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Light Wavebands & Their Effects on Plants

> Researchers are still learning about how light quality influences plant growth and development.

With the advancement of light-emitting diodes (LEDs), we are able to purchase — or even customize — LED arrays that emit different spectrums of light for plant growth applications. That's one of the exciting features of LEDs, to provide a specific light environment to produce crops with specific growth characteristics. This is especially possible when LEDs are the only light source; when lighting supplements sunlight, generally light quality has less dramatic effects. This article discusses how the four primary wavebands of light influence plant growth and development. Because of the diversity of plants though, there are always exceptions to these generalizations. Light wavebands also interact with each other, but only a few are mentioned here.

Blue light (400 to 500 nm). Chlorophyll in plants highly absorbs blue light that is used for photosynthesis. It also helps regulate the opening of stomata, which are tiny openings in the leaves that regulate the uptake of carbon dioxide (required for photosynthesis) and water loss. Blue light also generally acts to inhibit extension growth, so plants grown under light that contains blue typically have smaller leaves and shorter stems. For these reasons, many LEDs for plant applications emit at least a small amount (such as 10-20 percent) of blue light. In an indoor environment, plants grown without any blue light typically have an elongated appearance.

With respect to flowering, generally a low intensity has no effect, but a higher intensity (such as 30 μmol·m^{-2}·s^{-1}) can influence flowering of photoperiodic crops. We're continuing to learn how blue light influences flowering.

Green light (500 to 600 nm). When light strikes a leaf, it can be absorbed by, reflected from or transmitted through the leaf. Plants appear green because they reflect and transmit slightly more green light than they do blue or red light. Chlorophyll also absorbs green light poorly. For these reasons, green light is sometimes stated as not being useful to plants for photosynthesis. However, green light is still moderately effective since other pigments absorb the light and make it useful for photosynthesis. A more correct statement is that, generally, green light is less efficient at stimulating photosynthesis than blue or red light. In some situations, the greater reflection and transmittance of green light by leaves can be desirable. Green light can better penetrate a plant canopy and thus reach lower leaves. This can, in theory at least, reduce lower-leaf loss. However, few LED arrays contain green LEDs because they are less efficient than blue and red LEDs from both an electrical and plant response perspective.

Red light (600 to 700 nm). Most LED arrays emit a high percentage (often 75-90 percent) of red light because it is absorbed well by chlorophyll, and the electrical efficiency of red LEDs is high. Red light is considered the most efficient waveband for photosynthesis, but as mentioned previously, plants can be elongated in the absence of other light wavelengths. In short-day plants, delivery of red light during the night can prevent flowering. In long-day plants, red and far-red light combined is the most effective at promoting flowering of a wide range of crops. Therefore, red is usually the dominant color for photosynthetic and photoperiodic lighting.

Far-red light (700 to 800 nm). This waveband is not considered photosynthetically active, but far-red light does influence growth. The ratio of red to far-red light influences leaf and stem elongation and so plants grown under light that includes some far red will typically have larger leaves and taller stems. Depending on the application, this may or may not be desirable. Also as previously mentioned, far-red light plays a role in flowering of some long-day plants; so some LEDs developed specifically for flowering applications emit both red and far-red light.

Researchers are still learning about how light quality influences plant growth and development. In addition, lighting can influence other responses including flower and leaf color and the biosynthesis of compounds in food crops, such as antioxidants and vitamins. It's an exciting time for both controlled-environment agriculture and lighting industries because as the technology of LEDs advances, our ability to exploit that lighting increases. g

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