arranged to be adjustable being required in the lighting fixture.

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

7. The lighting fixture of claim 1, wherein a photosynthesis photon flux (PPF) value of the fixture per Watt is 0.35 $\mu mol\ s^{-1}\ m^{-2}$ or higher.

8. The lighting fixture of claim 1, wherein the spectral characteristics, intensity, the peak wavelength, and the full width at half maximum are controlled with a size, a number, and a species of quantum dots.

9. The lighting fixture of claim 1, wherein the first LED and/or quantum dot including third spectral characteristics including a freely adjustable peak wavelength in the wavelength range of 500 nm to 800 nm and arranged to exhibit at least 30 nm full width at half maximum, and

emission intensities of the first, second and third spectral characteristics are adjustable in any ratio.

10. The lighting fixture of claim 9, comprising at least one second LED and/or quantum dot with at least one of first spectral characteristics with maximum 50 nm full width at half maximum and a 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, at least the first spectral characteristics of the second LED and/or quantum dot being required in the lighting fixture.

11. A lighting device for plant cultivation, comprising:

the horticultural lighting fixture as claimed in claim 1,

wherein the lighting device comprises a plurality of quantum dots of different sizes.

12. The lighting device as claimed in claim 11, wherein at least one light emitting diode (LED) and/or a size distribution of the plurality of quantum dots is configured to produce an aggregate emission spectrum similar to a photosynthetically active radiation (PAR) spectrum, the aggregate emission spectrum providing a lower intensity in the green yellow (500-600) nm band and comprising a higher intensity spectral feature in the far red 700-800 nm band.

13. The lighting device as claimed in claim 11, wherein the size of at least one of the quantum dots is chosen so that the at least one quantum dot emits photons in a band or in various bands with preset relative intensities in the photon spectrum with a certain photomorphogenetic variable effected in plants.

14. The lighting device as claimed in claim 13, wherein the photomorphogenetic variable that is effected is any of the following biological parameters: weight, leaf number, root mass, stem height, and chemical composition of the plant at different time points or at harvesting maturity, the chemical composition including vitamin, mineral and/or nutrient content and/or concentration.

15. The lighting device as claimed in claim 11, wherein at least one of the quantum dots is made of one or more of any of the following alloys: cadmium selenide, cadmium sulphide, indium arsenide, indium phosphide, and cadmium selenide sulphide.

16. The lighting device as claimed in claim 11, wherein a size distribution of the quantum dots comprises the quantum dots of different sizes within a range of 2 nm-200 nm.

17. The lighting device as claimed in claim 11, wherein at least one of the quantum dots is produced by colloidal synthesis.

18. The lighting fixture as claimed in claim 1, wherein the at least one first LED and/or a size of the at least one quantum dot is configured to emit in the far red 700-800 nm band.

19. A greenhouse and/or growth chamber light device, comprising:

the lighting fixture as claimed in claim 1, wherein the light device comprises the at least one quantum dot.

20. A method for enhancing plant growth, comprising:

emitting, by the lighting fixture of claim 1, light to at least one plant in a dark cavity, the lighting fixture being the sole source of light.

21. The light emitting fixture as claimed in claim 1, wherein the light emitting fixture is surrounded by the dark cavity, optionally the dark cavity being configured to be closed with a lid.

22. The light emitting fixture as claimed in claim 1, wherein all or part of a light emission at a frequency of 600-800 nm is generated using a whole or partial wavelength up-conversion of radiation power of the LED and/or the quantum dot and/or by another electrically-powered quantum dot.