Multispectral LED array for plant research
Michael Stasiak, Dave Hawley, Per Åge Lyså and Mike Dixon, TechNote 001-2012

The goal of controlled environment plant production is to optimize productivity with precisely controlled and homogeneous environment conditions. Achieving this outcome requires an extensive array of technologies designed to establish and sustain such conditions. The most important of these is arguably the light source. Historically the conventional range of light technologies available for plant production has spanned fluorescent, incandescent, high pressure sodium and metal halide and has also included newer technologies such as the microwave powered sulfur lamp (plasma lamp) and induction lamp. In recent years the advances in light emitting diode (LED) technology have made the prospect of adding this to the list quite realistic. The unique capability of LEDs is the prospect of combining a variety of monochromatic lights to create a light source specifically tailored to plant photosynthetic requirements rather than the sometimes crude facsimiles offered by more conventional technologies.

In collaboration with Intravision AS (Norway) and COM DEV International, the Controlled Environment Systems Research Facility at the University of Guelph has developed a multispectral LED array designed specifically for plant studies utilizing our BlueBox precision growth chamber technology (Figure 1). Individually controllable spectra coupled with instantaneous measurement of whole plant photosynthesis and transpiration will form the basis of an NSERC funded research program investigating light mediated growth and development, remote non-destructive sensing of plant health and a unique method of instantaneous ion sensing in hydroponic solutions.

Intravision AS engineered and produced a prototype 'snowflake' array (Figure 2) consisting of 512 individual high powered LEDs using Philips visible LEDs and the specifications derived from a partnership workshop held in September, 2011. This prototype is air cooled and rated at 50% of the LED output capacity, whereas the final design, currently in production, is liquid cooled and will provide seven visible wavelengths at full power. The prototype array has allowed us to assess the spectral quality and control system, and to fine

Figure 1: CESRF small hypobaric plant growth chambers.

Figure 2: Prototype LED array
tune the requirements of the remaining UVA and far red sources, which are still being assessed and are easily adapted to the existing array platform. UVA and far red will complete the spectrum by extending light energy to 395 and 735 nm respectively.

The array is capable of providing a full spectrum (Figure 3) at 2000 µmol m⁻² s⁻¹ over a 0.5 m² area from a distance of 60cm. Individual wavelengths are fully addressable and dimmable and should provide up to 1000 µmol m⁻² s⁻¹ over the same 0.5 m² growing area. This light source will allow the systematic study of the effect of specific changes in spectral quality and quantity and their impact on productivity parameters including photosynthesis, water use efficiency, yield, time to flowering, and plant structure.

Figure 3: Spectral response of the prototype array using seven wavelengths and optimizing output to provide a flat (ish) PAR spectrum

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Controlled Environment Systems Research Facility
School of Environmental Sciences, University of Guelph, Guelph, Ontario, Canada