

insideGROWER

February 2019

CONTROLLED ENVIRONMENT AGRICULTURE

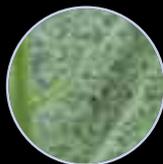
No Small Feat

Paul Sellow of Little Leaf Farms on being competitive with the biggest names in the lettuce biz.



PAGE 18

How Peace Tree Farms delivers year-round herbs for Wegmans



PAGE 26

Avoiding basil downy mildew before the seed is sown



PAGE 30

A cannabis nightmare: Bud rot

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Trying Something New

It's well into a new year and on that list of New Year's Resolutions (some of which are probably already broken, but that's okay, I'm not judging) you might have written "try a new crop," possibly of the edible variety.

The container herb and hydroponic produce market continues to expand with new (and growing) players all the time, particularly as labor and food safety issues continue to plague field growing. A recent survey of food bloggers showed the biggest trend for 2019 will be locally grown produce.

That's great news for our cover story subjects, Little Leaf Farms, a heavily automated hydroponic baby leafy greens grower in Devens, Massachusetts. They opened in 2015 and are currently working on their third phase of expansion. One of the founders, however, has roots in the ornamentals industry from a company many readers will know well. You can read about how Little Leaf got its start serving the New England states with fresh product that hits the shelves within 24 hours of harvest on page 12.

It's not always easy for ornamental growers to make the transition into growing container herbs or leafy greens. There's a definite learning curve to growing

something that other people will eat—considerations of size, flavor and freshness are all taken into account. I talked to Alex Traven, head grower at Peace Tree Farms in Kintnersville, Pennsylvania, about making that transition and what the upsides (and challenges) are in dedicating some space to this new endeavor. Read what he has to say on page 18.

Also, one of Alex's challenges was (you'll have to read the story to find out why I said "was") basil downy mildew. We tapped David Kuack to dive into this topic even more because it can be such a major issue with herbs, vegetables and ornamentals. His story, on page 26, breaks down why it's a concern and gives growers the tools they need to combat it.

To further help with the transition, Nancy Rechcigl of Syngenta provides tips for combating common disease problems while growing container fruiting vegetable and herb plants alongside ornamentals. You can find her helpful charts on page 22.

If you're considering cannabis as that new crop, you'll want to turn to page 30 to read through Brian Corr's description of bud rot and how to prevent or control

it. Since the buds are what growers harvest for sale, a late realization of bud rot can be devastating.

Just a note to add: one thing I've come to learn after talking to so many CEA operations is it's key to identify your customer potential and reach out to make those connections very early on. Crafting those relationships will help you better understand just how much product you need and when. You can invest in an amazing growing facility, but if there's no one to consistently buy your product, then it's all for naught.

Whatever new crop you decide to grow this year, I wish you luck, a good harvest and profitability!

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A Friend Remembered
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ON THE COVER

Paul Sellow, co-founder of Little Leaf Farms in Devens, Massachusetts, discusses how his indoor hydroponic lettuce business is quickly becoming one of the larger producers in the country.

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Farm Bill Finale

On Wednesday, December 12, 2018, Congress passed the new version of the Farm Bill in a swift bipartisan vote.

The Senate voted 87-13, while the House passed the legislation by a 369-47 vote. The President signed the bill on December 20, 2018, making the provisions in the new Farm Bill effective until 2023.

The main question is: What's in it for horticulture and controlled environment agriculture? There are four components that directly affect our industry:

- **The Specialty Crop Research Initiative (SCRI)**, allows for specialty crops to compete for the full \$80 million per year for specialty crop research. This was achieved by moving \$25 million in dedicated citrus industry funding, which was previously taken from the overall funding, into a separate trust fund. The new provisions provide a \$125 million increase over current law for the new five-year Farm Bill.

- **Specialty Crop Block Grants** provides continued funding at \$85 million a year. This represents a significant increase in total funding for the program over the five-year lifespan of the Farm Bill from \$375 million to \$425 million. The legislation also works to help ease existing hurdles in current law that have made the funding of marketing and multi-state projects more difficult.

- **Pest and disease research and prevention**, which maintains FY2018 funding at \$75 million per year. Overall, this is an increase of \$50 million over the life of the 2018 Farm Bill. It also reauthorizes the National Clean Plant Network, which protects key sectors from pathogen threats by providing access to pathogen-tested accessions of the newest varieties of tree fruit, berry, roses and other high-value horticultural crops.

- **Greenhouse Crop Insurance**, which initiates research and development into potential expansion/improvement of greenhouse crop insurance coverage.

Other key provisions include one that affects the breeding side of the industry, which is expanded plant intellectual property rights options, as well as language



throughout the research title to ensure prioritization of research into labor-saving mechanization

and automation in various USDA programs.

AmericanHort Senior VP Craig Regelbrugge called passage of the Farm Bill “a monumental win for the horticulture industry” in a press release. And Tal Coley, director of government relations, said, “Passing the Farm Bill was a critical priority for our organization in 2018, as grassroots action and lobbying efforts in Washington, D.C. played a big part in the success of this effort. AmericanHort members and grassroots partners sent hundreds of emails to their elected officials, while our advocacy team engaged directly with lawmakers and staff via joint efforts with the Specialty Crop Farm Bill Alliance.”

If you're interested in what else is included in the new Farm Bill, go to agriculture.house.gov/farmbill.

GAP Assistance Available in 16 States

The USDA announced it will provide \$3.7 million in assistance to fruit and vegetable growers in 16 states through the GAP Assistance Program. That money will help defray costs of undergoing voluntary USDA Harmonized Good Agriculture Practices audits in 2019.

“These audits help producers meet Produce Safety Rule standards and will also improve their ability to sell into markets that expect growers to demonstrate that they have incorporated a culture of food safety into their operations,” says Marketing and Regulatory Program Undersecretary Greg Ibach in a release to the media. “We are excited to be able to support producers pursuing these audits in the 2019 season.”

As of January 2, the USDA will offer funds to cover up to 100% of the costs associated with the Harmonized GAP audit and the Harmonized GAP Plus+ audit for growers in the following states: Connecticut, Delaware, Hawaii, Maine, Maryland, Massachusetts, Nevada, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Utah, Vermont, West Virginia and Wyoming.

Contact AMS' Specialty Crops Inspection Division for more information at (202) 720-5021 or by email at scaudits@ams.usda.gov.

Good News for 2019

According to a survey of food bloggers from FullTilt Marketing, the biggest food trend for 2019 is ... locally grown food.

This is what they say about locally grown: “With healthy meals and snacks, special diets and alternative protein products becoming the norm, fruits and vegetables are uniquely positioned to win. Produce is inherently healthy, non-processed and ‘free from.’ The rise of organic produce sales, value-added options and snack-based options speaks to this need. Growers have an opportunity now more than ever to tell their own stories, and build meaningful connections with consumers through education.”

Now, looking into FullTilt Marketing's background, it shows ties to the fresh food industry, so this may be reported through some rose-colored glasses. However, it's interesting they surveyed food bloggers because they're the ones who know what general consumers are routinely looking for in online recipes and food information.

What are some of the other trends? Specialty diets like Whole 30 and Keto; healthy kids meals; veggie-centric meals; global flavors and snack food ideas are just some of the other ideas mentioned.

Download the full report for free at www.fulltiltmarketing.net/bloggerreport.



Growing in Wastewater?

There's a bit of an “ick” factor to this, but give it a shot. *Forbes* recently published a story about the USDA's \$5 million grant to Georgia Tech to do a pilot program for growing produce using wastewater.

That seems a bit counterproductive considering all the recent *E. coli*-focused recalls, but the system will be designed to remove pathogens while keeping the nutrients. It's a fascinating idea, and one that could improve the sustainability efforts of growers. Georgia Tech will build a research facility for the project and is expected to start experiments in January, with the full facility completed in fall 2019.



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Biobest's Eco-Friendly Redesign

Always looking for a better way, Biobest recently announced it's switching its bulk *Amblyseius cucumeris* packaging from a plastic bucket to a paper bag.

"Reducing reliance on plastic is a key focus. With this in mind, our team has re-designed the packaging for the Biobest bulk *Amblyseius*-System, replacing plastic buckets with specially designed eco-friendly paper bags," the media release says. The paper bags replace 5-L buckets, which were used for the 125K, 250K and 500K bulk *Amblyseius*-Systems, but will deliver the same predatory efficacy.

The new packaging rolled out in December and the company says it will roll out additional eco-friendly packages for other predatory mites soon.

Find out more at biobestgroup.com. 

Online Fresh Food Purchases



The 2018 Online Grocery Shopper Study by the Retail Feedback Group (RFG) showed increases of over 50% year-over-year for people purchasing produce online, with 42% of respondents saying they purchased produce online. It tied deli meats and cheeses as the category with the most growth year-over-year.

In a release about the study, Brian Numainville, RFG Principal, said, "With an ever-increasing number of online grocery shopping options, consumers are clearly responding and purchasing a wide range of items. The willingness to purchase fresh items in higher frequencies than last year illustrates that providers are improving in their ability to overcome objections that historically have been limiters in these areas. While there is still room for growth, this finding provides encouraging news for retailers and others offering online food shopping services." 

HydroFarm and SANANBIO Team Up

HydroFarm announced in November it's teaming up exclusively with SANANBIO in the U.S. and Canada to launch a new line of horticultural LED products for greenhouse and indoor growing. The line is called PHOTOBIO Powered by SANANBIO and the focus of this line is for strong results for fruiting and flowering plants, according to a media release.

"PHOTOBIO Powered by SANANBIO is just the beginning of our partnership with SANANBIO," says HydroFarm CEO Peter Wardenburg. "Our mission has been to develop only the best in lighting solutions, specific to each crop with superior outcomes.

"A fixture's performance should be measured in real world trials rather than how it looks on paper. SANANBIO brings world-class research and production facilities to our partnership to help ensure that our customers achieve unparalleled results, whether growing high-quality legal cannabis or vertical vine crops, such as tomatoes and cucumbers."

According to SANANBIO Vice President of Technology Sales Michael Yates, his company brings multiple benefits to the table, including backing by the world's largest LED chip manufacturer Sanan Optoelectronics; an R&D team that can customize and design lighting to customer and plant needs; and large-scale manufacturing capabilities.

The product line includes PHOTOBIO-T and PHOTOBIO-T Duo (both LED Top Lights with light distribution targeting at true 1-to-1 replacement of HID grow lights); PHOTOBIO-M, a full-spectrum LED light for multi-level indoor cultivation; PHOTOBIO-V, a modular, high-efficacy lighting solution for vertical farming and PHOTOBIO-I, a highly efficient inter-canopy LED fixture for greenhouse growers. 



PHOTOBIO-M



PHOTOBIO-T Duo



Pure Flavor's New Distribution Center

Pure Flavor, a tomato and cucumber growing operation, broke ground on a new, 60,000-sq. ft. distribution facility just 10 minutes from the company's greenhouse range off of I-75 in Fort Valley, Georgia.

"We are strategically growing our business across North America and in doing so, need to

support this growth with regional facilities that reduce food miles for our greenhouse grown vegetables. Our new distribution center in Peach County will allow us to better serve our retail and foodservice customers throughout the southeast year-round," says company president Jamie Moracci in a media release.

According to the release, the new distribution center will "serve as a consolidation point, which will provide an opportunity for a greater assortment of Pure Flavor greenhouse grown vegetables to retailers and food service partners in the southeastern U.S. region starting in early 2019."

Pure Flavor also has distribution centers in Leamington, Ontario; Romulus, Michigan (near Detroit) and San Antonio, Texas. 

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Koppert Improves Spider Mite Control

Koppert Biological Systems unveiled the Spical Ulti-Mite in a new foil sachet to combat spider mites at the International Floriculture Trade Fair in the Netherlands in November. The new high-tech foil sachet is designed to ensure consistent performance in variable climate conditions, and performs three times better than other paper sachets, according to the company.

“Extensive research has resulted in a sachet that creates a better environment for the predatory mite to build up its population,” say Koppert experts in a media release. “The superior quality of the foil ensures the breeding system is better protected against environmental conditions that may affect the mites emerging from it. The sachet is narrower and slightly longer and gives the mites the very best condition to develop even more swiftly and strongly.”

Another bonus for the sachets is they conform to industrial compostable standards, so they can be disposed of with crop waste. Growers can use Spical Ulti-Mite to control spider mite in a variety of greenhouse crops and some outdoor crops like citrus and grapes. 



LumiGrow Case Studies

LumiGrow Lighting, an LED light supplier, has compiled a set of case studies from some of its customers on the company website. You can visit the main Customer Stories landing page and search through the case studies by industry.

For example, the last one sent out profiled Copperstate Farms, a cannabis operation in the unusually named town of Snowflake, Arizona. Copperstate was able to reduce its production time by 15%, allowing it to add another turn to its cannabis crops.

You can read the full story at www.lumigrow.com/customer-stories. 

Labor Certification?

The Equitable Food Initiative is an organization that certifies farms and growers for meeting rigorous labor practices, food safety and pest management, and you might wonder why you would need something like that if you’re already operating in an ethical and equitable manner.

The company notes that the EFI label of “Responsibly Grown, Farmworker Assured” gives consumers an additional reason to purchase products from growers who participate in the certification. It’s not just for consumers, though; with labor pools thinning out dramatically, growers can hold the certification as a way for potential workers to know they will be treated and paid fairly.

“We believe that if the workforce is properly trained and incentivized to collaborate with management in developing a safe, stable and dignified working environment, then new value is created for growers and buyers,” the company says on its website.

So far it has certified 27 locations with nearly 29,000 workers at farms with EFI-trained leadership teams. 

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Perfecting the Art of Lettuce

Little Leaf Farms is continually working at becoming more efficient and effective at growing baby leaf lettuce in a bid to be competitive with the biggest names in the game.

Story & photos by **JENNIFER POLANZ**

It was a brisk Monday morning in December when I ventured into the cozy office adjoining the greenhouse at Little Leaf Farms in Devens, Massachusetts. Space heaters were doing their best to cut the chill in the room, which featured blueprints covering most of the wall space surrounding four desks. Those blueprints showed multiple phases to the operation—including the newest Phase 3 slated for 2019 that will double the grower's size.

Don't be put off by the name, as the "Little" is clearly denoting the size of the lettuce leaf, not the size of the operation. At 2.5 acres for each of the first two phases, and 5 acres for Phase 3, it's quickly becoming one of the larger indoor hydroponic lettuce producers in the country. But size isn't the only thing Little Leaf has going for it. We'll get to all the details in a bit, but first, you might recognize where co-founder and CEO Paul Sellew got his start.

FROM THE BEGINNING

Paul grew up on the ornamentals side of the growing business, with his family starting Pride's Corner Farms in the 1970s. It's no surprise, then, that as an adult he started some of his own green industry businesses, including one called Earthgro. It was a commercial composting business "when nobody knew what that was," Paul explains. That grew to a large-scale, multi-plant operation from Maine to North Carolina, producing and selling a full line of lawn care products for the home gardening and professional grower market.

Scotts Miracle-Gro bought Earthgro in 1998, which gave Paul the time and seed money to help start a new passion project with Tim Cunniff: Backyard Farms. Located in Maine, it's a 42-acre greenhouse tomato growing operation that was pretty revolutionary at the time. It was scaled large enough to meet local demand for fresh produce and kept the tomatoes on the vine longer for a better taste.



Paul Sellew holds a container of Baby Spring Mix, which was on the shelf of a local retailer the next day.



After the lettuce is harvested and mixed, it goes into clamshells and is ready to receive a label on the packing line.

Paul had left the company by 2009 after getting it started up (it was later bought by Mastronardi Produce in 2017) and went on to create yet another successful company—Harvest Power—which essentially turns organic waste products into renewable energy and compost-based soil products. That company has built out all over the U.S. and Canada, but after six years, Paul was ready for a change. That’s when he and Tim, who also left Backyard Farms, started Little Leaf Farms.

“I was tired of traveling,” he says. “I live outside of Boston and Harvest Power was all throughout North America. I wanted to stay closer to home and was curious about the leafy greens space since aspiring entrepreneurs were asking me about it.

“The way I was thinking, no one was pursuing the strategy I thought was right.”

THE FOUR POINTS

What was the strategy Paul thought was the key to success? He lays it out for me—there are four points and not necessarily in any order:

1. A technology-controlled climate year-round regardless of outside weather conditions
2. The right growing system
3. The right varieties
4. The right management team

“If you’ve got those four things right, you’ll win,” he says simply.

Let’s start with the location and climate. Devens, Massachusetts, is an ideal location for a couple of key reasons. One, it’s not a town or city; it’s an enterprise zone. It used to be Fort Devens and was owned by the Pentagon up until 1996 when the Commonwealth of Massachusetts bought it and turned it into an enterprise zone to entice industrial and commercial businesses. The spot where the greenhouse sits used to be called Vietnam Village, Paul says, which was a training site during the Vietnam War. The spot is also near a small-scale solar utility company, which allows Little Leaf Farms to pull 30% of its energy from renewable resources. Sustainability, both environmental and economical, is one tenet of the company.

As for point No. 2—selecting the right growing system? That came down to who knew baby leaf lettuce the best, which led Paul to Green Automation. The folks at Green Automation are actually the ones who told me about Little Leaf Farms at Cultivate’18 this year and highlighted Paul’s fully automated baby leaf system in the booth. Green Automation started in Finland, but quickly began expanding to other European countries and then to the United States. It seemed like the perfect fit and it was the right start for Little Leaf.

IT’S ABOUT THE PEOPLE

We’ll get to the automation and varieties in a minute, but if there was one of those four points that might inch higher than the others, it’s the management part, Paul says. There are only 45 people who work at the growing operation and some of those people are in key management positions, including Head Grower Pieter Slaman, who came from one of the largest organic greenhouses in Europe, and Tim Cunniff, previously mentioned co-founder and Executive Vice President of Sales and Marketing. Tim, whom I talked with during that Monday morning visit, is a self-proclaimed produce guy who has extensive experience in the produce field, working for both Del Monte and Dole in previous jobs. He truly understands the nature of the business and what’s required to be a real player in the game.

It’s clear, too, that the entire team is a pretty tight-knit group, with easy banter in the breakroom and offices, and friendly “hellos” throughout the chilly packing area. (The greenhouse was a ghost town—not a soul in sight. There’s no need for anyone to be in there). In fact, because it’s so heavily automated, the most important people are often the ones doing routine maintenance on the mechanics to ensure everything remains as efficient as possible.

“People get caught up in the technology,” Paul notes. “But at the end of the day it’s the people. You have to go beyond the technology to be successful.”

LET’S GET AUTOMATED

Just how automated is this system? Completely. NFT gutters are recycled through the system, starting by receiving the rock-wool and then heading on a track system

to seeding. Once seeded, the gutter takes a turn from the warehouse area into the greenhouse, where it’s deposited in the germination chamber underneath the benches. The lower level is a nifty design from Green Automation—one that saves space and connects the germination chamber with the rest of the automated system. It moves through the chamber (again, automatically—actually, from this point on, everything up until packing is automatic so I won’t keep repeating it) within three days.

It continues on the “track” and is lifted up onto the top level growing line, where gutters are spaced by the control system according to where it is in the growing process. The gutters move toward the front of the greenhouse, with those ready for harvesting moving off the growing line and onto a conveyor to travel into the packing area, where a machine cuts the leaves and sends them on to the mixing line and then to the packaging line. All told, the process takes 25 days.

Paul says, too, during the growing process he takes full advantage of his greatest natural resource: the sun.

“It’s cost effective,” he says. “So many people are not using the sun. It doesn’t generate carbon emissions; it provides heat and it’s free. That’s why I’m bullish on the sun.” When he can’t rely completely on the sun, he has a mix of LED and HID lights to supplement.

What’s striking when looking at the greenhouse is the sea of green and the uniformity of the plants. There are no unsuccessful gutters, no plants that look significantly larger or smaller than the others, and no gaps in the system. Each gutter has an “address,” too, to allow for tracking and better control.

Little Leaf only grows varieties of meticulously chosen baby leafy greens for maximum efficiency, yield and profitability, and blends them in different ways to come up with the following:

Spring Mix—Arugula, green leaf, red leaf and blond leaf lettuce

Red & Green Leaf Mix—Just what it sounds like

Baby Crispy Green Leaf—The green leaf alone, which is a crisp, delicious bite (in my humble opinion) ►



Irrigation occurs at the end of each raft, and even the water temperature is monitored for consistency.



The efficient structure of the growing operation keeps the lettuce production consistent in size and weight.

CONTROLLING THE GREENHOUSE

Since Pieter came from one of the largest organic greenhouses in Europe, he's well versed in operating under a biological control program. And that's the extent of the pest control used in the greenhouse, aside from scouting and climate control. He also has two Cornell grads helping to run the biologicals program. It's part of the value proposition for Little Leaf, which is why it's on every package: Pesticide, Herbicide and Fungicide Free.

A great amount of care went in to building out Phase 2 of the operation, too, taking elements of what they learned from Phase 1 and incorporating them. That meant tweaking the design of the actual venlo-style greenhouse for better airflow, changes in the irrigation system to allow them to change the nutrient makeup at different points in the growing process and, in Phase 3, more controls over the shade curtains to continue to work on air flow.

"In lettuce production, we're still learning. There's no standard that's been developed yet with lettuce," Paul notes, adding it's the incremental improvements that provide even more consistency and efficiency. "We can see higher yields with better climate management. Then you get to the cost position where you can compete."

Sensors are constantly measuring and monitoring in real time, reporting back everything from light, humidity and irrigation water temperature. Control panels abound on multiple pieces of machinery to be able to monitor right at the site.

Food safety is of the utmost importance, with everyone required to wear hair nets, and those in packing and shipping required to wear special clothing, hair nets and gloves. Equipment surfaces are washed down twice daily and the water constantly tested for pathogens. Little Leaf is GAP certified and moving to Global Food Safety Initiative (GFSI) certification in 2019.

That water we just talked about comes from a rainwater reclamation system, collected from roof runoff and processed through a filter and UV disinfection to kill pathogens without using chemicals before going into a holding tank. After it's used, the irrigation water is refiltered, reoxygenated, disinfected and then used again. Paul notes the natural rainwater collection system provides 100% more water than they need.

WHAT'S NEXT?

That's more of a question for Tim, who's focused on building out the consumer demand and expanding commercial reach. The company has already shown it listens to its customers—when consumers balked at bags and asked for clamshells, the company made the switch. Tim says now they're offering a bigger size in response to consumer demand. Along with 4-oz. clamshells, they're now offering 8 oz.

"We're still introducing ourselves to the marketplace," Tim adds. "Same store sales are increasing and we were tapped out at capacity with the customer asking for more SKUs."

Hence, the need for expansion, which—if all goes as planned—that Phase 3 greenhouse should be harvesting in Q4 2019. At that time, they'll continue more of the product lines they currently produce, as well as add new products.

It's no surprise, too, that consumer demand is increasing. In a recent report on trends food bloggers are seeing for 2019, locally grown produce was at the top of the list. And recent recalls on California field-grown romaine lettuce showed just how much consumers want their locally grown stuff.

"Consumers were calling and saying the grocery stores were throwing our stuff out," Tim recalls. "They were not throwing it out, they were selling out."

And while the big players in the market—the Fresh Express and Dole brands—have lots of money for advertising, Little Leaf still drives consumer interest through social media, shelf talkers in the stores and its 800 number that's visible right on the front of the clamshell. He expects to do more marketing, too, in 2019. It's all about getting the customer to know the people behind the brand, Tim says.

"Aside from being local, safe and fresh, it's getting to know us," he says. "That's what drives the brand. The people who love us really love us and they tell everyone. The best marketing is a satisfied customer." 

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Is Hemp Worth the Time?

Passage of the Farm Bill brought hemp back into the picture, but is it worth investigating further as a potential CEA crop?

Compiled by **JENNIFER POLANZ**

Here at *Inside Grower* we're always looking for new crops that can be grown in a controlled environment setting. So when the passage of the Farm Bill included the legalization of hemp production, it piqued our interest.

First, a quick primer on hemp because it's rather confusing in taxonomy. Hemp is *Cannabis sativa*, the same species as marijuana, but a type that contains less than 0.3% THC (the primary compound in marijuana that causes the high).

Fun fact, not only did founding fathers like George Washington and Thomas Jefferson grow hemp, but Americans were legally bound to grow the crop during the Colonial Era, according to the Hemp Industries Association. Prohibition efforts of hemp didn't start until 1937 and the passage of the Marihuana [sic] Tax Act (though hemp production came back for a brief period during World War II when farmers were encouraged to grow it again). Prohibition was finalized in 1970 with the Controlled Substances Act.

Curious about the potential impact of the Farm Bill's legalization of hemp, which officially removes it from that Controlled Substances Act, I reached out to our cannabis expert Dr. Brian Corr to ask if there's any opportunity here for greenhouse growers. He dropped some serious knowledge on me, which I now drop onto you (the following is all in Brian's words except for my quick interjection in italics):

"There are some growers already producing what is defined as hemp (*Cannabis sativa* with less than 0.3% THC) in greenhouses. They (along with anyone else growing hemp, field or otherwise) will benefit by the Farm Bill clarifying that interstate commerce of CBD and other hemp-products will be allowed. Making interstate commerce clearly legal is a good thing for a greenhouse producer of hemp.

"On the flip side, with clarification of the rules, there will be a lot more people willing to get into hemp production and many of them will do field production. That will make greenhouse-produced hemp products uncompetitive in price. So, if I was going to make a prediction, I'd bet some greenhouse people will jump into hemp production thinking they now have an easy road, and maybe some people will make some money if they can fit it neatly into their crop rotation, but they will have to compete with field production for costs.

"On the flip side (again), there could be an opportunity for greenhouse operators to produce hemp liners for planting into the field. The challenge to that is it's a short planting season and in conflict with the bedding plant

season. But if someone can fit it into a logical rotation, there could be some money to be made."

A quick interjection, when I thanked Brian for his answer, he added this:

"I would add one important bit of info though—the Farm Bill is not the only legislation that matters for cannabis. The U.S. Food and Drug Administration (FDA) has weighed in on this issue. Many people in the cannabis world assumed the Farm Bill wrapped up all issues of legality, at least regarding hemp and cannabidiol (CBD). However, the FDA regulates CBD as a drug, since it was recently approved by the FDA for use in the anti-seizure drug Epidiolex.

"So—CBD, or products containing CBD, cannot be sold as a food or dietary supplement since CBD is an active ingredient in a registered pharmaceutical. Hemp can be grown for seed, fiber, biofuels, oils, etc., but sale of CBD is a problem. CBD was once prohibited because it was considered by the U.S. Drug Enforcement Administration to 'have no medical value and high potential for abuse' (a Schedule One drug). Now sale of products containing hemp-derived CBD is prohibited by the FDA because it does have medical value."

In the end, there are some opportunities for CEA growers looking to diversify their offerings. One recent report suggested the CBD market could be worth \$22 billion alone within a couple of years, although, again, Brian warns about that heavy regulation from the FDA. In fact, because of the massive interest, the FDA said in a recent statement explaining the regulations that it would be holding a public meeting soon to talk more about these products.

"We'll use this meeting to gather additional input relevant to the lawful pathways by which products containing cannabis or cannabis-derived compounds can be marketed, and how we can make these legal pathways more predictable and efficient. We'll also solicit input relevant to our regulatory strategy related to existing products, while we continue to evaluate and take action against products that are being unlawfully marketed and create risks for consumers," the statement said.

Brian weighed in again with this comment: "There are so many CBD products already being sold not only in states with medical marijuana programs, but across the United States. It will be difficult for the FDA to rein this in. I forecast the FDA will require CBD products to be labeled with the usual disclaimer: 'This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure or prevent any disease.' Other than that requirement, I forecast the FDA will allow sales to continue. But my crystal ball in the world of cannabis is always a little hazy, so this prediction may be way off."

We'll continue to watch the progress of hemp in this space and keep readers updated if regulations change. 

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Reader Service Number 217



by JENNIFER POLANZ

Peace Tree Farms has cultivated a relationship with Wegmans to deliver living herbs 52 weeks a year, creating more cash flow and year-round stability.

There's a mutual benefit to the relationship that's developed between Peace Tree Farms, a small certified organic grower in Kintnersville, Pennsylvania, and the regional grocery chain Wegmans. The grocer gets to tout how close the grower is to their Pennsylvania and New Jersey stores (a growing consumer want) and Peace Tree gets the consistency of weekly deliveries.

"For a greenhouse grower, for decades, you try to make all your money in one month of the year and hold on to it the rest of the year," says Head Grower Alex Traven. "This is 52 weeks a year. As far as cash flow, and hanging on to employees, it's an absolute dream, but it's got a lot of pitfalls.

"If you don't have that assurance they're not going to pull the plug or go to someone cheaper, then that's a big deal. That's the importance of the relationship."

CREATING THE CONSISTENCY

Alex says the customer is the key. Initially, Peace Tree was working with another large grocer, but the relationship was different.

"We were not a partner farm. With Wegmans, we are a partner farm and they definitely treat us as such and have a lot of compassion for how hard what we do is," he says. "You have to make sure you have a good relationship with whoever it is because you're going to have to invest a lot into creating the program for them."

For Peace Tree, that means producing nine different living organic potted herbs: basil, chives, cilantro, dill, mint, parsley, sage, rosemary and thyme (insert Simon & Garfunkel song lyrics here). Alex and the team at Peace Tree worked with the folks at Wegmans to develop the type of packaging and appearance they wanted to display in the store, which meant moving to a smaller pot size and changing to an open bottom box so employees didn't have to cut open the boxes.

Depending on the plant, it could take either six to eight weeks from seed to finish, or in the case of rosemary, a total of 16 weeks from sticking the cutting to finish. Depending on the time of year, it could go shorter or longer. They pull orders the day they ship them, and deliveries are made Mondays and Thursdays to the Wegmans warehouse distribution center in Pottstown, Pennsylvania, about two hours away.

THE DIFFERENCE WITH LEDS

One of the biggest game-changers with this crop has been the installation of LED lights, which in some instances has cut crop time by two weeks and resulted in 40% fewer losses. They chose the VYPRx Plus system from Fluence Bioengineering, which they were able to lease from the company.



Peace Tree produces nine types of living organic potted herbs exclusively for Wegmans grocery stores.

“It’s a monthly cost that’s really easy to recoup and it also gives us the opportunity—because technology keeps improving—that once the four years is up we can get new lights and sign up for a new lease,” Alex explains. “We’re not locked into the technology from this year; we can get whatever the latest is four years from now.”

The LEDs also helped on a different front: disease control. Basil production is notorious for susceptibility to basil downy mildew, which can wipe out an entire crop. Alex uses the LED lights to

interrupt the pathogen’s nocturnal activities, since it sporulates during periods of darkness.

“If you at no point let there be any period of seven hours of darkness, you can interrupt the circadian rhythm and prevent sporulation,” he says. “It’s a particularly bad disease because it’s incurable. Once it’s infected, it’s done. By the time you’re seeing it, it’s done. So you’ve got to be so far ahead of it.”

The LEDs alone don’t combat the downy mildew, though. Alex says they’re only part of a quality management strategy that also includes good climate control, preventative sprays, cultural controls and disease-resistant varieties.

“Last year, there were a couple of weeks where we were unable to ship basil entirely. This year, we made every single delivery,” he says of the enhanced regimen. “This year, the disease didn’t show up until a month or so later than last year, and I’d say there was no crop I lost more than 25% of. In a year that was historically wet and historically dark—perfect conditions of the disease—that I consider to be a huge victory.”

BRINGING IN BIOLOGICALS

The LEDs aren’t the only game-changer at Peace Tree. Alex’s use of beneficial insects has helped create an entire ecosystem in the greenhouse that preys on the pests. And don’t forget—this greenhouse isn’t exclusive to just the nine herbs being grown for Wegmans. It’s also home to hundreds of different ornamental and edible crops.

“We have a really comprehensive biocontrol program. A big part of my job is managing this ecosystem that I’ve created here,” he says. “There’s a couple different types of banker plant systems,



Peace Tree Farms installed the VYPRx Plus System LED lights from Fluence Bioengineering, which they are leasing.

and in all, I’m using over two dozen different organisms for pest and disease control.”

It’s something Alex has researched extensively and he is starting to become a voice in the industry to communicate the benefits of these predatory insect controls. He hosted a day-long workshop at Peace Tree in December, inviting growers from all over to come in and learn about his methods, as well as hear from experts Suzanne Wainwright-Evans from Bug Lady Consulting, Steve Bogdash from Marrone Bio Innovations and Jim Harvey from Penn State University Extension.

THE CHALLENGES

In-person events and speaking engagements are Alex’s way of spreading the word about sustainability, a topic that’s close to his heart as the second generation of an organically run growing operation. His parents, Lloyd and Candy Tra-ven, were one of the first growing operations in their area to receive organic certification. But Alex is frustrated with the organic certification, saying it can be prohibitive to growers who want to convert over, but have to do it incrementally.

“It discourages incremental progress,” he says. “There’s no incentive for that. There are a lot of people who would like to do things better, but they can’t get anything for their effort.”

Another challenge that hits closer to production is timing and short shelf lives. They’re still trying to time production capacity for known spikes in sales because Wegmans orders based on need. For example, mint sales always jump in late April/early May for the Kentucky Derby, and sage and thyme see greater demand around Thanksgiving and Christmas.

“We just have to figure out those peaks and valleys. So waste is definitely a challenging part because we don’t know what they’re going to order and we don’t have a lot of different customers—right now this product is exclusive to Wegmans—so we don’t have other outlets for it,” Alex notes. “It’s tough, but we’ve gotten a lot better with it.” 

Clean Up Your Act

Sanitation in hydroponic growing.

by SARAH BRACKMAN

Hydroponic growing has become a standard production method over the last 80 years. Its rise in popularity doubles and triples annually. The major crops grown hydroponically in the U.S. are tomatoes, peppers, lettuce, cucumber, herbs, strawberries and ornamentals.

Hydroponics gives you an extended season and a boost in yields, leading to an increase in profitability. Since both the water and nutrients are recycled, this is an ecologically responsible way to produce food.

Among the many benefits lurk potential pitfalls. There can be a large capital expense associated with the initial set-up. The hydroponic grower needs to be nutrient savvy and have a technical understanding of the system. These challenges are further compounded by the increase in disease pressure and algae through the recirculating water. Prevention and sanitation are the best defense a hydroponic grower has against potential production snags.

SANITIZING A HYDROPONIC SYSTEM VS. A CONVENTIONAL GREENHOUSE

Since hydroponics uses water as the medium, the potential for contamination from water-borne pathogens increases. On the upside, foliar disease usually decreases.

It's difficult to prevent and decontaminate a hydroponic system. The most common pathogens are *Pythium* and *Fusarium*. These notoriously persistent diseases readily travel through water. They produce an abundance of zoospores, as well as chlamydozoospores or oospores allowing for long-term survival. Many times, these reproductive structures will colonize dead plant debris, which protects them from attempts to treat the water. The level of prevention and sanitation in a hydroponic greenhouse needs to balance the increase in disease pressure.

Algae is a nuisance in hydroponic growing that plagues the system throughout production (Figure 1). They thrive in the oxygenated, fertilized water. Not only is it unsightly and messy, but it harbors pests and depletes the dissolved oxygen levels in the water.

This uninterrupted flow of liquid nutrient feeds algae and can create an impenetrable layer on greenhouse surfaces such as walkways, plastic, end walls, benches and on the inside of irrigation/mist lines. These conditions can be hazardous for workers and influence crop quality and yield. Algae grows in layers, so it's important to be diligent when cleaning. Sometimes physically scrubbing is best to ensure that products are penetrating each layer of algae.

A good way to decrease algae build-up and spread is to maintain your sanitation practices throughout the growing cycle, not just at the end of each crop cycle. Standardize practices, such as spraying racks, empty benches, walkways, and sanitizing pots and trays to maintain a clean environment during the production cycle. Be sure to check labels and make sure the products can be used while a crop is in production and doesn't have to be rinsed.



Figure 1. Algae is a nuisance in hydroponic growing that plagues the system throughout production.

In a hydroponic system, all contact surfaces and equipment that encounter flood water or plant material must be washed first and then disinfected. Washing with detergent *THEN* rinsing with water will emulsify organic matter and rinse it away. Plain water can't do that.

The photo of a steamed plug tray (Figure 2) gives us a visual of what can be left behind when only rinsing is used. The tray in this photo was rinsed and then steamed, but much of the organic matter still remains on the surface. This resulted in an infection in the next crop.

Incorporating the washing step will eliminate what water cannot. This is true of all surfaces, including water tanks, floors, benches and the irrigation system. Dead plant tissue harbors pathogens and decreases the efficacy of sanitizing agents, whether they're added to the irrigation water or used in between crop cycles.

KEEPING BIOFILM AT BAY

An important objective with cleaning and sanitizing is to keep biofilm from creating an irreversible layer on surfaces. This is a gluey mass of bacteria, algae and other free-floating microorganisms that form into a colony. The mass is protected with large molecules that are like the polysaccharide layer found in algae. Part of its survival strategy is creating a protective barrier using this slimy matrix. It's tenacious and difficult to completely eradicate.

We've heard of biofilm causing trouble in irrigation lines, but when surfaces aren't thoroughly cleaned, bacteria will continue to build up. Biofilm adheres to materials, such as stainless steel, plastic, copper, rubber and lead.

Disinfection seals the pathogen's fate by physically destroying it. There are many sanitation products available. These include activated peroxides (products with peracetic acid/hydrogen peroxide combination such as Sanidate 5.0), bleach, chlorine dioxide, quaternary ammonium, and ozone and heat/UV. Most of these treatments are oxidizers, which in-

creates the need to eliminate as much organic matter as possible.

Some are more powerful than others because of their stability in the environment. Activated peroxides are stable, high-level disinfectants. They're more resistant to



Figure 2. A steamed plug tray shows what can be left behind when only rinsing is used. The tray in this photo was rinsed and then steamed, but much of the organic matter still remains on the surface. This resulted in an infection in the next crop.

environmental factors, making them less prone to quick degradation. It's worth doing your homework on sanitizers prior to making a choice. Important considerations are the stability/power of the product, PPE requirements, REI restrictions and whether a rinse is needed after the application.

Irrigation lines, whether underground, soil level or overhead have a literal hidden dark side ... in the line itself. Water and nutrient make a very conducive atmosphere for many organisms. They're fed, sheltered and protected, which allows them to take root, grow and reproduce. This is biofilm and it moves when pieces break off and travel with the flow of water.

Some common problems that can be associated with irrigation line cleanliness are water-borne pathogens such as Pythium and Fusarium. They can easily become attached and thrive in biofilm. Pieces will eventually get swept up, move down stream and are then deposited everywhere water splashes. Clogged emitters are indicative of a severe problem. In order to eliminate this, the irrigation lines should be as much a part of the clean-up as the greenhouse surfaces themselves.

If you regularly shock and flush your irrigation lines, consider maintaining them by treating your irrigation water throughout the season. This is a very effective way to keep free-floating micro-organisms from attaching and growing. There are several options for treating irrigation water on a continuous basis. Take time when making your choice to consider your facility, budget and what your goal is. 

Sarah Brackman is Technical Sales for BioSafe Systems, LLC. She can be reached at SBrackman@biosafesystems.com.

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Expanding with Edibles

Tips for successful vegetable production.

by NANCY REHCIGL

Expanding and diversifying a product line is one way companies grow their business. Every year there are always exciting new varieties of flowering ornamentals being developed and offered in the potted and bedding plant category. However, some ornamental companies are looking at adding vegetable plants and herbs to diversify their offerings.

Pre-finished containers of fruiting vegetables and herbs can be produced along with and complementary to spring and summer ornamentals. Fruiting vegetables such as tomatoes and peppers, and herbs such as basil and rosemary, are popular favorites and well-suited for patio containers or garden transplants.

COMMON PROBLEMS

While many of the new vegetable varieties have been bred and screened for resistance to disease problems, it's still important to scout and be aware of some potential problems common to these crops. Leaf spots (caused by both fungal and bacterial agents), blights and mildews are the primary disease problems you may encounter, while two-spotted spider mites and whiteflies (*Bemisia* and *Trialeurodes* spp.) are the primary insects of concern.

Table 1 lists the key problems to be scouting for. Identification should always be confirmed through a commercial or state diagnostic lab. ▶

Table 1. Common Disease Problems

Crop	Diseases	Description
Tomato	Leaf spots (<i>Colletotrichum</i> spp., <i>Corynespora</i> spp., <i>Septoria</i> spp.)	Generally rounded spots with dark margins. Description varies depending upon pathogen. Target spot (<i>Corynespora cassiicola</i>) first appears as small, necrotic lesions with dark margins and light-brown centers on foliage inside the plant canopy. Cucumbers are also susceptible.
	Early Blight (<i>Alternaria</i> spp.)	Round, dark brown spots with concentric rings. First appears on lower foliage. Tissue around the spots may turn yellow. Spotted leaves may defoliate. The pathogen can also infect other solanaceous crops, such as eggplant and solanaceous weeds, that may be in the production area.
	Phytophthora Blight (<i>Phytophthora infestans</i>)	Dull gray, irregular-shaped areas of tissue appear to collapse, progressing from the edge of the leaf inward. Initially this tissue may have a dark, greasy appearance.
	Bacterial Leaf spots (<i>Xanthomonas</i> spp., <i>Pseudomonas</i> spp.)	Bacterial spot (<i>Xanthomonas</i> spp.) causes small, circular-irregular dark spots on foliage sometimes surrounded by a yellow halo. Spots can enlarge to 3 to 5 mm. Infected foliage tends to remain on the plants. Bacterial speck (<i>Pseudomonas</i> spp.) causes small, 2-mm lesions surrounded by a yellow halo. This can often be mistaken for early blight.
	Powdery mildew (<i>Oidiopsis sicula</i>)	Small, white, powdery mold develops on the upper leaf surface. More common late in production.
Peppers, Eggplant	Phytophthora Blight (<i>Phytophthora</i> spp.)	Dull gray, irregular-shaped areas of tissue appear to collapse progressing from the edge of the leaf inward. Initially this tissue may have a dark, greasy appearance. The entire leaf blade may collapse.
	Bacterial Spot (<i>Xanthomonas</i> spp.)	First appears as dark, water-soaked spots on the undersides of the leaves. Spots rapidly enlarge forming tan-reddish brown, angular lesions. Leaves develop a tattered appearance as lesions become necrotic and centers fall out.
	Cercospora Leaf Spot (<i>Cercospora</i> spp.)	Large, circular lesions up to ¼ in. in size with light-gray centers and dark margins.
	Downy mildew (<i>Peronospora</i> spp.)	Not very common, but may occur in areas of the country where tobacco is grown.
	Powdery mildew (<i>Sphaerotheca</i> spp.)	Patchy, white and powdery growth that first appears on older leaves later in production.
Cucurbits	Downy mildew (<i>Pseudoperonospora cubensis</i>)	Begins as small, angular yellow-brown spots on the upper surface of the leaves, later increasing in size. Under humid conditions, sporulation (purple in color) can be seen on the underside of the leaf corresponding to these areas.
	Powdery mildew (<i>Sphaerotheca fuliginea</i> , <i>Erysiphe cichoracearum</i>)	Powdery, white growth spreads quickly on the surface of the leaves. Affected leaves can wither and die.
Leafy Vegetables	Downy mildew (<i>Bremia</i> spp.)	Yellow, light-green blotchy areas appear on foliage, generally older leaves first. A downy mold can be seen on the underside of the leaf corresponding to these areas.
	Powdery mildew (<i>Erysiphe cichoracearum</i>)	Powdery, white growth spreads quickly on the surface of the leaves. Affected leaves can wither and die.
Herbs	Downy mildew (<i>Plasmopara</i> spp., <i>Peronospora</i> spp.)	Yellow, tan or reddish blotchy or angular areas develop on the upper surface of the leaf. Under high humidity, sporulation can be observed on the underside of the leaf corresponding to these areas. Basil is highly susceptible to downy mildew.
	Powdery mildew (<i>Erysiphe</i> spp., <i>Sphaerotheca</i> spp.)	Small, white and powdery mold develops on the upper leaf surface. More common late in production. Mint and rosemary are more prone to this disease.

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Pest Management

There are several plant protection products now registered to help protect vegetables and herbs grown for resale in the retail market. To meet the increasing needs of growers, Syngenta has recently expanded several commercial labels for this use. These products have demonstrated effective control of many common diseases and insects that can affect vegetable production.

Tables 2 and 3 provides a list of some of the current products available. Please consult the respective labels for specific directions on rates, use applications and labeled crops. 

Nancy Rechcigl is Technical Services Manager for ornamentals for Syngenta.



Above: Tomato leaf late blight.
Left: Powdery mildew on tomato.

Table 2. Products for Disease Control

MOA	Fungicide	Fruiting Vegetables							Leafy Vegetables	Herbs
		Brassica/Cole	Bulb Crops	Cucurbits	Eggplant	Peppers	Tomato			
NC	Milstop	x		x	x	x	x	x		
M	Obtego			x	x	x	x	x	x	
M1	Camelot O	x		x	x	x	x	x	x	
4	Subdue Maxx	x		x	x	x	x	x	x	
17	Decree 50 WDG			x	x	x	x	x	Cilantro	
11	Heritage	x	x	x	x	x	x	x	x	
7+11	Mural			x	x	x	x			
7+11	Pageant						x			
12	Spirato GHN	x		x	x	x	x	x	x	
19	Affirm WDG			x	x	x	x			
33	Alude	x	x	x		x	x	x	x	
40	Micora	x			x	x	x	x	Basil	
44	Cease	x	x	x	x	x	x	x	x	
44	Triathlon BA	x	x	x	x	x	x	x	x	
49	Segovis								Basil	

NC = Not Classified

Table 3. Products for Insect Control

MOA	Insecticide	Fruiting Vegetables							Leafy Vegetables	Herbs
		Brassica/Cole	Bulb Crops	Cucurbits	Eggplant	Peppers	Tomato			
M	Ancora	x		x	x	x	x	x	x	
M	Azatin XL Azatin O	x	x	x	x	x	x	x	x	
M	Ornazin 3% EC	x		x	x	x	x		x	
M	Captiva	x	x	x	x	x	x		x	
3+M	Pycana	x	x	x	x	x	x	x	x	
4A	Flagship 25 WG			x	x	x	x			
4A	Safari	x		x	x	x	x	x		
5	Conserve	x	x	x	x	x	x	x		
9B	*Endeavor	x		x	x	x	Tomatillo	x		
13	Pylon				x	x	x			
17	Citation	x	x	x		x	x	x		
20B	Shuttle O			x	x	x	x			
23	Kontos		x	x		x	x			

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Reader Service Number 210

Before the Seed is Sown

Starting with clean seed, incorporating timely cultural practices and using highly effective chemical controls can limit losses from basil downy mildew.

by DAVID KUACK

Downy mildew is the major disease of vegetable, herb and ornamental crops. The disease must be battled by both controlled environment and outdoor field growers. Crops that are at risk for high losses from downy mildew include cucumber, spinach and basil. Field-produced crops affected by the disease have seen major financial losses of \$7.5 billion covering 2.6 million acres.

In 2016, USDA awarded a four-year, \$2.3 million grant to seven universities across the country to develop management plans for downy mildew on cucumber, spinach and basil. Plant pathologist and University Distinguished Professor Mary Hausbeck at Michigan State University is the project director.

"I have been working with basil for several years and have pursued national downy mildew fungicide labels by working directly with the IR-4 Project," Mary said.

While waiting for the fungicides to become registered, Mary has worked with pathologists in other states, fungicide companies and EPA to secure emergency state labels for Michigan and several other states. Today, many fungicides are nationally registered and it wasn't that long ago that there were very few fungicides labeled for downy mildew on basil, especially when grown in a greenhouse.

"Basil may be exposed to downy mildew in different ways," Mary explained. "In southern Florida, the downy mildew pathogen (*Peronospora belbahrii*) has become part of the environment and can overwinter. In Michigan and other northern states, downy mildew cannot survive outside during the winter and must be introduced into a greenhouse or a field."

Mary said that this scenario is likely to happen through contaminated basil seed, which is probably how downy mildew was first introduced into Florida.

"Now the pathogen has become established and can overwinter there," she said. "Growers in Florida and other southern growing regions expect to deal with downy mildew all the time."

CONTROL DOWNY MILDEW FROM THE GET-GO

Mary said it's always good for growers to ask whether seed suppliers are sourcing their seed from an area that's free of the pathogen, and whether they are testing and treating their basil seed for downy mildew.

"For growers to be aware that the downy mildew pathogen can come in on the seed and to know as much as possible about the seed from the supplier is a good idea," she said. "How a supplier will speak to that I'm not sure. Testing and treating seed lots would definitely be helpful. The specialized techniques needed are under development and in some cases are proprietary."

Treatment of contaminated seed has typically focused on hot water treatment.

"When basil seed is treated with hot water there is a gelatinous exudate that oozes out of the seed," Mary explained. "This can cause issues with trying to handle and sow the seed."

Mary said that there's recently been an effort to steam the seed, which could be helpful for treating contaminated seed. Steam treatment also eliminates the gelatin coming out of the seed. She mentioned that there's a proprietary steam treatment technique that's been licensed by the seed company High Mowing Organic Seeds (www.highmowingseeds.com/blog/steam-treatment).

PROVIDING OPTIMUM CULTURAL CONDITIONS

Mary said growers looking to use the best cultural growing conditions to minimize basil downy mildew should keep moisture and relative humidity low.

"Growers should provide the optimal environmental conditions for the seed to germinate and emerge quickly," she said. "Then they should try to get the seedlings to thrive under drier conditions and lower humidity. Growers want to limit the amount of time that the plants are wet."

Under high-heat conditions, the downy mildew pathogen isn't favored. Once the relative humidity reaches 80% to 85%, it doesn't take much of a temperature drop for water in the air to condense, forming a fine film of water on plants. Using horizontal airflow fans to keep the air moving around the plants can help to keep the foliage dry.

"In a greenhouse, growers may have the option of not using overhead irrigation, but can irrigate pot to pot or with some other means that keeps the foliage dry," Mary said. "In the field, if there are consecutive rainy days, there is not a lot growers can do to keep the plants dry. In a greenhouse, growers must be vigilant and adjust the watering so plants don't become oversaturated, which increases the relative humidity in the plant canopy."

If the humidity is high and the plants stay wet for a long time, basil downy mildew can thrive under temperatures that aren't optimal. When Mary and her team did greenhouse trials, the temperature inside was 80F (26C) the whole time. She said they did get basil downy mildew to develop even under very warm conditions on some very susceptible varieties, proving that the spores form at a wide temperature range. The optimum temperature for downy mildew development is around 65F (18C).

"The pathogen is going to be fine at lower temperatures, but there is going to be some development at higher temperatures as well," Mary said. "It doesn't take much time for the pathogen to infect when the leaves are wet. A couple of hours are all the pathogen needs to produce spores on the undersides of the leaves."

Since the spores form in the dark during the evening and



Photo courtesy of Hort Americas.

Growers looking to minimize basil downy mildew should keep the relative humidity as low as possible, including using horizontal airflow fans to keep plants dry.

early morning hours, the pathogen reproduces so quickly that the dark mold growth on the undersides of the leaves seems to appear overnight.

“It doesn’t take much time for the spores to germinate,” she said. “Infections can occur that can’t be seen and the downy mildew pathogen can lay dormant in the leaves for several days or longer.”

SCOUTING IS CRITICAL

Mary said a critical element of a basil downy mildew control program is constant scouting.

“Any small outbreak, one or two infected plants that go undetected, allows the disease to ramp up,” she said. “Infected plants must be identified right away and disposed of immediately to prevent spread to other plants.”

Early symptoms can include leaf sections that are yellow. The undersides of the leaves have a dark, dirty appearance from the downy mildew reproducing. But Mary said she’s seen green leaves with no yellowing and yet there was downy mildew on the undersides of the leaves. She cautioned that while looking for yellow leaves is a good way to scout for basil downy mildew, inspect as many plants as possible by turning over the leaves to look for mildew.

CHEMICAL CONTROLS

Because the basil downy mildew pathogen is seed-borne, Mary said it’s critical that you apply fungicides immediately.

“Growers have better fungicide options to stop basil downy mildew today than ever before,” she said. “Growers should rotate chemicals. [And] growers concerned about seed contamination want to be sure they apply a fungicide as soon as the seed is sown because the growing media is going to be moistened and that could prompt the pathogen to develop.”

Mary suggested that Subdue Maxx be used early at seeding because it has systemic activity and won’t be deactivated by soilless media. And the timing of this treatment is critical. Other fungicides that can be used in an overall program with Subdue include Heritage, Ranman, Revus and phosphorous acid fungicides.

“I have been working with the IR-4 Project to make sure that any new chemistries that look good as a downy mildew control on other crops are entered into the IR-4 system so they can also be considered for basil,” Mary said. “At the most recent IR-4 Food Use Workshop in September, a project for the new fungicide picarbutrazox for greenhouse basil was chosen as a priority.” ▶

Mary said for organic basil production, options are more limited.

“The OMRI-certified products for basil downy mildew control may not provide the needed protection when growing conditions are cool and wet,” she said. “It’s important that growers keep the plants dry, scout for downy mildew, and immediately remove and dispose of diseased plants. This is an aggressive disease and growers must stay on top of it.”

RESISTANT VARIETIES

As part of the USDA multi-state grant, breeders at Rutgers University test their downy mildew-resistant basil varieties under the high disease pressure in southern Florida.

New basil lines have also been sent to Mary to test.

“I grow them and expose them to downy mildew to see if they become diseased,” she said. “Some of these new basil lines have been released recently and are commercially available, however, there may not be a lot of seed available.”

James Simon, professor of plant biology in the School of Environmental and Biological Sciences at Rutgers University, is developing basil varieties with resistance to downy mildew. The new varieties Rutgers Obsession DMR, Rutgers Devotion DMR and Rutgers Thunderstruck DMR are available to commercial growers from VDF Specialty Seeds (www.vdfspecialtyseeds.com).

David Clark, professor in the Horticultural Biotechnology and Genetics laboratory at the University of Florida, has developed the variety Amazel for the consumer garden market. This vegetatively propagated, seed-sterile variety is available from Proven Winners (www.provenwinners.com).

STOPPING SPORULATION WITH LIGHT

Researchers at the Lighting Research Center at Rensselaer Polytechnic Institute in Troy, New York, are studying the impact different light wavelengths, light amount, light durations and light application timing can have on the development of the downy mildew pathogen on specialty crops, including basil.

“Growers wanting to reduce the impact of basil downy mildew should avoid prolonged dark periods and high humidity,” said Jaimin Patel, Lighting Research Center. “If the proper nighttime lighting conditions and other environmental conditions are maintained, the pathogen can be suppressed. More than 85% humidity at night is conducive to the sporulation of the downy mildew pathogen.”

The nighttime light treatment happens when the pathogen is sporulating, said Jaimin. Avoiding the dark is going to have a large impact on the pathogen, but the spectrum and amount are equally important, he explained.

“If an effective dose is not used, sporulation will still occur even if the lights are on all night. We are currently conducting research to determine the optimum light dose,” said Jaimin.

In earlier research while a postdoctoral associate at the University of Florida, Jaimin found that red light was able to significantly reduce the severity of downy mildew in basil. 

Some of the information used in this article first appeared in the Hort Americas August 2018 News blog article.

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Photo courtesy of Mary Hausbeck, Michigan State University.

In some cases, early symptoms of basil downy mildew include sections of leaves appearing yellow.



Photo courtesy of Jaimin Patel, Lighting Research Center.

The undersides of the basil leaves have a dark, dirty appearance from the downy mildew reproducing.



Photo by James Simon, Rutgers University.

Since the basil downy mildew pathogen (*Peronospora belbahrii*) can come in on the seed, growers should make every effort to know as much as possible about the seed they receive from their suppliers.

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Bud Rot of Cannabis

by DR. BRIAN CORR

Although cannabis is described as a “weed,” there are about 100 fungal diseases that have been reported, caused by fungal genera from *Achylya* to *Verticillium*. If someone looked hard enough, they would probably find *Zygosporium* on cannabis somewhere, so the fungal possibility very well might be A to Z.

In addition, some common bacteria genera (notably *Agrobacterium*, *Pseudomonas* and *Xanthomonas*) can affect cannabis. And there are a few viral diseases reported. However, very few of the bacterial or viral diseases are common in production and even fewer have a significant impact on yield.

However, two out of the many fungal

diseases can be of great significance. One (bud rot) is the topic of this article. The other (powdery mildew) will be discussed in a future article. Miscellaneous diseases will be addressed in another future article.

DISEASE DESCRIPTION

Bud rot can be a heartbreaking disease for a cannabis producer because very often there aren't symptoms of a problem until shortly before harvest—or sometimes not even until after harvest. The bud (inflorescence) is found to be rotting, often from the inside out.

The damage caused by the fungus may be enough to prevent sale of the bud, but in addition, the viable spores or

other infective particles in the bud may result in failure of the dried flower when tested for yeast and mold (depending on testing method). A few moldy flower buds can result in an entire batch being rejected.

CAUSAL ORGANISM

Bud rot is almost always caused by *Botrytis cinerea*. This fungus is found almost everywhere on earth. It's an equal-opportunity organism, capable of infecting hundreds of different plant species. Exclusion is extremely difficult since the spores can travel long distances in air.

Botrytis can affect any above-ground portion of cannabis plants, including leaves and stems, but since the buds are the most valuable portion, it is infection of the bud that causes the most concern. A common name for *Botrytis* is gray mold due to the gray color of the mycelia and spores. However, often this fuzzy gray growth isn't evident, especially if humidity is low. The first signs of disease are usually brown necrotic leaves or flowers.

If there's any question about the presence of *Botrytis* in damaged plant tissue, a simple diagnostic test is to put the damaged tissue in a plastic bag with a moist paper towel, then store the bag at room temperature overnight or up to 24 hours. If *Botrytis* is present, the high humidity in the bag will allow mycelia and spores to develop and become visually evident.

I said bud rot is *almost* always caused by *Botrytis cinerea* because there occasionally are examples of bud rot that don't match up with the usual characteristics of *Botrytis cinerea*. Unfortunately, positive identification of the causal organism is difficult due to restrictions on transportation of plant samples and because university laboratories in the United States (until recently) have been ▶



Symptoms of bud rot can be very obvious. This plant has large amounts of necrotic tissue, but no obvious signs of mycelia or spores.

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restricted from working with cannabis.

There may be instances where the disease is caused by an unusual strain of *Botrytis cinerea*, a different *Botrytis* species or perhaps a totally different fungal genus. We don't know and won't know until more testing can be done.

PREVENTION AND CONTROL

Infection of a plant by *Botrytis* requires the presence of free moisture on the plant surface, not simply high humidity. Exactly how long water must be present for infection to occur hasn't been determined for cannabis, but on other crops free water must be present on the plant for multiple hours.

The knowledge that water must be present on the plant for infection to occur is an important clue to preventing bud rot. Cannabis buds can become wet from condensation when the bud temperature drops below air temperature and the humidity is high.

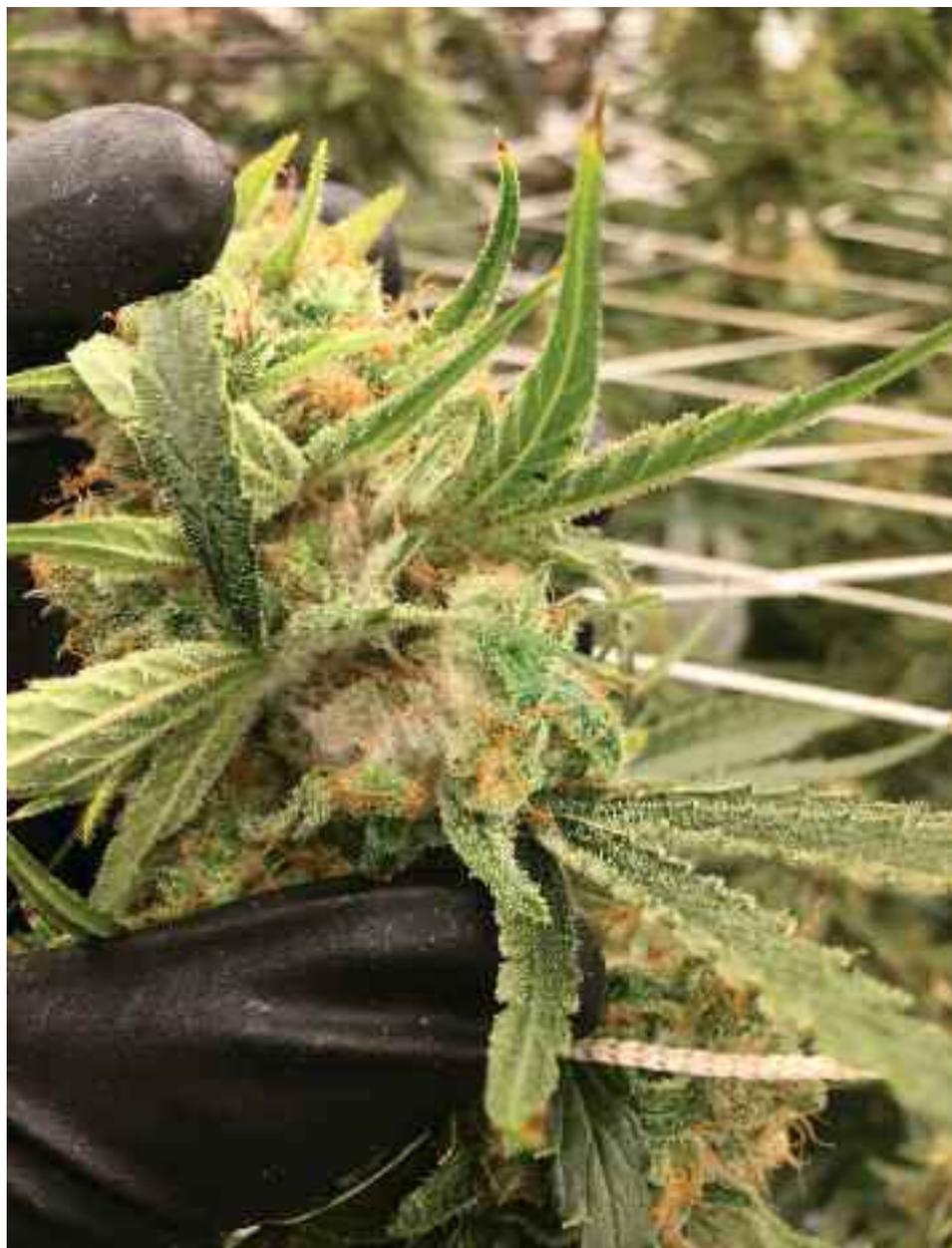
During the day, the bud temperature is usually as high or higher than the air temperature, but when lights have turned off and/or the sun goes down, the bud temperature can drop. Lower bud temperature combined with evapotranspiration, which can increase humidity and reduce the dewpoint, can result in condensation on the buds. Dehumidifica-

tion, either by ventilation or mechanical dehumidifiers, is critical to prevent condensation.

Some cannabis strains appear to have hydathodes, structures which allow water to be released from the edge of the leaves in a process called guttation. Guttation typically occurs when the leaves are cool, the humidity high and the roots are warm with ample water. These conditions can occur at night in a cannabis production site. Guttation fluid typically contains sugars and sugars can contribute to *Botrytis* germination and infection. Inspect cannabis plants first thing in the morning to check for moisture on the buds from condensation and/or guttation.

Good irrigation practice for minimizing bud rot requires irrigation to be done early enough in the day that excess water has evaporated, minimizing humidity. Avoid saturated soil late in the day to minimize guttation. Monitoring bud temperature and keeping it above the dew point will prevent condensation.

While there are no known cannabis cultivars (strains) resistant to *Botrytis*, some strains are more susceptible than others. Strains with dense flower buds are often requested by cannabis consumers, but dense buds retain moisture and can develop bud rot more readily than more open buds. Many strains clas-



Above: *Botrytis cinerea* is an extremely common fungus, possibly even on strawberries in your refrigerator.

Left: Symptoms of bud rot can be subtle. This flower bud has mycelia developing inside the bud, but no obvious signs of necrotic tissue. The interior of the bud may be completely affected.

sified as *sativa* or “*sativa*-dominant” have more open bud structure and therefore are less likely to develop bud rot.

Because *Botrytis* can develop and produce spores on dead or dying plant tissue, removing senescing leaves is an important part of disease control. All

plant material cleaned up from plants must be placed in covered containers and removed from the growing area daily. No leaves should be left on or under benches to develop spores to further infect plants.

Botrytis bud rot can even develop after buds are harvested. Drying cannabis flowers is a balance between drying slowly enough that the flower buds develop the organoleptic characteristics desired while drying quickly enough to prevent *Botrytis* development. If the harvested crop is known to have bud rot developing, increase drying speed to reduce the chance of further development of the *Botrytis*.

Plants with adequate calcium are more resistant to *Botrytis*. Foliage sprays with a calcium compound reduce the incidence of *Botrytis*. Typical rates are 1,000 ppm sprayed weekly. Calcium chloride dihydrate is a common product for sprays. Mix 14 grams of calcium chloride dihydrate per gallon. Use of an approved wetting agent will ensure good coverage.

Some growers report success applying

silicate compounds to make the plant more resistant to *Botrytis* infection, as well as other diseases. There are several potassium silicate products commercially available that can be applied as a drench or spray.

Always test a small portion of the crop for signs of phytotoxicity before treating the entire crop.

Use of fungicides for control of bud rot is very restricted by regulations in most jurisdictions. In the U.S., some states don’t allow any pesticide applications at all, while some states have developed lists of approved pesticides.

Regardless of what fungicide might be used, thorough coverage is essential since most have no systemic activity. If the plant part isn’t covered, it’s not protected. See Table 1 for examples of active ingredients used in cannabis production to minimize *Botrytis* bud rot. [IG](#)

Dr. Brian Corr is a consultant with over four decades of experience in the greenhouse industry. He has advised legal cannabis producers for the last three years. You can reach him at Brian.Corr@SycamoreHortConsulting.com.

Table 1. Some active ingredients for control of *Botrytis*.

ACTIVE INGREDIENT
<i>Bacillus amyloliquefaciens</i>
<i>Bacillus subtilis</i>
Citric acid
Copper compounds (e.g., copper octanoate)
Extract of <i>Reynoutria sachalinensis</i>
Harpin proteins
Hydrogen peroxide/peroxyacetic acid
Potassium bicarbonate
<i>Streptomyces lydicus</i>
Sulfur

Notes: Always check regulations in your area to determine what is allowable. Always follow label recommendations. Some growers have indicated hydrogen peroxide may affect terpenes by oxidation.

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