Going Green to Stay in the Black

MAKE AN LED LIGHTING INVESTMENT THAT PAYS OFF.

By Kevin Wells

A greenhouse operation, like any business, wins on its margins. Every infrastructure investment must be evaluated for its ability to sustain profit margin gains. Lighting is no exception.

Yield gains achieved through artificial lighting are impressive. A general rule of thumb is that every one percent increase in the daily light integral results in a one percent increase in production. But as double-digit electrical rate hikes begin to take effect across the United States, profit margins achieved through increased crop yields are quickly erased by the higher operating costs. That's why growers are increasingly making the switch to energy-efficient LED lighting.

Growers responsible for the financial performance of their operations face two pressing questions: Will the new breed of LED lighting ensure healthy crops, and if so, is there a clear cost-benefit case to be made for making the switch? The answer to the first question is absolutely, yes. To the second question, the answer is often, but not always, yes.

The first step in evaluating a lighting retrofit or new installation purchase is gaining a basic understanding of the application of LED technology to crops.

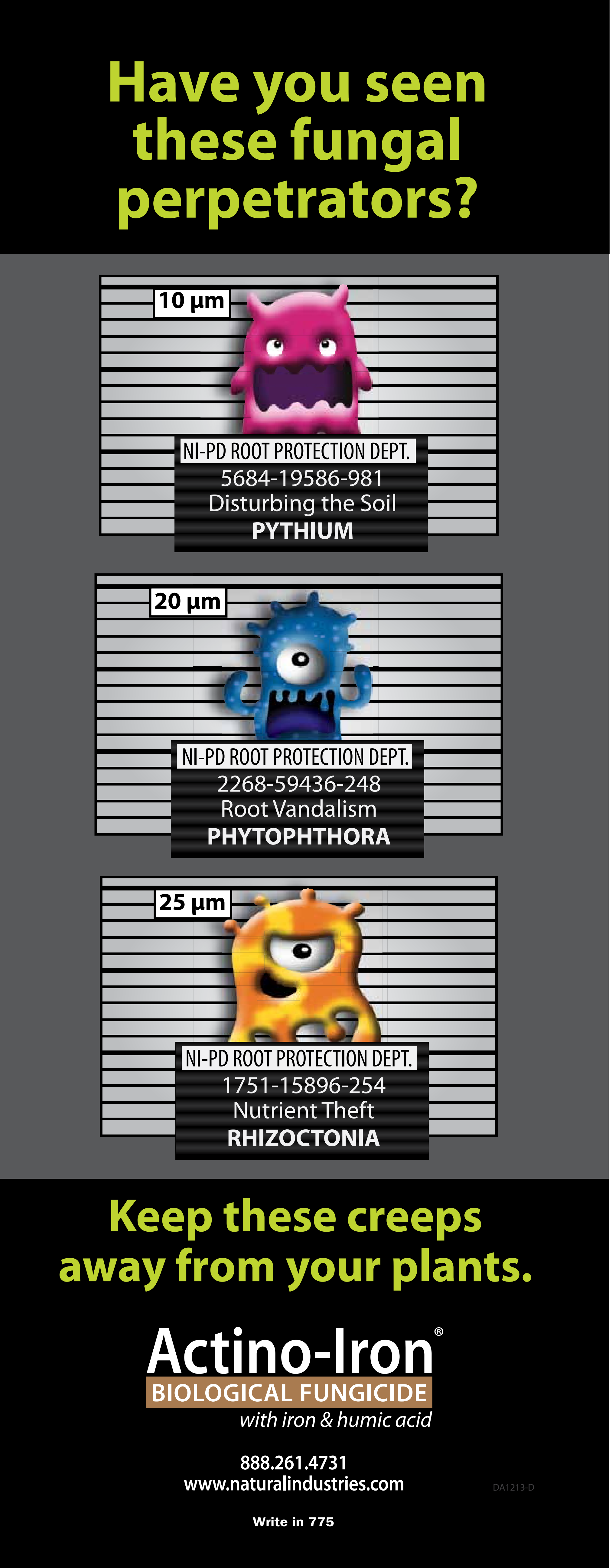
To encourage energy efficiency, many utilities offer rebates and subsidies for LED lighting. Explore financing plans from manufacturers and distributors. They may make your lighting investment cash-flow positive from your first electrical bill.

Targeting Light to Elicit Plant Responses

As regular readers of *GPN* are aware, plant scientists define light in the 400-to-700 nanometer (nm) spectral region as photosynthetically active radiation (PAR). Plants perform photosynthesis using two types of chlorophyll: Chlorophyll-A, with peak response at 430 nm and 680 nm, and Chlorophyll-B, with peak response at 450 nm and 660 nm. For simplicity, we'll call these key plant response regions "red and blue PAR." The green we perceive, at around 525 nm, isn't of much use to plants.

LEDs allow engineers to create fixtures that emit light precisely tuned to plant response areas within the PAR range rather than the broad spectrum of light humans perceive. This signature characteristic of LED lights makes them highly energy efficient. It also requires some adjustment in the way we measure light for use by plants. The ratings most growers are familiar with are the lumen and the lux, both of which measure the amount of light we see. But human visual response is very low at red and blue, and highest at green. That's why a high lumen or lux rating does not necessarily make a lamp better suited to growing plants.

To accurately measure the amount of energy present for photosynthesis we must use a spectroradiometer. This instrument measures energy in Watts at each specific wavelength over a range. The measurement is then translated into micromoles per meter squared per second ($\mu mol/m^2*s$) to tell us how many photons in a spectral range fall on the



plant each second. As spectroradiometers are expensive instruments, not usually found outside laboratories, manufacturers should publish independently verified spectroradiometric data showing the energy per wavelength produced by their lamps. This data allows growers to directly compare the ability of fixtures to produce photosynthetic light.

Crossing the Performance Barrier

Spectroradiometric readings reveal that the most powerful of the previous generation of LED lights matched the red and blue PAR output of 600-watt LEDs. Generally, these LED lights are an economically sound option when used to illuminate crops such as leafy greens and as supplemental or intercanopy lighting for tomatoes and other vine crops, where they can be placed very close to leaves without risk of heat damage.

Advances in LED technology have enabled the commercial release of LED lights that match and even exceed the photosynthetic output of 1,000-watt HID lights. With red and blue PAR now at parity between the most powerful LED lights and the most powerful HID lights, growers can make apples-to-apples comparisons between fixture types for high-light requirement plants such as flowers and fruiting vegetables.

Nowadays, LED lights grow just about everything imaginable, from algae in massive photo-bioreactor tanks and tomatoes in converted warehouses to peace lilies in greenhouses and cotton and spring wheat in research labs.

Adjusting Light

One of the chief advantages of some LED fixtures is their ability to customize the light output spectrum. By varying the output power of individual colors, the grower can simulate seasonal light changes over a multi-week growing cycle. This type of spectrum change is similar to the effect achieved by starting plants under metal halide lamps for vegetation and then changing to high-pressure sodium lamps for flowering. Growers can even tailor the light spectrum to suit individual plant types.

Minimizing Shadowing of the Plant Canopy

Except in cases where a precisely controlled environment is paramount, there is no more cost-effective light source than the sun. It's a false economy to select an inexpensive, low-powered LED light that must be spread blanket-like over your plant canopy. Instead, look for a high-light-density fixture with a small hardware footprint to make the most of the sun's contribution to your daily light integral.

Maximizing Electrical Infrastructure

Some of the growers we work with sought to increase production through additional HID lighting only to discover that they had reached the power capacity of their current electrical wiring. The most cost-effective way for these growers to add more light was to start replacing aging fixtures with new LED lights. This example illustrates:

A 100 Amp 240VAC circuit breaker can support two dozen 1,000-watt HID lights or 40 650-watt LED lights. By switching to LED lighting, a grower adds 300 percent more red and blue PAR light with no power bill increase.

Replacing lights as they degrade is a good strategy for many growers, particularly those who have made a significant investment in conventional lighting. LED lights can be installed just like HID lights and operate right alongside them, making the transition seamless.

Weighing the Bottom Line

Most growers' initial interest in LED lights stems from the energy efficiency gains they expect to achieve from them. In fact, growers can expect anywhere from 40 to 70 percent energy savings from LED lighting versus HID fixtures. But will these energy bill savings offset the higher up-front cost of the LED lights? It depends.

Ask your lighting solution

provider for a financial analysis that includes the price you pay for electricity as well as your light runtimes to help you make that determination. For example, a grower paying nine cents or more per kilowatt-hour and running lights for at least four months out of the year is likely to see a compelling ROI. If you pay less than that for electricity and your daily light integral supports your yield objectives, you might want to remain on the sidelines for a while longer or conduct a limited trial to assess your results.

To encourage energy efficiency, most utilities offer rebates and subsidies for LED lighting. Additionally, some manufacturers and distributors offer financing plans that can make your lighting investment cash-flow positive from your first electrical bill. Explore these options as well as new equipment buy-back programs that keep you at the forefront of lighting technology.

Finally, take stock of your operation. Are you satisfied with your current production and cycle times? How could your greenhouses be modified to support business growth or diversification, such as adding a hydroponic vegetable crop? The lighting plan you receive from your solution provider should not only take into account parameters like your daily light integral, but it should also support your business strategy.

Armed with this information, you'll be prepared to make energy-efficient, green lighting selections that keep your business solidly in the black for many years to come. g

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