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October 2018

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We remember Henry Ford as the innovative businessman who streamlined production of the car, creating the first assembly line and bringing automobiles to the masses. It was quite a feat, but he didn't do this in a vacuum. He relied on the successes and failures of many inventors and car manufacturers before him.

It's something to remember as we continue into this new era of using technology to grow food crops. There will be failures, and new startups will either learn from those missteps and correct them in their own operation, or follow in the footsteps of those who came before. In the beginning, especially with new technology, there will be more failures than successes, too. There are always the early adopters who may be too early for their time, too ambitious or just haven't been able to see the big picture yet. But, eventually, businesses will come along that take into account what's already happened and create the right balance for success.

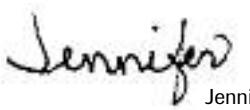
Where are we right now in that process? It's hard to say. We have a lot of newer companies coming in to CEA, particularly on the vertical farming side, and it's unclear yet whether all the kinks, for lack of a better word, have been worked out. This month's cover story—Eden Green Technology in Cleburne, Texas—has ambitious expansion plans, but started in a modest fashion, building a 40,000-sq. ft. facility smack next to partner Walmart's distribution facility. Do they have the right formula? Read more on page 12 and decide for yourself (remember, I just report the facts of what they're doing; I don't endorse a method or philosophy).

Speaking of new technology, freelancer Anne-Marie Hardie profiled a unique relationship between Truly Green Farms and nearby ethanol producer Greenfield Global to provide waste heat and carbon dioxide to the greenhouse in a mutually beneficial partnership. Read more about how that developed on page 22.

On another note, we asked Dave Kuack to round up some of the more recent variety introductions that work well in a controlled agriculture environment. He went above and beyond to provide some great new opportunities for CEA growers. Check those out on page 16.

And for those early adopters who've taken the deep dive into medical and recreational cannabis, turn to page 32 to see Brian Corr's story on preventing and treating the two most problematic pests: root aphids and mites.

Whether you're considering jumping in to a newer segment like vertical farming or cannabis, or polishing your skills in other areas like hydroponic or traditional greenhouse growing, I hope you find what you need in this issue.



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ON THE COVER

A wall of lettuce for Walmart grows at Eden Green Technology. What started with a salad dinner has developed into a burgeoning indoor vertical growing operation with plans to expand into seven more locations by 2020.

DEPARTMENTS

FEATURES

New Water Treatment Solution

A company called Silver Bullet Water Treatment recently announced it's launching a Controlled Environment Agriculture Business Unit to bring its advanced oxidation process for sustainable, green chemistry water-treatment solutions to CEA growers.

"Controlled environment agriculture is a natural market expansion for Silver Bullet," says Dave Lisle, CEO of Silver Bullet Water Treatment, in a news release. "Our process technology and system designs are ideal for growers seeking sustainable alternatives to harsh, hazardous chemicals, such as chlorine, while also improving water quality, being nutrient-program compatible and effectively controlling plant disease outbreaks and phytotoxicity."

The company conducted a pilot case study with a grower in Oakland, California, on a recirculating hydroponic growing system. The Silver Bullet system operated under controlled conditions versus a traditional "wet chemistry" chlorine water treatment system throughout an eight-week period, according to the release. During the trial, plants became infected with fusarium on the chlorine-treated side while they remained uninfested on the Silver Bullet side. Visit www.silverbulletcorp.com for more information.

NASA Continues to Explore Growing Food in Space

The possibility of living in space becomes even closer if we can grow food out there. To that end, NASA has awarded $125,000 for collaborative research with a company called UbiQD and University of Arizona's CEAC to "explore using quantum dots to tailor the spectrum of sunlight for optimized crop growth for in-space and planetary exploration missions."

That all sounds rather Star Trek-ish, but the product is a film-type material to help process light more efficiently for the plants. Here's what Dr. Gene Giacomelli says in a media release about the funding: "We are excited to be working with UbiQD to explore this innovative approach in managing wavelengths of light from light source to plant leaf within a food plant production application. This technology has the potential to improve the PAR light source efficiency, thereby becoming a game-changer for indoor crop production."

So it's not just of benefit out on Mars or the moon, but in your greenhouse as well. In fact, in early trials with tomato greenhouse growers, they've seen yield improvements of 20% to 30%. We'll keep in touch with the folks at the CEAC to see how this research continues to impact greenhouses on Mother Earth.

New Growtainer for Microgreens

CEA Advisors, the company behind the Growtainer—a modular vertical production environment inside a shipping container—now has a 20-ft. Growtainer optimized to produce microgreens.

CEA Advisors worked with CropKing to outfit the Growtainer, which has a vertical rack system containing five production levels. Each level contains three 10-in. wide by 12-ft. long NFT CropKing gutters for a total of 360 linear feet of production, equaling a potential harvest of 108 "1020" grower trays per week, according to a news release. Each level contains three to four energy-efficient, crop-specific, full-spectrum LED fixtures.

The container has a 6-ft. utility area and 14-ft. climate-controlled production area. Go to www.microgreens.growtainers.com for more details.

Organic Herb Production Guide

Call it more of a comprehensive overview of organic herb production, updated from a previous publication by the ATTRA Sustainable Agriculture Program, managed by the National Center for Appropriate Technology (NCAT).

The guide is free to download and costs $3 for a print version, available at https://attra.ncat.org. In it, the ATTRA details the U.S. herb market, suitable herbs for organic greenhouse production, some production methods, IPM programs, pests and diseases and possible controls.

If you're exploring converting ornamental space into organic herb production, this is a nice start to help make your decision.

MightyVine to Double Size

Business has apparently been good for Rochelle, Illinois-based MightyVine, a hydroponic tomato grower, as news comes out recently of its plans for expansion.

According to a story in *The Chicago Tribune*, MightyVine plans to double its size in response to demand from its large customers, which includes Costco, Walmart and Jewel-Osco. Chairman Jim Murphy told the media outlet they will break ground in September on a $16 million expansion project that includes two 7.5-acre greenhouse bays, bringing its total to 30 acres under glass.

This is the second major expansion for the company, which started in 2015 and harvested its first tomatoes for sale in 2016.

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It's always fascinating to hear about new ventures popping up across the globe and the latest one in Dubai is—in typical Dubai fashion—very ambitious.

CropOne and Emirates Flight Catering (EKFC) have plans for a 130,000 sq.-ft. indoor vertical farm (the world's largest so far) in which they hope to grow 6,000 lbs. of greens and herbs under LED lights for flights leaving Dubai International Airport. According to a *Business Insider* story, EKFC caters for Emirates Airlines and all the other airlines at the airport, making it one of the world's largest airline catering operations.

They will break ground in November 2018 with the plan of providing greens and herbs by December 2019 for 105 airlines and 25 airport lounges, according to the story. Interestingly, CropOne already has a vertical farm in Millis, Massachusetts, and delivers locally there under the Fresh Box Farms brand.

What's also interesting is the partnership CropOne has made—EKFC provides a steady customer base and constant demand for the farm. The story also notes challenges other vertical farms and companies interested in such ventures have faced, including the tidbit that Panasonic and Google have both abandoned vertical farm projects in the U.S.

New Bioinsecticide from Vestaron

Vestaron announced that Spear-T, a bioinsecticide, is now available for greenhouse use. Spear-T will be distributed by Isagro USA for the greenhouse vegetable market. Vestaron will announce additional distribution rights for the greenhouse market at a later date. The active ingredient of Spear-T is GS-omega/kappa-Hxtx-Hv1a.

This active ingredient is based on a peptide in the venom of the Blue Mountains funnel-web spider of New South Wales, Australia. Folks at Vestaron identified the genes responsible for producing the peptide. They inserted the genes into yeast and mass produced the peptide in fermentation tanks.

The mode of action of Spear-T is unknown, but earlier studies on various insects and mites suggested that it's likely a neurotoxin. Two potential targets of the active ingredient are a voltage-gated calcium channel and a calcium-activated potassium channel. The intoxicated insects first contract their limbs uncontrollably, causing them to lose movement coordination and finally results in paralysis and death.

Unlike the original venom, which is injected by the fangs of the spider, Spear-T works by contact. Its targets include broad mite, thrips, twospotted spider mite and whiteflies. Additional pests may be added in the future. REI is 12 hours.

New OMRI-listed, Plant-based Fertilizer

Growth Products announced its new, 100% organic, OMRI-listed, plant-based fertilizer, Macroganics 4-3-2. This fertilizer is designed to offer the maximum analysis available for primary nutrients (N-P-K) in a liquid form. In addition to the highly concentrated N-P-K, Macroganics contains 18 L-Amino Acids, Natural Wetting Agent from Yucca and a food source for beneficial bacteria.

According to Growth Products, Macroganics is a non-clogging, easy-to-use fertilizer for food crops, ornamentals and turf and is ideal for supplemental feeding. Macroganics provides an effective boost of nutrients and organic matter both in root feeding and foliar spray applications, and it contains no animal by-products.

For more information, go to growthproducts.com.

Global Veg Greenhouse Project Numbers

Vegetable greenhouse operations worldwide have announced 201 new projects or funding plans in recent months, totaling more than 10,000 acres of greenhouse space, according to Gary Hickman of Cuesta Roble Consulting.

Of these projects, 60 are in the United States spread throughout 32 states. "The total USA planned area is 642 hectares (1,586 acres), which, if completed, would be more than a 70% increase to the current USA vegetable area," Gary writes in a release detailing the global growth. "In Canada, 14 new announced projects have been found, totaling 253 hectares (625 acres). That would be a 16% increase in total Canadian greenhouse vegetable area."

Mexico, he adds, has nine new projects proposed at 332 hectares or 820 acres, for a 10% increase in total area. The largest growth acreage-wise outside the U.S. is Russia, which announced more than 2,500 acres from 23 projects, for a 34% increase in currently known greenhouse vegetable area. Gary says that's three times what was projected for last year.

The July 2018 listing of all 201 proposed greenhouse vegetable projects is available for a fee from Cuesta Roble Consulting as an emailed excel file. Gary also offers a complete listing of the more than 2,200 known current world greenhouse vegetable growers in 106 countries, called the 2018 World Growers Listing. For more information, visit www.cuestaroble.com.

BrightFarms Secures $55M

The expansion of BrightFarms continues with $55 million more in equity financing led by Cox Enterprises. The company is a communications, media and automotive services provider, and it was joined by existing BrightFarms investors Catalyst Investors, WP Global Partners and NGEN Partners, according to BusinessWire.

BrightFarms, as you may know from our February 2018 *Inside Grower* cover story, has an ambitious expansion plan to start 15 more growing operations in three years. Since that story, the company already announced a new location in Abilene, Texas. That makes five, along with Rochelle, Illinois; Culpeper County, Virginia; Bucks County, Pennsylvania; and Wilmington, Ohio.

It's interesting that a mostly communications-focused company made the investment. Cox Enterprises was started over 100 years ago by James M. Cox, who purchased the *Dayton Evening News*

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(later the *Dayton Daily News*). The company grew from there and today it includes a global portfolio that also includes Autotrader and Kelley Blue Book. So why invest in a greenhouse company?

In 2007, the enterprise launched Cox Conserves, a national sustainability program where some of the goals include sending zero waste to the landfill by 2024, and to be carbon and water neutral by 2044. It's invested more than $100 million toward sustainability and conservation projects, and now BrightFarms is one of those opportunities, says CFO Dallas Clement.

"Since our founding in 1898, Cox has embraced innovative, game-changing businesses in their earliest stages like radio, television, cable TV and broadband. BrightFarms presents a unique opportunity to reshape agriculture production and drive positive environmental change by growing in local, controlled environment agriculture farms," he says in the BusinessWire release. "We are excited about the opportunity to support BrightFarms' growth as it scales into a national brand."

Edible Flowers Rising in Popularity

Did you know dianthus flowers are edible? The Vineland Research & Innovation Center in Vineland Station, Ontario, Canada, has been researching customer preferences related to edible flowers to help growers better position themselves in the marketplace after hearing that Whole Foods named floral flavors the No. 1 consumer food trend for 2018.

Edible flowers are surging in popularity as evidenced through research conducted by Alexandra Grygorczyk, PhD, Vineland's Research Scientist, Consumer Insights.

"In 2015, we surveyed consumers on their preference for edible garden plants (strawberries, raspberries, gooseberries) and also included an edible flower option in the study," said Alexandra. "We found 35% of respondents were highly interested in edible flowers and would prefer purchasing edible flowers for their garden over more traditional plants such as strawberries and raspberries."

Freeman Herbs, a Beamsville, Ontario-based grower and distributor of fresh herbs in Canada, partnered with Vineland in 2017 to gain a better understanding of the edible flowers market. Following Freeman Herbs' production trials on over 25 types of edible flowers screening for ease of production, blooming and compact shape for container production, 10 plants were selected for profiling by Vineland's trained sensory panel and more than 200 Greater Toronto Area consumers.

"We were able to segment consumers in two groups: the bold flavor fans (56%) favoring strong aromas and spicy tastes; and the smooth texture lovers (44%) preferring smooth textured and subtly flavored flowers," said Alexandra. Results also showed edible flowers, such as nasturtium and candy pop mint, should be marketed to the bold flavor fan group, while impatiens and dianthus are of interest to smooth texture lovers.

"These research findings have been instrumental in outlining our business plan to expand into the potted edible flowers market," said Jeff Nickerson, General Manager, Freeman Herbs. Freeman Herbs will be launching edible flowers in 4-in. pots in the produce aisle in 2019. Find out more at www.vinelandresearch.com.

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A New Look for Vertical Farming

Jaco Booyens, co-chair of Eden Green Technology, came on board after seeing the proprietary growing technology developed by Eugene and Jacques van Buuren.

Eden Green Technology's new operation in Cleburne, Texas, features unique, proprietary technology, as well as a reliance on a trusted energy source—the sun.

by **JENNIFER POLANZ**

There's a new company shaking up the vertical farming scene and they've brought some unique concepts to the table. Eden Green Technology keeps the benefits of the vertical farm concept, but removes the indoor growing aspect in favor of greenhouse production, as well as adds some new technology to the mix.

The company has been flying under the radar a bit as larger vertical farm companies with powerful names attached to them (Jeff Bezos and Kimbal Musk, for example) garner the headlines. But with the recent opening of its Cleburne, Texas, facility, and a partnership with Walmart to supply its nearby distribution center, Eden Green Technology is ready for its moment in the sun—literally and figuratively.

THE BACKSTORY

I recently spent quite a bit of time on the phone with Jaco Booyens, co-chair of Eden Green Technology, who told me the story of how he met creators Jacques and Eugene van Buuren, two brothers who come from an engineering background.

A South African native, Jaco had returned there for a speaking engagement when the host of the event introduced him to the van Buuren brothers. The host invited Jaco for dinner with the van Buurens.

"All I had for the meal was salad, and I was instructed to have the salad with no dressing, and there was no protein in the salad. At the end of the meal I was asked, 'What do you think?'" he recalls of the meeting. "I said 'This is one of, if not the best, salad I've ever had in my life.' I've never tasted flavor like this. And they said, 'Well, that's what we want to talk to you about. We do that. We grow that.'"

The "why" of the brothers' story is equally compelling, based on Eugene's experience with hungry children at a South African orphanage during a Christmas visit. A boy continued to take food during the visit, but wasn't eating it. He was bringing it to his sister, instead, telling Eugene "it's her day to eat." Jaco recalls hearing the story and how the brothers decided then to come up with a way to feed more of the global population. It took them the next eight years to develop the proprietary system they use today.

The day after that salad dinner, the brothers took Jaco to the production facility. He said once he saw that technology used to grow leafy greens, he was ready to help them bring it to the United States. Jaco had connections to Walmart, and once the retailer vetted the technology for themselves, they entered into a partnership. Why Walmart? Because of its immense distribution channels. But more on that in a bit.

WHY IT'S DIFFERENT

We all know the talking points of vertical farming: less waste, more plants grown per square foot, a reduction of reliance on chemicals and reduced transportation to the end consumer. However, vertical farming hasn't been the huge success across the board that some had predicted and for various reasons (see the sidebar for a recap on the ups and downs of traditional vertical farms). At least one of those reasons, though, can be the energy expenses and that's the first aspect where Eden Green has tried to change the game.

The new farm in Cleburne, at 40,000 sq. ft., is a well-built, but simple and inexpensive, polycarbonate Conley greenhouse.

"For us, we have to create a closed environment to keep the plant out of the elements, but this is not about an expensive structure," Jaco notes, saying the construction is in line with the tenets of the business, which is to feed more people nutritious food faster and cheaper. Internationally, Eden Green works with Richel out of France. The greenhouse setup allows Eden Green to leverage the sun's rays, of which the Dallas area gets on average 232 days, and reduces energy costs. In fact, it gets too much sun, and they're diffusing 80% of the sunlight for optimal growing environments.

The Crisply brand of three different blends will be harvested the same day it's delivered to the Walmart distribution center in Cleburne, Texas.

The next aspect that differs from a traditional vertical farm is the setup inside. It's a true vertical farm in that the plants are grown in vertical towers called vines in a medium-less (no soil) microclimate bubble. Each vertical vine only takes up 1 sq. ft. footprint on the ground and stretches 18 ft. into the air.

"We feed each vertical vine independently," Jaco explains. "We can treat that vine for exactly what it's housing. If it's housing basil, we're going to feed basil the way basil wants to be fed, under the conditions basil wants. Now it becomes an algorithm of what do we want to plant—we use big data; we have a lot of big data we are capturing on the history of each plant, how they perform in our system, how to make it better. Always improving, always tweaking."

This method allows Eden Green to control the growing zone for each vine (Jaco notes one day in the summer the temperature in the greenhouse was 109 degrees, but at the root level of the plant it was 50 degrees and at leaf level 58 degrees). The true vertical nature allows for more plants per square feet and to have a wider mix of products because they can customize the vines, he says. The average crop time to harvest is about 27 days for lettuce, which translates to 10 to 15 harvests per year.

The Cleburne facility also uses water captured from greenhouse condensate and then infused with nutrients for irrigation, rather than relying on the local city's water. New technology out of MIT allows them to detect pathogens in the facility and in the environment around the facility, essentially allowing for elimination before it gets to the plants.

"We detect a pathogen at the micron level," Jaco says. "We quickly deal with it, eliminate it and move forward. We create a patient record, like in a hospital.

"We're tracking the individual plant down to its root and its leaf level; if there's something happening on the root zone of that individual plant, not just the vine or the greenhouse, each individual plant. And not just the plant, the contact surface of the vine, the contact surface of the floor, the air around the vine, the roof structure, the wall structure internal and external, and then the external environment."

CURRENT STATUS

Jaco says the benefits for its current customer, Walmart, and potential other customers, are numerous. Instead of relying on field-grown crops in the West, making the multi-day trek across the country ▶

A Quick Overview of the Vertical Farm Space

It seems every day there's a new vertical farm in the news. Recently, we saw the announcement about CropOne and Emirates Flight Catering (EKFC) partnering to build the largest indoor vertical farm in the world in Dubai (see the details on page 8). That partnership features a dedicated customer base—all flights taking off out of Dubai International Airport, as well as all the restaurants there.

Fluctuating customer needs is one of the biggest challenges in the vertical farm business, along with labor costs and energy expenditures. Plenty, a vertical farm start-up with Jeff Bezos' name attached on the funding list, has more than $200 million in investor money and hopes to be able to scale up quickly next to big cities for maximum impact. Then there's the mainstays in the field, like AeroFarms, which has been steadily growing and producing leafy greens in indoor vertical farm environments for the last decade.

But for all the big names and bright LED lights, there are others that didn't take long before they had to turn off the lights. FarmedHere is one of them, a promising venture that started in Chicago and had announced expansion plans into Louisville before succumbing to increased "operation costs and increasing competition in the Chicago market," according to a *Chicago Tribune* story.

Then there's Metropolis Farms, once considered to be the start of a larger vertical farming hub in Philadelphia. Now that story is playing out in the courtroom, as investors accuse owner Jack Griffin of defrauding them. They say his crop projections were never realistic, and the business fell behind in rent and utility payments before closing the doors for good.

Despite the ups and downs of this segment, there continues to be research, funding and expansion within it, particularly thanks to increased interest in cannabis vertical farming.

to distribution centers, the plan is to have growing facilities located next to distribution sites for same-day delivery (more on expansion plans in a bit).

Right now, the Cleburne facility is situated about 200 yards from a Walmart distribution center, and by October, will be ramping up deliveries there. By February, the Crisply brand of non-GMO, pesticide-free salad mixes from Eden Green is expected to be in every Walmart in Texas.

Eden Green can supply Walmart and other customers with a wide mix of product, too, not just salad greens. The Cleburne facility is currently growing 45 different varieties of produce; 20 of those are for the Walmart partnership with premium herbs and salad mixes. They're also growing strawberries, as well as other products for research and development for future customers.

Walmart has three exclusive salad mixes right now under the Crisply brand name coming from Eden Green: Sweet Greens, Spicy Greens and Spring Greens. A fourth, called Smart Greens, is a blend of kale, spinach and bok choy and will be coming soon.

The vertical vines are 1-sq. ft. wide and 18-ft. tall, and are fed independently to maximize the growth environment for each crop.

SCALING UP

As we've mentioned before, the company's ultimate goal is to feed as many people as possible as inexpensively as possible, so Jaco says the plan from day one is to scale up for bigger locations in more segments of the country. Cleburne, which just saw its U.S. press launch in June and has already delivered its first harvests, will be expanded. The company already knows where its next seven sites will be located across the U.S., with a goal to complete those by 2020. Initially, they'll start around 250,000 sq. ft. (though Cleburne started smaller) and grow to 1 million sq. ft. by the final phase. According to Jaco, none of those facilities will need supplemental lighting for leafy greens and other produce products.

The company also has made a pledge to have a beneficial impact on its nearby communities. The First Fruits program provides the first and best portion of each harvest to local communities in need. They hope to fulfill the produce needs of the Dallas and Fort Worth area food banks by the end of 2018. That model will continue for every location Eden Green builds.

"We have to feed the world," Jaco says. "We make every decision in this company still today with that in the forefront of our memory. Every financial decision comes back to 'is this going to feed people?'"

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Especially for CEA

Controlled environment growers are expanding their product offerings with an increasing number of edible crops. While salad greens and herbs continue to be popular for locally grown markets, CEA growers are looking to diversify and increase their customer base with a wider selection of products. Here are some recent introductions to consider.

by **DAVID KUACK**


1


2


3

Bejo Seeds (www.bejoseeds.com)

Cucumber

1 Lisboa F1 is an American-style parthenocarpic slicing cucumber for production in greenhouses or under row covers during the early spring. Fruit is dark green and 7- to 8-in. long. It matures in 45 days.

HIGH RESISTANCE: *Cladosporium cucumerinum* (Ccu), *Podosphaeria xanthii* (Px)

INTERMEDIATE RESISTANCE: *Pseudoperonospora cubensis* (Pcu), cucumber mosaic virus (CMV), cucumber vein yellowing virus (CVYV)

2 Yildo F1 is a very productive 6-in. parthenocarpic snacking cucumber. Fruit has smooth thin skin that doesn't scratch easily. It matures in 55 days.

HIGH RESISTANCE: *Cladosporium cucumerinum* (Ccu), Papaya ringspot virus (PRV)

INTERMEDIATE RESISTANCE: *Pseudoperonospora cubensis* (Pcu), cucumber mosaic virus (CMV), *Podosphaeria xanthii* (Px)

Tomato

3 Resolute F1 is a main-season, vigorous, determinate variety that's highly adaptable. It produces large 9.5- to 15-oz. fruit. Its small blossom end scar and firm red interior make for a high usable fruit count with a low cull rate. The fruit matures in 72 days from transplant.

HIGH RESISTANCE: Tomato spotted wilt virus (TSWV), *Fusarium oxysporum* f.sp. *lycopersici* (Fol), *Verticillium albo-atrum* (Va), nematodes

De Ruiter (www.deruiterseeds.com)

Cucumber

4 Davida is an English cucumber that produces high-quality long fruit for the spring and summer.

HIGH RESISTANCE: Cucumber vein yellowing virus (CVYV), *Corynespora cassiicola* (Cca), *Cladosporium cucumerinum* (Ccu), *Podosphaeria xanthii* (Px)

INTERMEDIATE RESISTANCE: Cucumber green mottle mosaic virus (CGMMV), cucumber mosaic virus (CMV)

Pepper

5 Alison is a blocky red pepper that has high yield potential. With its early production and excellent fruit quality, it's ideal for the bulk market. Alison's average fruit weight is 220 to 240 grams.

HIGH RESISTANCE: Tobamovirus Races 0-3

Enza Zaden (www.enzazaden.com)

Lettuce

6 Fairly is a medium- to large-sized butterhead variety. It offers reliable performance under different production conditions. It produces leaves with a fresh green color. Fairly is very highly tolerant to internal tipburn.

7 Cristabel is a frilled iceberg lettuce with dark green thick leaves. Plants have a more upright growth habit and are high yielding. Cristabel is a reliable variety under various production conditions.

8 Eazyleaf is a broad range of varieties that feature a one seed, one-cut, multiple-leaves approach. Eazyleaf varieties deliver new colors, loft and 3D-texture to bags and clamshells. Eazyleaf leaves can be sold as a pre-cut mix or as a whole head marketed to consumers as one-step, easy-to-prepare salad greens.

Harris Seeds (www.harrisseeds.com)

Basil

9 Italian Large Leaf produces strong yields of broad, dark glossy green leaves. The 2- to 4-in. wide leaves are very aromatic. This variety is more durable than other basils, such as Genovese. The well-branched plants grow 12- to 18-in. tall and 24-in. wide. It's an excellent choice for hydroponic container growing and live herb production. ▶

Harris Seeds
(www.harrisseeds.com)
continued

Lettuce

1 Super Jericho thrives in hydroponic and aquaponic production systems. It produces sturdy, robust plants with large, light green leaves that are succulent, sweet and crisp. Super Jericho was developed to endure the heat of summer in arid regions of the world. It performs extremely well during the heat of the summer in the United States. Super Jericho's firm leaves stay crunchy and delicious while retaining its sweet, crisp texture. It also performs well in cool-season plantings. It's resistant to tip burn and lettuce mosaic virus.

Tomato

2 Indigo Rose produces fruit that typically ripens to the size of a golf ball, but can grow as large as a tennis ball. This semi-indeterminate variety can grow in a bushy vine with minor pruning or training. It's ideal for greenhouses and outdoor production. Indigo Rose has good flavor when grown in warm temperatures, but the fruit develops its truly extraordinary "plum" taste when grown in cooler conditions.

PanAmerican Seed
(www.panamseed.com)

Basil

3 Newton is a fast-growing, highly Fusarium-resistant variety with a traditional sweet, Genovese flavor with no licorice aftertaste. Large, bright green crinkled leaves are great for fresh use or for cooking. Newton performs well in both nutrient film technique and deep raft hydroponic production systems.

Tomato

4 Artemis is an indeterminate tomato that matures in 50 to 55 days from transplant. Its fruit has a rich, sweet flavor and a firm texture. Early maturating fruit on long trusses provide large harvests early in the season. Artemis performs well both in high-tunnel and open-field production due to its resistance to both root zone and foliar diseases. Artemis is resistant to Fusarium Race 1 and 2, tobacco mosaic virus and tomato mosaic virus, nematodes and *Fulvia fulva* leaf mold. ▶

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Sakata (sakatavegetables.com)

Beet

1 Fresh Start is a fast-growing baby leaf hybrid variety grown only for its leaves. It doesn't form a usable root and is suitable for container growing. It matures quickly in 25 to 35 days. This U.S.-patent-protected variety features dark green leaves with dark red petioles. The leaves have well-defined veins and a crunchy texture. The leaves can be cut multiple times for an extended harvest. It's a perfect addition to baby leaf salad blends.

HIGH RESISTANCE: *Peronospora farinosa* f.sp. *spinaciae* (Pfb) Race 1

Spinach

2 Seaside is a superior-quality variety for baby leaf and microgreens production. It has a moderately slow growth rate and an upright plant habit—both critical for producing mild-tasting, easy-to-harvest greens. It can also be grown to the mature leaf stage. Seaside has a smooth, thick, very dark green, spade-shaped leaf, which allows for resistance to mechanical damage and easier cleaning. It has multiple-race downy mildew resistance for growers who require a premium disease package.

HIGH RESISTANCE: *Peronospora farinosa* f.sp. *spinaciae* (Pfb) Races 1-11, 15, 16

INTERMEDIATE RESISTANCE: *Peronospora farinosa* f.sp. *spinaciae* Races 12, 14

Swiss chard

3 Fire Fresh is a hybrid with bright red petioles and vivid green leaves that add bold color to baby leaf salads, spring mixes and stir-fries. The crunchy leaves are round to oval with a slight texture. Fast-growing plants have an upright habit that keeps the leaves clean for harvest. Fire Fresh leaves can be harvested at baby size in about 25 to 35 days or at full leaf size in about 55 to 65 days. Swiss chard leaves hold their color and resist leaf miner damage that discolors other leafy crops.

HIGH RESISTANCE: *Cercospora beticola* (C)

INTERMEDIATE RESISTANCE: *Peronospora farinosa* f.sp. *spinaciae* (Pfb) Race 1

Seeds by Design (seedsbydesign.com)

Tomato

4 Sugar Plum F1 is an ultra-sweet hybrid grape tomato. It is heavy yielding and sets in clusters. The 1-in. red plum-shaped fruit makes it perfect for a summer snack. Enjoy this indeterminate tomato for indoor production throughout the summer.

5 Sunny Boy F1 has a determinate plant habit that sets well in many conditions, especially in greenhouses and high tunnels. Its 6- to 8-oz. deep yellow fruit is globe-shaped and firm. The fruit contains few seeds and is very sweet.

Mizuna

6 Red Streaked Mizuna is the perfect addition to hydroponically grown salad blends. This dark red mustard with its frilly deep cut leaf edges adds color and texture. IG

DAVID KUACK is a freelance technical writer in Fort Worth, Texas. He can be reached at dkuack@gmail.com.

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Photo Credit: Jodi-Lyn Photography

Matt Korpan (left), Operations Manager, with Hilco Tamminga, Director of Operations, for Truly Green Farms in Chatham, Ontario. Truly Green has partnered with nearby ethanol producer Greenfield Global to help heat their tomato greenhouse.

Truly Green Farms uses an ethanol company's excess "waste heat" to save on energy costs.

by **ANNE-MARIE HARDIE**

Energy consumption is on the mind of most growers, including investing in regular energy audits and energy conservation strategies. However, for Cedarline Growers in Dresden, Ontario, the escalating cost of energy inspired an economically and environmentally sustainable partnership with a nearby ethanol producer, Greenfield Global.

The year was 2008 and the price of gas was at a record high, making it challenging for growers to expand their existing operations. At 16 acres of sweet bell peppers, Cedarline Growers was at capacity, but its operators knew replicating their current growing model wouldn't be economically sustainable.

"We were out of infrastructure; the gas was tapped out," said operations and general manager Hilco Tamminga. "The price of gas had been extremely high. We needed to invest into infrastructure that would mitigate our energy exposure."

After going through one gas spike, Cedarline Growers was wary about investing in a natural gas-fueled production line, so they began to look at alternative sources of energy.

"[Greg Devries and I] initially looked at the potential of collecting methane gas," said Hilco. "But we quickly discovered that collecting methane had its challenges, akin to pushing a cart uphill, and this particular project would require services such as water and electricity, in addition to natural gas as the backup fuel source to be brought in—a large investment with a limited amount of methane to be harvested."

With methane on the back burner, Greg and Hilco ▶

continued their research journey to find the right solution for their existing energy dilemma. Little did they know that the answer would come forward at a chance meeting at a local farm show in 2010.

It was here where Greg met with the individuals from Toronto-based ethanol producer Greenfield Global, who had an operation in Chatham, Ontario. During this conversation, they discovered that one of the by-products from ethanol production was uncontaminated carbon dioxide, which could potentially be captured and used to supplement their plants.

"We were attracted to the idea that Greenfield had access to carbon dioxide that was untethered by heat," said Hilco. "Having large amounts of CO2 available without the need to run our boilers is huge."

In addition to carbon dioxide, there was a substantial amount of waste heat that was produced by the plant. Heat that the partnership intended to harness and use to fuel Cedarline Growers' new operation.

"Greenfield is all about efficiency," shared Hilco. "If they could use the 70-degree water themselves, they would." Greenfield required their water to be in the mid 20s in their production cycle. To get there, they needed to build in the capacity to cool the extra energy.

It was the ideal situation, paving the way for their new company and greenhouse facility, Truly Green Farms. The new facility would be in Chatham, adjacent to the Greenfield location, with underground piping constructed under Bloomfield Road, connecting the two plants to each other.

One of the key aspects to ensure that this partnership worked was understanding the energy demand within the greenhouse versus the energy available.

"It is important to recognize the seasonal fluctuations in greenhouse energy, requiring less in the summer when the weather is warmer," said Hilco.

To get to the right solution, both Greenfield and Truly Green Farms did a lot of homework, including several trips to Europe to research other heat-transfer operations.

"We had to make sure that there was adequate energy available—equally important would be the question what would happen to the energy if it could not be utilized in the greenhouse. Both companies did significant engineering in order to get there," said Hilco.

This included oversized grow pipes, double grow pipe and separate mainlines for different heat sources, conventional and waste. In addition, they needed to ensure that this project would not interfere with either Greenfield Global's or Truly Greens' core business—ethanol and tomatoes, respectively. Redundancies are built into the process to ensure that both entities can move forward in their own operation, whether it's producing ethanol or the production of tomatoes.

The project was laid out in four (22.5-acre) phases, allowing the time to fully monitor each component and ensure the overall success of the program. During the initial phase, which began in 2013, the excess carbon dioxide was introduced to the plants, which allowed the growers to manage the carbon dioxide levels for the tomato plants' benefit.

"In 2017, we installed the needed equipment—condensers, heat exchangers, etc. Most of this equipment was installed on Greenfield Global's property," said Hilco. "With phase two completed and operational and phase 3 in our sights, the timing was right to trigger the investment into the part of the project that would see the capturing and collection of the waste heat."

Photo Credit: Jodi-Lyn Photography

The four 6MW heat exchangers deliver heated water to the greenhouse to keep the temperature at the optimal level.

Photo Credit: Jodi-Lyn Photography

Supply-and-return headers keep the water flowing, with the hot water for the greenhouse and the cooler water returning back to Greenfield Global.

To get there, Truly Green installed four heat exchangers in their boiler room. The heated water is delivered from Greenfield to Truly Green through an insulated line underground. This hot water is then used to heat the greenhouse and cooler water is sent back to Greenfield through the loop. Even in the dead of winter, said Hilco, the water enters the greenhouse at 65 degrees, goes through the loop (heating the greenhouse) and returns to Greenfield at approximately 48 degrees (a drop of about 15 to 17 degrees). The double grow pipe, which was designed by Dutch engineers, helps ensure that the recycled water returns to Greenfield at a lower temperature.

"The entire process has been a wonderful collaboration," said Hilco. "We made a design that benefited both entities without impacting the core business."

Over the past winter, Truly Greens saw a 50% reduction in energy costs, but Hilco is confident that there's potential to save even more.

"The system is still brand new," said Hilco. "We have to learn to work in the system; we will be doing some tweaking yet."

ANNE-MARIE HARDIE is a freelance writer/speaker from Barrie, Ontario, and part of the third generation of the family-owned garden center/wholesale business Bradford Greenhouses in Barrie/Bradford, Ontario.

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Getting Your Water Right

How to make sure you have the ideal soilless media pH when growing indoor veggies and cannabis.

by **ED BLOODNICK & TROY BUECHEL**

Often the question is asked: What's the ideal pH of a water/fertilizer solution for crops grown in a soilless medium?

First, let's define what soilless media is and then explain why pH is so important. Soilless media is made with a combination of organic and inorganic components, such as Sphagnum peat moss, aged bark, coir, perlite, vermiculite and other materials. Soil found outdoors consists of sand, silt and clay that's heavy weight and contains various amounts of organic matter, depending on its origin. Soilless media are used to grow potted crops because they're lightweight, have high water retention, much higher air space, no herbicide contamination and low risk of plant pathogens compared to soil.

The pH of a soilless media is important because it directly impacts the availability of nutrients, especially micronutrients. The ideal pH of a soilless media is between 5.5 to 6.2. If the pH is higher or more alkaline, then iron, manganese, boron, copper and zinc become less available for uptake by the plant roots, which can result in one or more of their deficiencies.

If the pH is lower, then the soilless medium becomes more acidic, making these same elements more available. If their quantities are too high in the soilless medium, they may be taken up by plant roots at toxic levels. Macronutrients—such as nitrogen, phosphorus, potassium, calcium, magnesium and sulfate—are less influenced by soilless medium pH, but are required in much higher amounts. Fertilizer application rates more than compensate for any availability issues related to soilless media pH.

Example of micronutrient deficiency in basil, which can be from insufficient fertilizer application or from high pH of the growing medium.

WHAT CAUSES pH TO CHANGE?

If the ideal pH of a soilless medium is 5.5 to 6.2, then the ideal pH of the water or fertilizer should also be 5.5 to 6.2, right? This isn't necessarily true.

First, the pH of the water or fertilizer solution has absolutely no influence on the pH of a soilless medium. The reason is that soilless media has its own buffering capacity and its pH doesn't change rapidly from added inputs. However, a soilless media is also like a filter that filters out and retains fertilizers and elements coming from the water. As fertilizer and elements from the water build up in a soilless medium, they influence the chemical properties of the soilless medium. For example, if fertilizer and nutrients from water start to build up in a soilless medium, then the electrical conductivity or parts per million also increases.

The elements that cause the pH of a soilless medium to change include the bicarbonates and carbonates in the water. These elements can be thought of as limestone. The more bicarbonates or carbonates present in your water, the more "limestone" you're adding to a soilless medium, which causes its pH to rise.

In most water-analysis reports, the bicarbonates and carbonates, along with a few other elements, are added together to form a value called alkalinity. As with bicarbonates and carbonates, the higher the water alkalinity, the greater the ability to raise the pH of a soilless medium.

To counteract the effects of the water alkalinity, most indoor growers use reverse osmosis systems to remove alkalinity, as well as other nutrients from the water. This does work, but it's an expensive solution. In most greenhouse growing operations, reverse osmosis units are only used when sodium, chloride, alkalinity, etc. are excessive and can cause crop damage. Most water sources don't have high enough levels of these elements to cause crop concerns, so reverse osmosis units aren't needed.

Also, consider that reverse osmosis units remove beneficial elements, such as calcium, magnesium, sulfate and micronutrients, from the water. Many water sources have sufficient levels of one or more of these elements. By removing them, you often need to purchase additional specialty fertilizer(s) that provide these nutrients.

HOW CAN YOU FIX pH?

A more economical way to address the influence of water alkalinity on the pH of a soilless medium is to analyze the water source and match a fertilizer to the water quality. The first step is to look at the alkalinity of the water and verify that the fertilizer used is acidic enough to counteract the pH increase influenced by the water alkalinity. If the water alkalinity is very low, then a fertilizer with little to no acidity may be adequate and work well. On the other end, some water alkalinities are so

high that fertilizer may not be sufficient to control pH. If this is the case, then acid can be injected into the water to neutralize some of the water alkalinity.

The next step is to make sure the fertilizer used also provides all essential elements that are missing from the water. For example, if the water is deficient in calcium, then a special calcium-based fertilizer must be used. (Keep in mind that calcium-based fertilizers tend to cause the pH to increase in a soilless media over time, so a more acidic fertilizer should be rotated to counteract this pH drift. Check with your fertilizer supplier for their recommendations for your water type and crop requirements.)

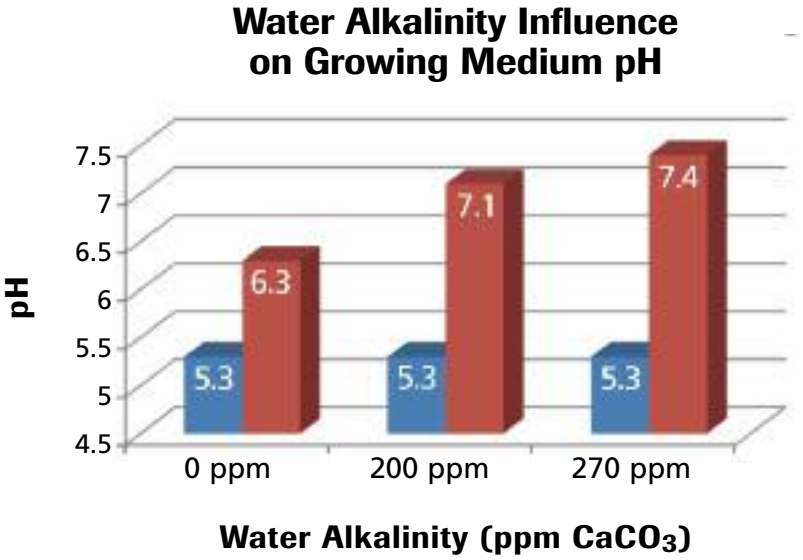

Table 1. This chart shows that the higher the water alkalinity, the more the pH of the growing medium rises, regardless of the water pH.

The bottom line is that while the pH of the water or a fertilizer solution doesn't influence the pH of a soilless media, the alkalinity of the water does impact its pH. Reverse osmosis systems will remove alkalinity from the water and minimize upward pH movement; however, it's more economical to use the water "as is" and match a fertilizer(s) with the water quality to provide all the nutrients required by the crop for optimal growth.

ED BLOODNICK is Director of Grower Services and **TROY BUECHEL** is Horticulture Specialist–Mid-Atlantic U.S. for Premier Tech Horticulture.

Can You Use It in the Greenhouse?

A greenhouse chemical usage guide for vegetable growers.

by **BEN PHILLIPS & CRAIG ANDERSON**

Vegetable growers often use greenhouses or hoophouses to start transplants for field production or for full-season protected culture. Certain types of pests and diseases can be reduced in these controlled settings, but the occasional outbreak may require treatment from a pesticide. Vegetable transplants can sometimes benefit from preventative applications of a fungicide before they reach the field.

Many foliar-applied pesticides have longer residuals in certain greenhouse settings. Usually, pesticides degrade with exposure to sunlight. Greenhouses that use UV-blocking materials remove a large spectrum of light between 10 and 400 nm that we cannot see with our own eyes, but contributes to pesticide degradation. Therefore, sidewalls and coverings that block UV-light increase residual activity of pesticides. Glass and acrylic sheeting, and untreated polyethylene films allow the most amount of light across the entire spectrum to penetrate to the crop canopy. Fiberglass, polycarbonate and rigid PVC sheeting, as well as PVC and treated polyethylene films, can either partially-block or fully-block UV light.

GREENHOUSE LABEL LANGUAGE

The label is law. Label language will indicate whether a certain pesticide application is allowed in a greenhouse and a restriction statement is usually found in the "Directions for Use" section. Very often, greenhouse applications are only allowed on certain crops or crop stages. Some labels contain different rates and recommendations for the same crop inside and outside of a greenhouse. For example, streptomycin is an antibiotic that's only allowed on tomato transplants in the greenhouse as an effective control for bacterial diseases and isn't allowed for use on outdoor tomatoes at all.

Occasionally, a label will not indicate greenhouse restrictions, but also won't provide special instructions for greenhouse use. When the label is silent on greenhouse use, it's classified as an implied use and can be used as long as the target crop is on the label. Always double check the label that comes with your specific product and formulation.

Starting vegetable transplants in an enclosed hoophouse may still require you to apply a preventative treatment of pesticide before moving them to the greenhouse or field.

A. When a pesticide is applied:	B. Workers and other persons, other than appropriately trained and equipped handlers, are prohibited in the:	C. Until:	D. After the ventilation time has expired, the restricted-entry interval:
(1) As a fumigant	Entire enclosed space, plus any adjacent structure or area that cannot be sealed off from the treated area	*The ventilation criteria are met	Continues from the time of application
(2) As a smoke, mist or fog, or as a spray using extra fine (XF), very fine (VF) or fine (F) nozzles	Entire enclosed space	*The ventilation criteria are met	Begins for the entire enclosed space
(3) Not as in (1) or (2), and for which a respirator is required for application by the pesticide product labeling	Entire enclosed space	*The ventilation criteria are met	Begins for the treated area
(4) Not as in (1), (2) or (3) and: From a height of greater than 12 in. from the planting medium, or as a spray using medium (M) or larger coarse (C) nozzles	Treated area, plus 25 ft. in all directions of the treated area, but not outside the enclosed space	Application is complete	Begins for the treated area
(5) Otherwise	Treated area	Application is complete	Begins for the treated area

* When column C of the Table specifies that ventilation criteria must be met, ventilation must continue until one of the following conditions is met:
1. Ten air exchanges are completed.
2. Two hours of ventilation using fans or other mechanical ventilating systems.
3. Four hours of ventilation using vents, windows or other passive ventilation.
4. Eleven hours with no ventilation followed by one hour of mechanical ventilation.
5. Eleven hours with no ventilation followed by two hours of passive ventilation.
6. Twenty-four hours with no ventilation.

For example: When a pesticide is applied as a smoke, mist or fog, or as a spray using extra fine (XF), very fine (VF) or fine (F) nozzles, workers and other persons other than appropriately trained and equipped handlers, are prohibited in the entire enclosed space until the ventilation criteria are met. After the ventilation time has expired, the restricted-entry interval begins for the entire enclosed space.

A1: Since fumigants are primarily inhalation hazards, the ventilation time counts down along with the product's REI. If a fumigant had an REI of 48 hours, and the grower chose to ventilate for 24 hours without ventilation, they must still wait another 24 hours because the REI is 48 hours total. If the fumigant had an REI of 12 hours, and the grower chose to ventilate with 11 hours of no ventilation, followed by one hour running the fans, then they would have to wait one more hour to re-enter.

A2: The REI is delayed for non-fumigants because they're considered a residual contact hazard. For a product with an REI of four hours, sprayed in an enclosed space with a Fine nozzle, the grower would need to ventilate the entire space by any of those methods listed above before the REI would actually start ticking. If a grower chose to wait 24 hours without ventilation, then that REI is effectively 28 hours.

A3: Products that require a respirator usually have smaller droplet sizes. This increases inhalation hazard while spraying, but once dried and the air ventilated, the product would have a lower airborne likelihood from mechanical forces. An applicator/handler uses a respirator to protect themselves for the potential of inhalation due to mixing/loading/application methods used. No one is allowed into the entire space until it is vented. Then, the REI applies to just the treated area to limit residual contact activity of products.

A4: If the grower used Medium nozzles using the same product as in the A2 example, then only the 25 ft. around the treated area would need to be ventilated before the REI kicks in. For greenhouses, a "treated area" can be as small as one plant.

If the Restricted-Entry Interval (REI) of the product is greater than four hours (in an enclosed space) or 48 hours (in an outdoor space), a warning sign must be posted for all applications. If the REI is less than or equal to four hours (in an enclosed space) or 48 hours (in an outdoor space), workers can be notified with either an oral warning or a posted sign. Employers must also post application locations when a label requires "dual notification" regardless of the stated REI.

HOW DOES A REGULATING AGENCY DEFINE A GREENHOUSE?

Each State Department of Agriculture can define what a greenhouse is for their regulatory purposes. The Michigan Department of Agriculture and Rural Development (MDARD) defers to the Worker Protection Standard (WPS) for its definition of a greenhouse.

The most recent update to the WPS has termed it "enclosed space production" and defines it as "production of an agricultural plant indoors or in a structure or space that is covered in whole or in part by any nonporous covering and that is large enough to permit a person to enter." So if a pesticide label doesn't allow its use in an "enclosed space production" area, then you cannot use it in a poly film hoophouse, even when the sidewalls are rolled up and end walls are open.

EPA anticipates that most greenhouses, hoop houses, high tunnels and similar structures will fall within the definition of enclosed space production, but a final determination will be made on a case-by-case basis, applying the parameters of the definition to each situation.

Some operations will use "shade cloth" during certain production/market phases. Shade cloth used within a greenhouse would be subject to the "enclosed space production" procedures. Where "shade cloth" is the sole "covering," the employer will need to determine if the particular material is porous or nonporous.

In addition, there are "porous" versions of Polyethylene (PE), Polypropylene (PP), Polyvinylidene fluoride (PVDF), Polytetrafluoroethylene (PTFE) and Ethyl Vinyl Acetate (EVA). As there hasn't been guidance issued on these materials, consider the traditional greenhouse structures to be "enclosed space production" areas.

WORKER PESTICIDE SAFETY & GREENHOUSE APPLICATIONS

Greenhouse pesticide applications require compliance with re-entry and spray notification regulations under the WPS. The table on page 29 is modified from the "How to Comply with the 2015 Revised Worker Protection Standard" manual and identifies the entry restrictions when applying pesticides for enclosed space production to ensure workers and other persons aren't exposed to the pesticide(s) being applied. The restrictions depend on the types of pesticide(s) or application method used. Read the table by starting in Column A and following the scenario to Column D.

BEN PHILLIPS is Vegetable Extension Educator at Michigan State University in Saginaw, Michigan, and **CRAIG ANDERSON** is the Agricultural Labor and Safety Services Manager with the Michigan Farm Bureau.

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Reader Service Number 215

Pesky Pot Pests

by **DR. BRIAN CORR**

Cannabis plants are relatively free of arthropod pests (insects and mites), but can develop infestations that can range from a nuisance to the cause of serious reductions in quality and yield. Although there are many potential pests of cannabis, this article focuses on general prevention strategies and the two most problematic pest categories: mites and root aphids.

Control of pests begins with exclusion of pests. Any plant material brought into the production site should be inspected for pests. If pests are found, the best choice is to discard the new plant. Regardless of whether any pests are found, incoming plants should be treated with pesticide and kept in isolation for at least three weeks to watch for pests or signs of damage from pests.

Exclusion is also a day-to-day activity. Air inlets should be screened with thrips-proof screens (choose appropriate ventilation fans to overcome the resistance of the screens). Screens that excludes thrips will exclude most other pests.

Employees and visitors can inadvertently bring in pests on their clothes. Some employees may be growing cannabis at home, with pests in their private grow. Employees should change into a clean uniform when they arrive. Ideally, visitors shouldn't be allowed if they've visited another cannabis facility that same day. However, inspectors and sales people often visit multiple facilities in a day. For that reason, all visitors should cover their clothes with a full-body Tyvek suit.

MONITORING

After exclusion, the second most important part of any pest control program is monitoring. Some pests can be observed on sticky cards hung just above the crop, but non-flying pests won't be found on cards. For this reason, a routine, weekly monitoring of the crop should be done. There should be an inspection pattern with a checklist of representative locations evaluated to ensure the entire growing area is evaluated.

Evaluations and sticky card counts should be recorded to watch for trends, both short term and long term. The palest ink is better than the best memory.

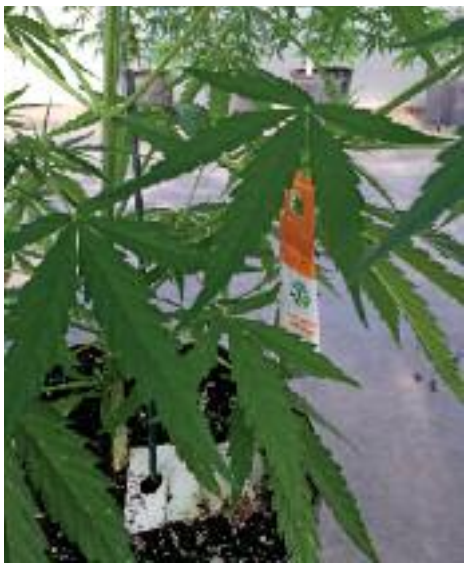

Photo courtesy of Koppert Biological Systems.

Figure 1. Sachet in the plant canopy designed to protect predatory mites as they're released.

Photo courtesy of Koppert Biological Systems.

Figure 2. Russet mites on the underside of a cannabis leaf. Note the size relative to the developing trichomes.

CONTROL MEASURES

Because the U.S. EPA cannot approve pesticides for cannabis, most states with cannabis regulations have taken conservative approaches to allowable pesticides, only allowing the safest pesticides.

Since pesticides are limited, many cannabis growers combine biological control agents (BCAs) with compatible pesticides or use BCAs exclusively. Introducing BCAs in the mother stock area is good practice—not only does this prevent development of problems, stock plants have few trichomes. Sticky trichomes can limit movement of predatory BCAs, limiting activity later in the crop.

Biological control agents can be released in different ways, but controlled-release sachets are particularly effective. Some are designed specifically to release the BCA over an extended time. Other sachets are made to keep the BCA moist and cool, an important characteristic in bright and warm cannabis crops (Figure 1).

MITES

As a group, mites are the most troublesome pest in cannabis production. Even the biggest mites are difficult to see and the smallest mites are essentially invisible without a strong hand lens or binocular scope. By the time damage is evident, control is difficult because of the numbers present and because mites are often in leaf axils or the flowers, making it difficult for pesticides or biological control agents to reach the mites.

Twospotted spider mites *(Tetranychus urticae)*—Although these mites are visible without magnification, they're often not noticed until the webbing they spin is seen on and between leaves. These mites prefer hot and dry conditions, often found in cannabis production. As the mites feed, they insert their mouthparts into plant cells, resulting in stippling and yellowing. Twospotted spider mites affect many plant species and therefore are found wherever plants are found.

Photo courtesy of Chris Freeman, Bioline Agrosciences.

Figure 3. Leaf discoloration and curling caused by russet mites.

Photo courtesy of Chris Freeman, Bioline Agrosciences.

Figure 4. Sachets used in propagation must protect the predators from excessive moisture.

Photo courtesy of Chris Freeman, Bioline Agrosciences.

Figure 5. Root aphids on cannabis roots.

Broad mites *(Polyphagotarsonemus latus)*—Broad mites are very small, about half the size of twospotted spider mites. Most people require at least a hand lens to see them. They're usually identified by the damage they cause, not observation of the mite itself. Damage is typically seen on new leaves, which become distorted, twisted or thickened, often curling in from the edges. Flowers can be affected as well. In a severe infestation, new growth is completely killed. In comparison to twospotted spider mites, broad mites prefer higher humidity and will develop at lower temperatures. Broad mites also affect a wide range of plant species.

Hemp russet mites *(Aculops cannabicola)*—Unlike the other two mites, this mite is specific to cannabis. About the same size as a broad mite, most people cannot see them without magnification (Figure 2). They feed on leaves, flowers, meristems, and notably, trichomes, reducing resin production. The damage is almost always seen before the mite—leaf bronzing, leaf curl, and in severe cases, death of the meristem (Figure 3).

MITE CONTROL

More than any other pest, exclusion of mites is critical. Although mites can be carried on the wind, the most common means of introduction is on plants brought from another source or on the clothing of someone entering the production site.

Mites, especially broad and russet mites, work into crevices in the plants, making it difficult for pesticides or biological control agents to reach them. For that reason, plants with a severe infestation should be bagged and destroyed, since it's unlikely the pests can be eliminated in a reasonable time.

The predatory mites *Amblyseius andersoni, Amblyseius cucumeris* and *Neoseiulus (Amblyseius) californicus* can help control broad and russet mites. *Amblyseius swirskii* is reported to be effective in some reports and not in others. *Amblyseius andersoni* and *Phytoseiulus persimilis* are helpful for control of twospotted spider mites. (Check with your biological control agent supplier for the most up-to-date recommendations.)

In many states, entomopathogenic fungi such as *Beauveria bassiana, Metarhizium anisopliae* and *Isaria (Paecilomyces) fumosoroseus* are approved for use on cannabis.

These fungi and predatory mites cannot control a severe infestation, and therefore, must be used preventatively, or at least at the first signs of an infestation. Ideally prevention starts during propagation (Figure 4).

When allowed by state regulations, azadirachtin, citric acid, oils, pyrethrins, soaps and various essential oils can be sprayed for control of mites. The essential oil derived from rosemary is reported to be especially effective. Thorough coverage is required or control will be limited.

A unique aspect of mite control is that it's important to also control insects to control mites. Some mites can hitch a ride on insects like whiteflies to get from one plant to another.

ROOT APHIDS

The second troublesome category of cannabis pests is root aphids. Although there are aphid species that can affect the leaves and stems of the plant, root aphids (presumably *Pemphigus* sp.) are the most problematic. Because root aphids are out of sight on the roots, they often go unnoticed until the population becomes significant. Usually the first sign of problems is unexplained poor growth, which looks very much like nutrient deficiency.

When roots are examined, root aphids can still be missed, since they're dark or covered with a waxy protection. They're often misidentified as mealybugs or even components of the growing medium (Figure 5). Watch for crawlers emerging from the growing medium or out of the drainage holes during irrigation.

Like mites, exclusion of root aphids is critical, since established root aphids are very difficult to eradicate. Most enter on plants, though winged root aphids can enter through unscreened air intakes. The winged adults may be found on sticky cards and can be confused with fungus gnats, but have shorter legs and stouter bodies.

If allowed, the entomopathogenic fungi *Beauveria bassiana, Metarhizium anisopliae* and *Isaria (Paecilomyces) fumosoroseus* are reported to be effective against root aphids when drenched to saturate the root ball. There are no reports of predator mites or insects being effective against root aphids.

Drenches with pesticides are sometimes recommended for root aphids, but for the commonly allowed pesticides, the rates required are typically close to phytotoxic levels.

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.

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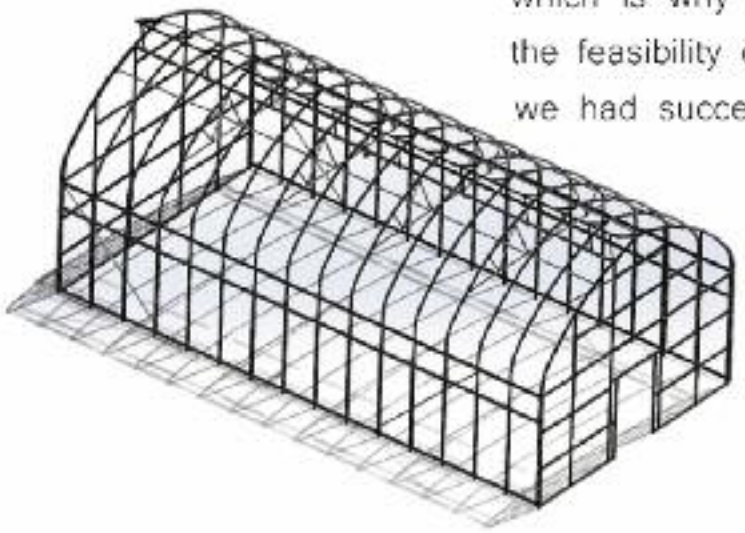

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