Figure 1C describes the relative sensitivity spectrum of the insect eye of a honeybee (*Apis mellifera*) as measured in "Flower colour as advertisement", Chitka L. & Kevan, P.G. (2005), In Dafni, A., Kevan P.G., Husband, B.C. (eds.) Practical Pollination Biology. Enviroquest Ltd., Cambridge, ON, Canada, pp. 157-196 in accordance with the prior art. This spectrum confirms that there is a reasonable extent of overlap in high sensitivity bands of insect vision and high reflectance bands of flowers. In fact, the analysis of reflectance spectra of 180 flowers showed that the reflectance peaks match sensitivity peaks of pollinating insect vision in Chittka L. & Menzel R. 1992, "The evolutionary adaptation of flower colours and the insect pollinators' colour vision", Journal of Comparative Physiology A 171: 171-181, which document is cited here as reference.

There are serious disadvantages in the prior art. The aforementioned spectral observations have been used only for trapping insects as pests. Also artificial illumination solutions for plants of the prior art, of which WO/2011 033177 is perhaps the most developed, have addressed the enhancement of only photosynthetic growth of the plants, not their reproduction or fruit production. It is very difficult for pollinating insects to find flowers in greenhouses when it is winter, cloudy weather or otherwise dark, and/or when the air stands still. Realising natural pollination activity that would be as high quality as the natural process, or even higher quality in greenhouse environments is therefore a substantial problem burdening the prior art.

SUMMARY

Embodiments of the invention seek to solve the aforementioned disadvantages. Embodiments of the invention are directed towards a system and a method for effectively illuminating plants so that they may achieve the desired photosynthetic growth and are pollinated more frequently by insects.

Embodiments of the invention also seek to provide an illumination device that is harmless to the pollinating insects in a greenhouse environment.

According to a first aspect of the present invention, there is provided a horticultural light device, comprising at least one LED and/or quantum dot arranged to emit an emission spectrum comprising at least two spectral peaks that coincide with photosynthetic absorption peaks of plants, wherein the emission spectrum comprises emissions at two or more wavelengths of high photoreception sensitivity of insect vision, wherein high sensitivity is understood to exceed a 70% level of maximum of said photoreception sensitivity in the UV (300-400 nm) to far red (700-800 nm) band.

According to a second aspect of the present invention, there is provided a plant cultivation method, wherein the method comprises illuminating insect-pollinated plants with a light device comprising at least one LED and/or quantum dot emitting an emission spectrum comprising at least two spectral peaks that coincide with photosynthetic absorption peaks of plants, wherein the emission spectrum comprises emissions at two or more wavelengths of high photoreception sensitivity of insect vision, wherein high sensitivity is understood to exceed 70% level of maximum of said reflectivity and/or sensitivity in the UV (300-400 nm) to far red (700-800 nm) band.

As disclosed, the plants are illuminated with a lighting device that comprises LEDs and provides strong emission peaks at wavelengths that coincide with the reflectivity of the flowers being cultivated. This has the effect that the insects can see the flowers better, and therefore find them more easily, which increases the efficiency of pollination by the insects. A further improvement to this aspect is to choose those wavelengths for emission peaks that have a high reflectivity from flowers and/or high sensitivity in the insect vision. The best effect is achieved when the aforementioned high reflectivity and high vision sensitivity coincide. This is the preferred emission wavelength for a pollination enhancing lighting device as it increases the visibility of the flowers in the eyes of the insect maximally.

The wavelengths that are typically suited as emission peaks are for example 348 nm, 375 nm, 435 nm, 533 nm, 538 nm with an error range of ±10 nm. The light device is typically realized with LEDs and/or quantum dots. A *quantum dot* is a semiconductor whose excitons are confined in all three spatial dimensions.

The peak wavelengths may vary depending on the plant species being cultivated and the insect used to cultivate the said plant. For example (*B. terrestris dalmatinus* and *B. terrestris sassaricus*) exhibited spectral peaks at 348 nm, 435 nm and 533 nm and 347 nm, 436 nm and 538 nm, please see Skorupski P., Döring T.F. & Chittka L. 2007, "Photoreceptor spectral sensitivity in island and mainland populations of the bumblebee, *Bombus terrestris*", Journal of Comparative Physiology A 193: 485-494, which is cited here as reference. *B. impatiens* has its photoreceptor spectral sensitivity peaks at 347 nm, 424 nm and 539 nm, please see Skorupski P. & Chittka L. 2007, "Photoreceptor spectral sensitivity in the bumblebee, *Bombus impatiens* (Hymenoptera: Apidae)", Plos ONE 5: 1-5, which document is cited here as reference. Any or all of the aforementioned peaks could be used as center wavelengths for light emitter spectral peaks of the invention.

Embodiments of the invention combine the aforementioned light device with a light device that enhances the photosynthetic growth in plants. This light device typically has a peak in the blue emission, low green and/or yellow emission, and a peak in the red and/or far red emission. This maximises photosynthetic growth as it coincides with the absorption peaks of Figure 1A. This emission is also typically produced by LEDs and/or quantum dots.

A horticultural light device as disclosed is characterised in that the said light device is arranged to emit at least one spectral peak at a wavelength that coincides with increased reflectivity of flowers of pollinating plants.

A plant cultivation method as disclosed is characterised in that the pollinating plants are illuminated with a light device emitting at least one spectral peak at a wavelength that coincides with increased reflectivity of flowers of said pollinating plants.

The "coincidence" in this application is understood as the positioning of spectral peaks that aims to maximize the incoming photons from the flower to the insect eye, and ultimately maximize the neurological vision signal that the insect eye generates from the photons. Therefore the peaks do not need to mathematically exactly coincide, in accordance with the invention the peaks need only to coincide to a degree that sufficiently maximizes the neurological vision signal in the insect eye.

The said aforementioned increased reflectivity and/or sensitivity is understood to exceed the 90%-, 80%-, 70%-, 60%-, 50%-, 40%- or 30%- level of maximum of said reflectivity and/or sensitivity in the UV (300-400 nm) to far red (700-800 nm) band. For example if both the reflectivity and the sensitivity would be at 70% level of maximum, the end visual signal detected by the insect would be 0.7*0.7=0,49, i.e. roughly half of the signal that exact coincidence of maximum peaks could produce. This is most probably a sufficient level to assist the insects in pollinating the plants very significantly.

The plant illumination device and method according to embodiments of the invention may have the advantage that the LED and/or quantum dot based design is harmless to the pollinating insects. Prior art light devices relying on electric discharge typically attract insects, but also heat to extreme temperatures, killing many pollinating insects that are drawn close to the prior art light device. A further advantage of the invention is that as the insects see the flowers better; pollination efficiency is increased, leading to more enhanced reproduction by the plants, higher volume and quality fruit production and an increase in crop. The better survival rate and improved vision have a synergistic added advantage: the insects are known to be capable of learning to operate in different illumination wavelengths and conditions. However, if the insects are killed by hot lamps very early on, no learning will have taken place. A light device that is not lethal to insects also adds to improved pollination by its effect of allowing more educated insects to pollinate the plants more effectively than ever before. The light device provides also for better rested insects as the insects find to their nest easier with the inventive light solution than without it. As the insects are capable of learning, it is possible that the insects can work quite effectively in illumination conditions where the peak wavelength of the illumination is not at maximum sensitivity, when they are provided with the chance to adjust to the lighting conditions.

LEDs according to embodiments of the invention may provide also an improvement to current solution using HPS and HID (High Intensity Discharge) due to their capability of easy spectrum in-situ tuning, e.g. UV LEDs can only be turned on during a pollination event, i.e. when pollinating insects are present near the plants. When turned off UV light does not assist harmful insects, such as pests, to find plants. This is not possible in HPS and HID lamps of the prior art. Producing UV light also consumes more energy and therefore it is beneficial to use that spectrum off when not used.

An even further advantage according to embodiments of the invention is that as the light device according to embodiments of the invention may enhance both reproduction and growth, this enhancement has a synergistic improvement in crop levels that goes beyond the levels that could be achieved by using either one lighting solution individually or separately. Even further, the