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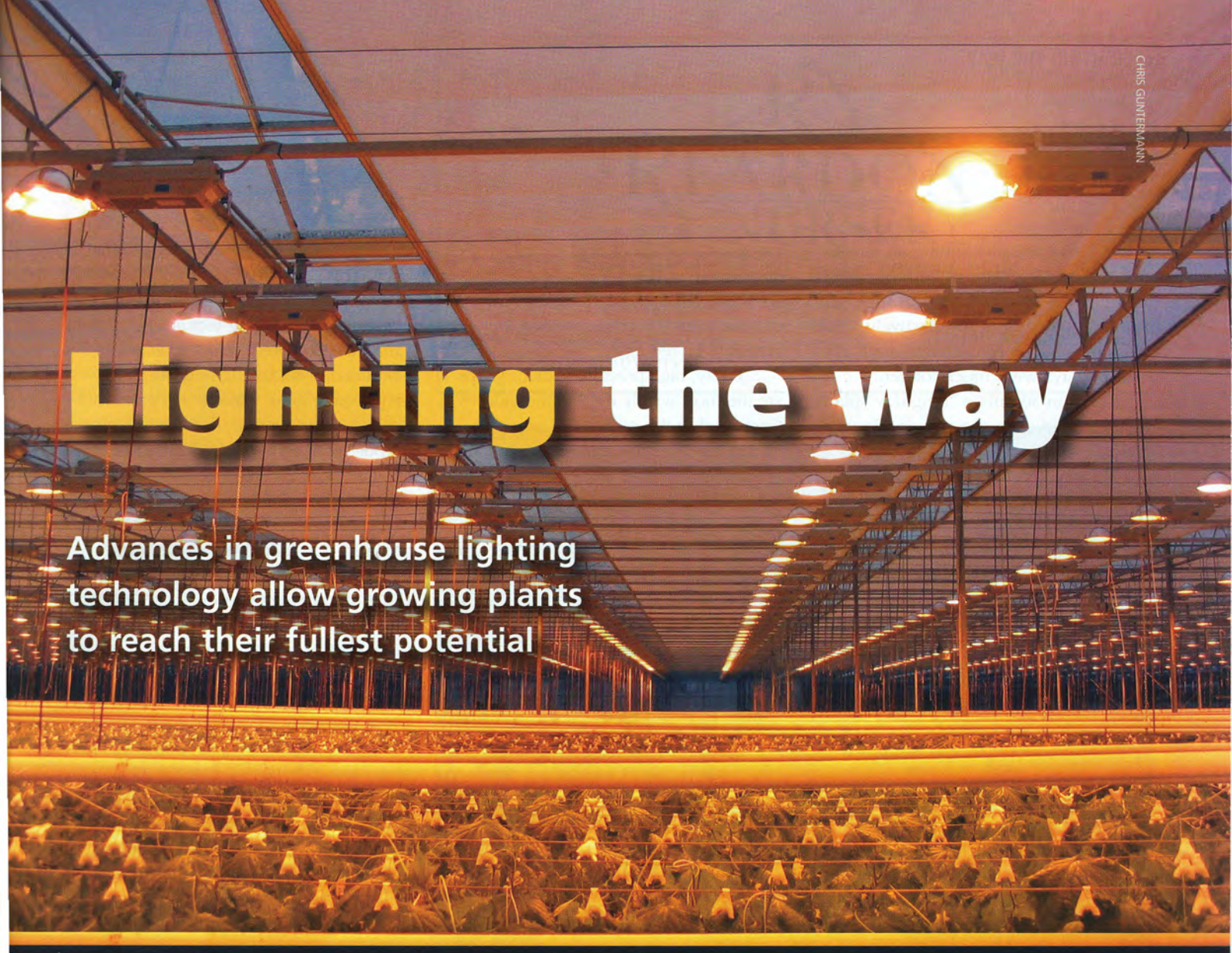

CHRIS GUNTERMANN

Lighting the way

Advances in greenhouse lighting technology allow growing plants to reach their fullest potential

By Miles McCoy

It's an elementary truth — plants simply need light to grow.

But over the past several decades, greenhouse growers have become much more sophisticated in their use and manipulation of light.

Two different kinds of light are frequently used in today's greenhouses. There's natural light and artificial light. Growers have become very adept at adding the latter to enhance plant growth.

Artificial greenhouse light started with simple incandescent light bulbs, but over time, it expanded to include other types of light sources, such as LED grow lights. These gradual improvements have reduced energy costs, expanded the spectrum of light that reaches plants, and expanded growers' overall ability to stimulate desired plant growth.

Creating longer or brighter days

The addition of supplemental light to encourage better plant growth is sometimes termed "photosynthetic lighting." It can have many benefits for plants, according to greenhouse consultant Chris Guntermann, of Horticultural Services Inc. in Oregon City, Ore.

"The added light builds carbohydrates, improving growth," he said. "Other side effects are warmer leaves, drier leaves, and a harder or thicker epidermis, so (you end up with) less disease."

Lighting in the morning can also allow a grower to run air slightly cooler. That's because the lights can warm leaves during the coldest part of the night. Some research also indicates that chloroplasts and mitochondria become more efficient when they are lit in the morning.

The plants are responding to the quantity of light photons hitting the plant. Researchers have adopted the term "daily light integral," or DLI, to measure this amount. It is the amount of photosynthetically active light received daily on one square meter of plant surfaces. Any light with a wavelength of between 400–700 nanometers is deemed to be "photosynthetically active light."

Daylength-regulation lighting is distinct from supplemental light. It refers

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to the use of artificial lighting to create longer days. This type of lighting often is used in early spring, when days are still short. Growers use it to effectively "trick" their crops into reacting physiologically as if the days were much longer.

This can stimulate "long-day" plants to flower earlier in the season. By using this method, a grower can make certain seasonal plants available to garden centers for a longer time window. The plants become more marketable, and sales increase. There are several techniques to accomplish this, depending on the grower's need.

"Longer day length for long-day plants is usually accomplished with short lighting periods in the middle of the night, also called 'night interruption,'" Guntermann said.

Night interruption can be more cost-effective than other daylength-regulation techniques, because it requires less light exposure. Plants are very sensitive, so low light levels can be effective. Additionally, off-peak power can be less expensive.

Lighting sources

While growers have used these tricks for decades, significant advances have been made in the basic lighting choices. Both incandescent and fluorescent bulbs were obvious choices for many years, followed by the adoption of the sodium vapor light.

Michigan State University greenhouse lighting researcher Erik Runkle wrote about the subject in *Greenhouse Products News*. "When plants are exposed to at least 10 foot-candles (of light), all common light sources — incandescent, high-pressure sodium, metal halide and fluorescent lamps — are equally effective," he stated.

Foot-candles are a common measure of illumination, equivalent to approximately 10 lux, or 10 lumens per meter.

Growers moved away from incandescent lamps, since they were energy-inefficient and can cause stem elongation from too much far-red light. Their first alternative, the compact fluorescent lamp, was an improvement over the incandescent bulbs. But, while cost effective, Runkle noted they might "delay flowering of some long day crops because they emit very little far-red light."

Today, high-pressure sodium lamps are the most widely used in the industry. Compared to the earlier choices, these HPS lamps are more energy efficient and last longer. Their light spectrum is strong in orange, but lacking in red and blue.

In most greenhouses, between 75 and 35 percent of the outside light will penetrate the structure and reach the plants.

This orange spectrum encourages rapid fruiting, flowering and budding.

They also add heat, which might be another advantage.

"Lights can be useful as an auxiliary heating source as well as providing growth energy," Guntermann said.

He suggested that growers compare their electric rates to available fuel rates on a Btu basis. "You may find your PUD (public utility district) electric is cheaper than propane per Btu," he said.

The most recent advance for growers to consider is the "light-emitting diodes" or LEDs. This new lighting technology has created an entire industry.

LEDs have some compelling advantages — they take less energy, and can offer a much wider range of light spectrum choices. They also have a superior "power to light" ratio, which measures the amount of energy required to produce a light unit. This potentially makes LED lighting more energy efficient.

One must remember, though, that LED lights are still relatively new, and may have limitations.

"It is an emerging technology with variable cost-benefit ratios at this time," Guntermann said. "High-output LEDs may require large fixtures that can block natural lighting, while some very-high-output LEDs may require significant cooling to retain efficiency. Effective uses include growth chambers."

One company, LumiGrow, recently received considerable venture funding to continue to improve their line of LEDs. Company representative George Chan said the company has addressed these concerns in their newest designs.

Greenhouse design considerations

Before one considers adding artificial light to the equation, one should first make sure they are maximizing the natural light that enters the greenhouse. The design of the greenhouse is a major factor. Even a well-designed greenhouse will have a reduced range of light that enters.

In most greenhouses, between 75 and 35 percent of the outside light will penetrate the structure and reach the plants. In other words, 25–65 percent of the light will be blocked. That's a lot of lost light. That's why growers should consider ways to increase light transmission, which is simply the amount of light that penetrates the greenhouse.

Here are some tips:

- Position the greenhouse wisely relative to the sun. When light strikes the greenhouse covering at an angle, the transmission rate will be lower than when the light hits the glazing material head on.
- Clean or replace greenhouse coverings regularly. Dust and dirt can reduce the entering light by as much as 20 percent. Clean coverings will allow the most light to enter.
- Utilize greenhouse frames with a wide-pane or open roof design. These are better for letting in light. Shading from the structure can reduce light penetration by 15 percent. Better designs will reduce this.

• Avoid hanging baskets above light-hungry crops. The hanging baskets will reduce the light transmission to any plants positioned below them.

• Finally, reduce overhead "clutter" such as heating units, pipes and conduits. They can all block light. Conduits are necessary, of course, for any form of artificial light. One should position them to avoid blocking natural light.

An alternative future?

The development of LED technology has the potential to lead to radical new approaches to greenhouse growing. There is the potential to create growing rooms that are completely enclosed. One scientist has even promoted the idea of "vertical farms" — multi-story towers for growing crops.

Although this particular application may seem farfetched, others are actually putting LEDs to use in ways that make natural light unnecessary.

LumiGrow is a commercial manufacturer of LED grow lights. According to the company website (www.lumigrow.com), Green Winter Farm in Palmer, Alaska, is using LumiGrow LEDs to grow fresh basil commercially for local consumption, in an enclosed warehouse.

It seems like a limited, expensive strategy. But, if one considers added temperature control and less heat requirements; few, if any pest problems; and simpler automated watering and fertilization options, reduced costs might make it more feasible. It is a trend similar to the recent increase in "tunnel" (basically large, poly-covered, U-shaped cold frames) production of produce and berries.

Control of plant growth is, and will remain, a way to improve the products greenhouse growers offer the consumer. But its uses in the future may be more like science fiction.

Miles McCoy is the owner of Sustainable Hort LLC, a sustainable and organic products marketing firm. He has more than 25 years of experience in the green industry. He can be reached at miles@sustainablehort.com.