insideGROWER
CONTROLLED ENVIRONMENT AGRICULTURE
June 2017

Growing in Space

NASA and other researchers show that growing plants in the cosmos is a real possibility, p. 12

PAGE 24
A possible fungi opportunity

PAGE 28
Highlights from the 5th annual Indoor Ag-Con

PAGE 30
Nutrient deficiencies in arugula

PRO-MIX®

NOTHING SAYS GROWING MEDIA BETTER™

MP MYCORRHIZAE™ ORGANIK™

PRO-MIX MP MYCORRHIZAE ORGANIK provides the perfect solution for growers in need of an organic-certified growing medium that delivers well balanced air/water qualities. Enriched with mycorrhizae, this growing medium will not only improve the overall growth and increase yields of your crops, it will also increase plants' resistance to environmental stresses.

PROVEN RESULTS†

+150% DRY WEIGHT

BROCCOLI
MP MYCORRHIZAE ORGANIK

+82% DRY WEIGHT

TOMATO
MP MYCORRHIZAE ORGANIK

† Results obtained from independent plant growth trials. Individual growth results may vary to a degree. Additional results and details are available.

1 800 667-5366
VISIT **PTHORTICULTURE.COM**

Reader Service Number 200

ALYSSUM TO ZUCCHINI

NEXUS HELPS YOU GROW

Trust the Nexus team of experts to provide turnkey solutions that deliver the ideal growing environment for ALL your crops. Whatever you need – heating, cooling, lighting, curtain systems, insect control, benches, irrigation and fertigation systems, growing systems and environmental control systems.

NEW CROPS. NEW NEEDS. NEW OPPORTUNITIES.
NEXUS GROWS WITH YOU.

allied 4040

www.nexuscorp.com | 800.228.9639

NEXUS GREENHOUSE SYSTEMS
LEADERS IN GREENHOUSE SYSTEMS INTEGRATION®

Reader Service Number 201

Geeking Out

I've written a lot of cool stories over my years as a newspaper general assignment reporter and as a trade magazine editor in horticulture. However, I have to say, this month's cover story may top them all.

I'm not ashamed to admit I'm a total geek, and I have strong love of all things sci-fi and fantasy. I'm not picky either—Star Wars, Star Trek—I love it all. And right now, I feel like we're in a golden age where sci-fi meets fantasy meets reality and we're *this close* to breaking through the barriers that keep us grounded on Earth.

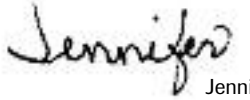
Don't get me wrong, I love this planet. But space—that's where dreams are made. And the infinite possibilities of space and time are within decades of being explored. NASA had set its sights on manned missions to Mars by 2030s and that's what prompts our cover story today.

There are numerous challenges in long-range, manned missions to the Red Planet, as well as upon touch down. While it's likely food will be prepackaged the way it is currently on the International Space Station, researchers are doing the heavy lifting now to make sure astronauts will have access to fresh fruits and vegetables that can be grown easily on spacecrafts and on Martian soil. Mark Watney's famous potatoes from "The Martian" won't be the only delicacy in this adventure—think leafy greens, tomatoes, green beans, radish, legumes and quinoa. The food serves two purposes: to provide supplemental nutrition and to give astronauts on the long journey something to remind them of home. Food is good for the soul, after all. Turn to page 12 to learn more about how researchers are growing food in space and what the implications are back home.

We're not just making advances in space, though. Researchers right here on the mothership are continually working to give growers better information about their crops, including those at Cornell University. Neil Mattson and Tanya Merrill provide us great data about how to spot nutrient deficiencies in arugula, something that's popular but understudied in the leafy green segment. You'll find that research on page 30. If it's strawberries you're interested in, work is being done there to improve yield and size with less nitrogen. Check out that story on page 20.

It's always great to look at growing from a different perspective, too. John Bonner of Great Lakes Growers brings a unique perspective to hydroponic lettuce and herb growing from his days working at his family's ornamental flowers greenhouse. Get his take on growing on page 22.

It's different perspectives that help us grow and expand our horizons. Maybe someday we'll be looking at Earth from a unique perspective: via a starship window. Hey, one can dream, right?



Jennifer Polanz
MANAGING EDITOR-AT-LARGE
feedback: jpolanz@ballpublishing.com

June 2017

insideGROWER

CONTROLLED ENVIRONMENT AGRICULTURE

A Friend Remembered
G. Victor Ball, Editor from 1949–1997

GrowerTalks general offices are located at:
PO BOX 1660, West Chicago, Illinois 60186 U.S.A.
PH: 630.231.3675 **FAX:** 630.231.5254
TOLL-FREE: 1-888-888-0013
www.growertalks.com

BALL PUBLISHING

GrowerTalks (ISSN 0276-9433) is published monthly by Ball Publishing, PO Box 1660, West Chicago, Illinois 60186, United States. Subscriptions are free to qualified readers in the US. Subscription price for non-qualified readers is $35 per year US and Canada. All other foreign subscriptions must pay $99/year to receive/continue to receive *GrowerTalks* and *Green Profit*. *GrowerTalks* is a registered trademark of Ball Horticultural Company in the U.S. Periodicals postage paid at West Chicago, IL and at additional mailing offices. Postmaster: send address changes to *GrowerTalks* Magazine, PO Box 1660, West Chicago, Illinois 60186, United States.
Printed in the U.S.A.

GreenProfit Supplement Enclosed

ON THE COVER

This zinnia isn't hanging from wires; it's floating in microgravity at the International Space Station. (For real!) We spoke with experts at NASA and researchers who are studying how growing plants in space can not only supplement the diet of astronauts, but help us be more successful growing food here on Earth

Photo Credit: NASA Kennedy Space Center

DEPARTMENTS

FEATURES

NatureFresh Farms announced in April that it will build a new 106,000-sq. ft. distribution center in Leamington, Ontario, in response to the demand for greenhouse-grown products. The new facility is expected to be completed by mid-summer.

"The continued expansion of our operations and launch of new products is a direct result of the growth of the NatureFresh Farms brand," says President Peter Quiring in a statement released by the company. "Over the last few years, we have increased our production capacity to meet the demands of our retail partners. Our commitment to quality, regardless of season, is enabling NatureFresh Farms to be an integrated supplier 12 months a year."

The statement also said the company has outgrown the 60,000-sq. ft. distribution facility opened in Toledo last fall to service the 45 acres of greenhouse built in Delta, Ohio. That distribution center is expected to be expanded in the months to come, as well.

Mucci Farms Announces Greenhouse Expansion

Another Canadian greenhouse grower, Mucci Farms, announced its intentions to double its greenhouse space in Kingsville, Ontario, for strawberry production. The expansion to 24 acres is expected to be completed by the fall, according to a story that ran in the *Windsor Star*.

"We've been experimenting with it for the last two years, but I think finally we've got all our ducks in a line and are making some serious headway," Joe Spano, vice president of sales and marketing, told the *Windsor Star* about growing strawberries under glass. "We're getting some serious traction with this new item."

Mucci Farms first shipped greenhouse-grown strawberries to Canadian and U.S. retailers in October, and the response was strong, prompting the expansion. The story says the company partnered with Dutch growers to help them with the production process, since greenhouse-grown strawberries are quite common in Europe.

Joe told the *Windsor Star* they have enough land to continue with Phases 3 and 4 for expansion, eventually resulting in quadruple the amount of the original 12 acres of production space. An added benefit of greenhouse strawberries, he adds, is that they require no pesticides.

Staay Food Group Building First Large-Scale Vertical Farm in Europe

The Staay Food Group, a leading fresh fruit and vegetables grower in the Netherlands, is building the first large vertical farm in Europe at a location in Dronten. The facility will serve one of Europe's biggest supermarket chains and be used for testing and optimizing processes for future, larger vertical farms.

The facility will use Philips GreenPower LED horticulture lighting in its 900-sq. meter (approximately 9,688-sq. ft.) facility to be used for growing pesticide-free lettuce. Staay, Philips Lighting and vegetable breeder Rijk Zwaan collaborated and undertook extensive research over the past three years to determine the best combination of lettuce varieties and growth recipes in order to improve crop quality and yields, according to those at Philips.

"Our plant specialists at our GrowWise research center in Eindhoven are testing with seeds of a selection of the most suitable lettuce varieties, to define the best growth recipes and to optimize the crop growth even before the farm is running," says Udo van Slooten, managing director of Philips Lighting Horticulture LED Solutions.

The facility is scheduled to begin operating in the second half of 2017.

A New Look for lēf Farms

The Loudon, New Hampshire, baby greens grower lēf Farms recently unveiled new packaging with a classic black retail bag showing off the greens through a clear front window. The bags also have patented perforations to maximize shelf life.

"When you have a product that's so different than the ordinary spring mixes out there, we felt the standard clamshells and pillowcase-style bags just wouldn't do it justice," says Sales & Marketing Manager Donald Grandmaison in a statement. "Our message touts that 'fresh is right here,' so we needed to apply that thinking to everything we do. Sure, fresh is about the product, but it's also about the ideas … and even our marketing."

Build Your Greenhouse with GATORSHIELD®

- Gatorshield® Tube – Unparalleled Corrosion Protection, Superior Strength & Formability
- Fabrication – Customize tubes to your greenhouse needs
- Engineering & Design Support

No other galvanized tube manufacturer demonstrates the product portfolio or 40+ years of experience in greenhouse structures offered by Allied Tube & Conduit.

allied TUBE & CONDUIT®

800.882.5543
atc-mechanical.com

[atkore] [AtkoreInd] [AtkoreInternational]

A PART OF atkore

Reader Service Number 202

Top Organic Products: The Winner Is ...

According to Nielsen, organic purchases are growing. Based on U.S. sales over 52 weeks ending July 30, 2016, volume sales of products with an organic claim rose 13%. So what's most popular when it comes to organic? Pre-packaged salads came out on top, followed by berries and apples. Chicken came in fourth and herbs, spices and seasonings rounded out the Top 5.

Carrots, beverages, bananas, value-added vegetables and lettuce filled out the rest of the list, in that order. I find it interesting that lettuce came in 10th, but pre-packaged salads came in first. So it's not just the lettuce, but all the salad necessities ready for eating that ranked the highest. We're truly living in an age of convenience.

Fighting Two-spotted Spider Mite

Biobest recently released information about how to control and knock down a two-spotted spider mite outbreak on greenhouse-grown cucumber. Not addressing the situation early can lead to major crop damage, according to the release, which goes on to state Biobest recommends a multi-pronged approach for optimal control.

"A resourceful pest, spider mite can survive cool winter conditions by hibernating in the glasshouse frame, making thorough disinfection between crop cycles prudent," says Pascal Briand, IPM and pollination specialist at Biobest.

As days lengthen and temperatures rise, spider mites become more active. Early detection is key. However, unlike flying pests—such as whitefly, aphid and thrips—spider mite cannot be reliably monitored using sticky cards. To detect symptoms, close crop inspection involving the whole plant (see picture), is essential. The pest generally appears first in hotspots—in warmer and dryer parts of the glasshouse.

FarmedHere Shuts Down

FarmedHere, a large warehouse growing business in the Chicago suburbs, has closed its doors.

Here Holdings, the parent company of FarmedHere, cited high labor and energy costs and increasing competition in the Chicago market as the reason they decided to cease operations. The business was founded in 2011 in Bedford Park and was quickly touting itself as America's largest indoor farm.

Certainly, at $23 million for a 90,000 sq.-ft. warehouse with five layers of growing beds, the square-foot cost was through the roof compared to greenhouse production. Pair that with the cost of operating the lights and the aquaponics system that provided nutrients to the crop, and you can see that it's an expensive way to grow greens and herbs.

We featured FarmedHere on the cover of the September 2014 *Inside Grower* magazine. I asked tough questions of then-CEO Mark Thomann; to his credit, Mark had good answers that almost had us believing they could make it work. But the *Chicago Tribune* reported that last year, FarmedHere had hit the point where it either needed to get bigger to offset the high production costs or get out of growing and focus instead on making branded products.

Current CEO Nate Laurell told the *Tribune*, "The more I learned about the reality of farming, it led to a change of strategy. We continue to be big believers in the (local food) space."

(By the way, Nate replaced Matt Matros, who replaced Mark Thomann; perhaps that leadership turnover was a sign of the challenges facing the business ...?)

The branded products, to be produced at Here Holding's food processing plant in Carol Stream, Illinois, will be under the Here brand and will feature juices, salad dressings and spreads made with product grown by other local farms such as MightyVine, a big new hydroponic greenhouse range located in north central Illinois. —*Chris Beytes*

No more West Louisville FoodPort

The demise of FarmedHere has a trickle-down effect. A while back, FarmedHere had announced that they'd be opening a second location in Kentucky at an interesting place called West Louisville FoodPort. They'd be the anchor tenant in a $55 million, 24-acre food, education and entertainment complex. But developer Stephen Reily pulled the plug on that project when FarmedHere withdrew last August due to "internal financial problems," according to *Louisville Business First*.

Stephen told the publication that the setback reflected the gap between the excitement surrounding indoor farming and the much harsher current reality for the still-budding industry.

Standards for Cannabis?

ASTM International (the largest voluntary standards developing organization in the world), announced in March it would launch a new committee focused on creating technical standards and guidance materials for cannabis, pending final approval from its board of directors.

About 60 industry representatives, associations and others convened on February 28 at ASTM International's global headquarters in Philadelphia and decided to create a volunteer committee on cannabis. The committee plans to focus on standards development in six technical areas (which will be subcommittees):

- Indoor and outdoor horticulture and agriculture
- Quality management systems
- Laboratory
- Processing and handling
- Security and transportation
- Personnel training, assessment and credentialing

"With its decades of experience in industries such as pharmaceuticals, medical devices, packaging, agriculture, pesticides and more, ASTM International is the perfect place for standards development for the cannabis industry," says Dr. Ralph Paroli, immediate past chairman of the board, and director of R&D in measurement science and standards at the National Research Council of Canada. Dr. Paroli was voted to serve as the committee's first chairman.

Custom Control Solutions | **Intelligent** Monitoring and Alarms | **Comprehensive** Data Acquisition and Analysis | **Nutrient** Management System | **Remote** Access and Control

Multi-Feed RM Nutrient Injection System

ADVANCED Climate Control Systems

Argus provides advanced climate control systems that are customized to each grower's requirements - and are adaptable to their changing needs - enabling them to operate their facilities exactly the way they want.

To learn how we can customize a solution for you, contact sales@arguscontrols.com or visit **www.arguscontrols.com**

ARGUS CONTROLS

Reader Service Number 203

Kemin Crop Technologies Adds Sales Manager

Kemin Crop Technologies has named Brett Cranston sales manager, responsible for the direct sales of Kemin products to commercial hort operations focusing on fruit and vegetable markets. The company is an initiative of Kemin Industries focused on providing solutions for commercial greenhouses and commercial horticulture.

"Brett will have the opportunity to go beyond the role of a sales manager and take a leading role in the strategic planning and evolution of the crop technologies initiative in the horticulture industry," says Riaan van Dyk, worldwide vice president of marketing and strategy for Kemin Industries. "We're excited to bring his perspective and leadership to the team."

Brett comes from Extenday USA, where he served as a technical field and sales support member. He's a graduate of Iowa State University with a bachelor's degree in Agriculture Education and Agronomy.

"I'm looking forward to working closely with our customers to provide tailored solutions to their existing programs to enhance crop performance and profitability," Brett says.

Pest Scouting Best Practices

Biobest recently released information on best practices for scouting for pests in fruit and vegetable growing operations, and found sticky traps are ideal for identifying whiteflies and/or thrips.

"We recommend growers distribute around 10 sticky traps per hectare at the beginning of the cultivation process," says John van Eijk, crop protection specialist at Biobest in the Netherlands. "Many pepper growers choose to change the traps at the start of the crop, after the cleanup spray program when the pest populations have been knocked right back. Traps should ideally be hung immediately above the crop."

Growers can change the traps every two weeks to monitor for pests year-round. "Yellow traps are generally used, as the color attracts whitefly and thrips, as well as leafminers and fungus gnats," he says. "However, if the key pest target is thrips, we recommend using blue sticky traps as they are the most effective at attracting this pest."

John says routinely scouting for pests and entering pest counts in an Excel spreadsheet allows the production team to follow pest developments closely and take prompt action. He adds growers also can use rolls of sticky plastic tape, sold under the name Bug-Scan by Biobest, to catch pests in crops, such as tomato grown under artificial lighting.

The company even has a YouTube video on how to best use the rolls: www.youtube.com/watch?v=OQGD3UQCvZk.

Summer Veggie Trials in California

Here's a new event for you fans of everything vegetable, from artichokes to zucchini: Five vegetable breeders will be hosting open houses and field days at seven locations in California August 14 to 19. In fact, the Summer Vegetable Trials are now an annual event, formalized in 2015 by the National Garden Bureau (of which the five breeders are members).

Think of it as Spring Trials for edibles, where you tour trial sites, view new and existing vegetable varieties in field and garden settings, and learn about sales and marketing opportunities.

The participating breeders are:

PanAmerican Seed, Woodland
www.panamseed.com
Crops featured: Vegetables
Tel: (541) 914-5548
Trial dates: August 14-18
Appointments are mandatory, no drop-ins.
Contact: Josh Kirschenbaum

Sakata Seed America, Salinas
www.sakatavegetables.com
Crops featured: Cool crops. 2017 AAS Edible/Vegetable and Ornamental trials.
Tel: (408) 782-5379
Trial dates: August 14-16
Appointments are mandatory, no drop-ins.
Contact: Jiana Escobar

PanAmerican Seed's Josh Kirschenbaum at last year's Summer Vegetable Trials.

Sakata Seed America, Woodland
www.sakatavegetables.com
Crops featured: Warm crops
Tel: (408) 782-5379
Trial dates: August 16-19
Appointments are mandatory, no drop-ins.
Contact: Jiana Escobar

Seeds By Design/Terra Organics, Chico
www.seedsbydesign.com and www.terraorganics.com
Crops featured: Cucumber, herbs, squash, pumpkin, gourd, pepper, tomato, melon and watermelon. 2017 AAS Edible/Vegetable trial and AAS Ornamental trial.
Tel: (530) 438-2126 *for appointments on other dates*
Contact: Miles Rogers or Susan Birdseye

Seeds By Design/Terra Organics, Willows
www.seedsbydesign.com and www.terraorganics.com
Crops featured: Vine crops and 2017 AAS Ornamental trial
Tel: (530) 438-2126 *for appointments on other dates*
Contact: Miles Rogers or Susan Birdseye

Seminis/Monsanto Home Garden
www.seminis-us.com/home-garden
Crops featured: 2017 AAS Edible trial and Commercial vegetable trials
Tel: (314) 694-8052
Tours Thursday and Friday mornings, RSVP to schedule a time.
Contact: Nick Pucci

Syngenta at Syngenta Flowers, Gilroy
www.syngentafhg.com
Crops featured: In-ground and patio trials featuring tomato, pepper, squash, beans, cantaloupe and watermelon. 2017 AAS Ornamental trial.
Tel: (408) 847-7333
Dates: August 14-18
Contact: Jeannine Bogard or syngenta.flowers-1@syngenta.com

For more information about the vegetable trials or the National Garden Bureau, contact Diane Blazek at blazekdiane@gmail.com.

THE FINAL FRONTIER

The importance of growing vegetables in space and what we can learn from it here on Earth.

by Jennifer Polanz

Long-term survival in space and on other planets is becoming a very real possibility, thanks to the ongoing efforts of researchers across the globe on the ground and at the International Space Station. There are still major problems to address when it comes to long-term travel: cosmic radiation exposure, the return journey and even what to do with that pesky human waste (seriously—NASA just gave away $30,000 in a Space Poop Challenge trying to find effective ways to collect and route human waste away from astronauts while wearing a spacesuit in microgravity for six days. The struggle is real, people).

What they have started to overcome, thanks to extensive work by those researchers, are challenges related to growing food in space and on other planets. The first step is growing food while on the journey to say, Mars, which is NASA's goal by the 2030s (only 15+ years left), and then to grow food on said planet. We'll take a look at just some of the research that covers both and what we can gain from it back here on our home planet.

The ultimate controlled environment

Astronauts on the International Space Station still dine on pre-packaged food (although it sounds much healthier and tastier than the paste and freeze-dried food of older space missions). However, for the past two years, the crew on the ISS has been growing food crops, first starting with leafy greens and then adding zinnias (to test flower production) and tomatoes. The crew now has a new crop of Chinese cabbage, added in February. They grow these crops via the Veggie system, developed by ORBITEC, a Madison, Wisconsin-based high-technology development company.

"Veggie allows us to test simple strategies of food production in the same environment that the astronauts are living and working in," says Dr. Gioia Massa, Veggie project scientist for NASA at the Kennedy Space Center. "We are using Veggie for both scientific testing of plant growth in microgravity, for testing of food crops and as a garden for the crew. We are sending a second Veggie unit up this year, and that will allow us to test more crops, to try to move to more sustained production and also to test different environments in a side-by-side manner."

That system is called the Advanced Plant Habitat (APH), a larger closed-loop system with an environmentally controlled growth chamber. These experiments will test different red/blue light ratios on leafy greens and dwarf tomato plants, respectively, Gioia adds. A resupply mission delivered the APH to the ISS in April.

One major component to the initial growing experiments done on the ISS was to ensure the lettuce grown was safe to eat. Once deemed safe and edible, the experiments continued to test flowering and longer-duration growth with the zinnias. Most recently, they were testing repetitive harvest of lettuce so more lettuce was produced from a single set of lettuce seeds.

What other challenges did the crew run into?

"Truly, our biggest challenge for the duration of this project has been to adequately water the plants in space and on the ground," notes Nicole Dufour, Veggie project manager for NASA at Kennedy Space Center. "In the absence of gravity, water behaves quite differently than it does here on Earth. Since Veggie is a passive system, using no power for pumps, we are relying strictly upon capillary action to feed the water to the plants.

"In the beginning, we had issues where the plants were not getting enough water and then issues where the plants were getting too much water. We have reached an operational point now where we think we have found a way to balance the water supply to avoid those issues. Based on our experience, we are also working on a new water delivery system for Veggie that will be flown and tested within the next year."

Robert Morrow, Senior Scientist at ORBITEC, says the Veggie system was designed to be a stowable, simple plant growth system without having a significant impact on ISS resources. It's primarily an LED light cap, he says, which provides sufficient light to support good plant productivity.

"Veggie uses a bellows shaped enclosure to help maintain a relative hu-

midity level elevated in comparison to ISS cabin humidity," he explains. "To keep the system simple, temperature and atmospheric composition control is provided by flowing ISS cabin air through the system."

His challenge was more focused on providing relatively high levels of light, a reasonable growing area and some level of environmental control while not draining ISS resources, he says. "The use of LED lighting, a simple collapsible enclosure (bellows) and use of an atmospheric exchange system for environmental control allowed us to address those constraints."

So what's the end goal with this growing exercise?

"This was consciously developed as a precursor to larger salad crop production systems to be used for missions, such as Mars transit," Robert notes. Astronauts may not get their entire diet from space-grown food, but they can supplement with fresh, nutritious fruits and vegetables. According to NASA, the ongoing effort will continue to look at: seed selection for reliable germination in space, watering techniques to grow the most food with the least amount of water, fertilizer (consider its weight, which is a major concern in space transit), compactness of plants, power efficiency, quick growth and robotics to produce the most amount of food with the least amount of labor.

Once on the ground

Fast forward 25 years or so, give or take a few years. We're on the ground on Mars—now what? That's where other researchers on the ground come in, like Dr. Wieger Wamelink, ecologist and researcher at University of Wageningen in the Netherlands, and Dr. Gene Giacomelli, director of the Controlled Environment Agriculture Center at the University of Arizona and technical investigator of the Prototype Lunar Greenhouse.

Gene's crew at the CEAC has been working on perfecting the prototype for decades, beginning first by creating a recirculating hydroponic system that would grow food at the South Pole in the Antarctic. That project was the precursor for the Lunar Greenhouse, which started in earnest in 2006. About seven years ago, the project received a major boost. "NASA asked for designs to grow plants on the moon," Gene says. "We had already done it. When we wrote the proposal, we sent them a picture of the working unit.

Photo Credit: NASA Kennedy Space Center

Above: Astronauts Kjell Lindgren (left) and Scott Kelly (right) take their first bite of their harvest on the International Space Station in August 2015.

Below: University of Arizona graduate student Sean Gellenbeck stands inside the Prototype Lunar Greenhouse at the Controlled Environment Agriculture Center.

"They saw that we weren't drawing something up to begin testing; we already had a product there."

He gives full credit to the faculty, staff and students at the CEAC for their hard work on the effort, noting their experiences and expertise were critical to the Lunar Greenhouse's success.

In fact, the project was so successful in the Phase 1 portion funded by NASA's Steckler Space Grant that it received funding for two more phases. By Phase 3, the CEAC was one of five research organizations awarded money. With grant money, they worked on perfecting the 18-ft. long, 8-ft. diameter cylinder to try to meet NASA's requests: to engineer it so one cylinder could provide one astronaut with all their daily drinking/washing water, all of their daily oxygen and half their daily calorie consumption.

"That was something that had rarely if ever been done at NASA," Gene adds, noting they

Photo Credit: Univ-Arizona NASA Space Grant

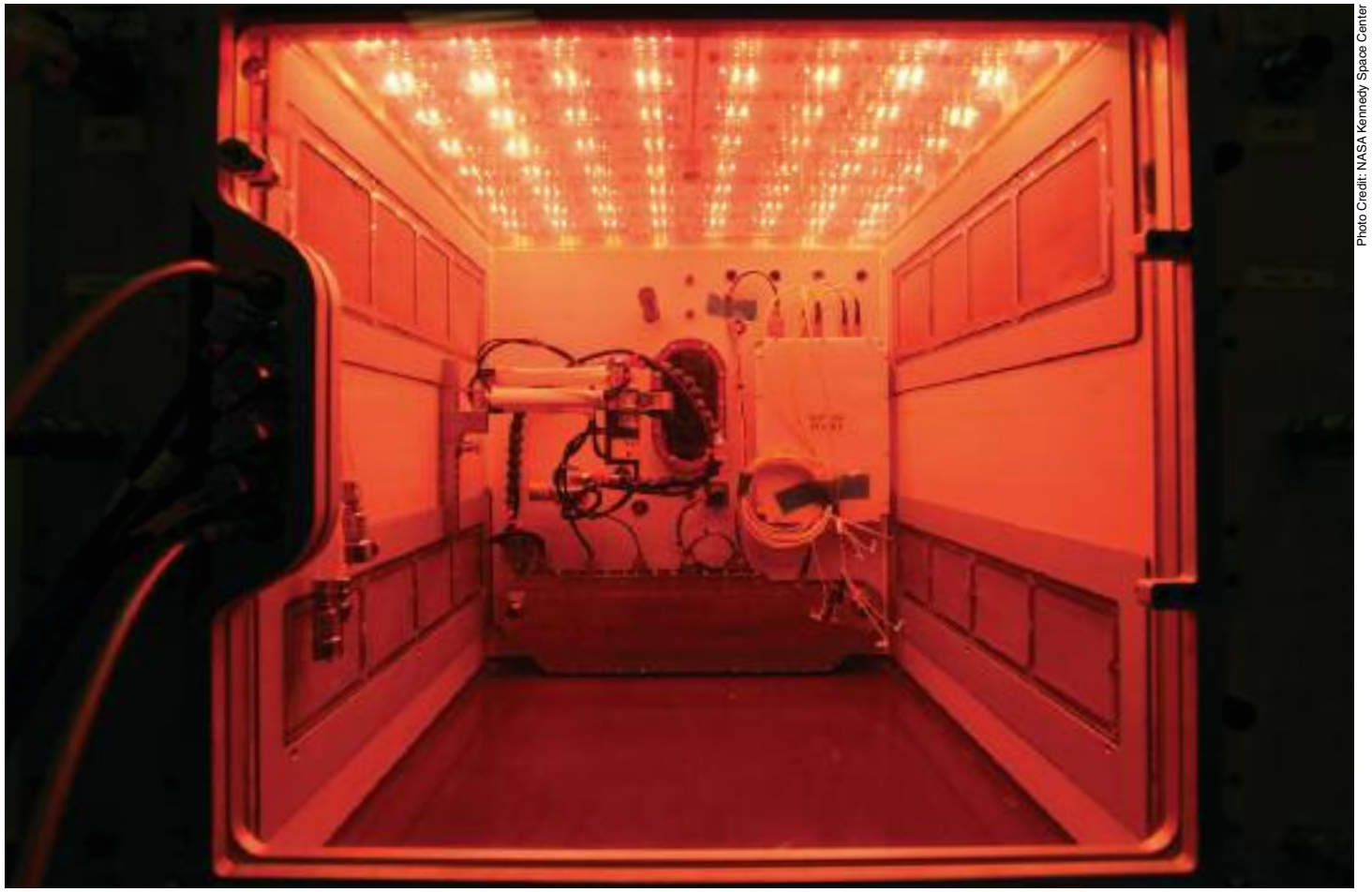


Photo Credit: NASA Kennedy Space Center

The Advanced Plant Habitat is a larger closed-loop system that was scheduled to launch with a resupply mission to the International Space Station in April.

grew sweet potato, basil, three types of lettuce, tomatoes and strawberries. "They wanted to demonstrate these plants could function in a common environment."

In the end the CEAC researchers were able to deliver on some of the requests: they could provide all of the drinking and washing water an astronaut would need, but only half of the oxygen and half of the 1,000 calories NASA wanted. While it didn't exactly get to the numbers needed, the research showed that it could be possible by experimenting with different volumes and plant types.

Meanwhile, in the Netherlands, a lifelong science fiction fan, Wieger started his research of growing plants in moon and Mars soil simulant on his own. However, it has grown to become funded by his institute, as well as via crowdfunding.

"When people travel to Mars in (the) future they will have to live there for longer periods of time," he says, explaining his fascination with the research. "They could, of course, bring along all the food they need, but it would be much tastier and more convenient to be able to grow your own food there. And if the food tastes good, the astronauts will eat more of it, which is good for their health."

He began by recreating soil from the moon and Mars from NASA's data on those soil structures. "The Mars soil we use in our experiments comes from a volcano on Hawaii and the moon soil from a desert near Flagstaff in Arizona," he says. "They cleaned it and used a big roller to roll over the moon soil to make it extra dusty, as it is on the moon."

To conduct the experiments, he uses a normal greenhouse, but in the future, he'd like to move them to a closed room to better resemble what would happen when astronauts grow food in a fully controlled environment on Mars. He's experimenting with more than 20 different plants species, including tomato, potato, rye, rocket or rucola, peas, green beans, cress, radish, quinoa and lupin, as well as legumes and green manure (growing plants to be ground up and added back into the soil as fertilizer), plus wild plants.

His results have been pretty astonishing, with a good many of the plants growing through to harvest. "After some improvements based on the results of that first experiment we were able to grow many crop species and last year had an enormous harvest, especially for the green beans and tomatoes," he says. "Besides the crops we needed for analyses, we were able to serve two meals for our crowdfunders based on the harvested crops, which tasted great."

So what challenges did Wieger run into? Similar ones that NASA found, like water and bringing useable air into a controlled environment. He added with Mars there's a different rub: toxic elements in the soils, like perchlorate.

"If they are taken up by the crops, this can cause problems, and in the case of perchlorate, even plants will not grow in it," he notes. "In the end, however, it will come down to do we have enough energy available, because everything you do on another planet will cost energy. Likely that will be solar power."

Closer to home, the Controlled Environment Agriculture Center at the University of Arizona has created a Prototype Lunar Green-

house Module (LGH) in collaboration with NASA as a way to sustain plant and human life on other planets. The LGH is "equipped as a Bioregenerative Life Support System, through the design and construction of an innovative hydroponic plant growth chamber," according to a website for the project. The idea is to launch the LGM on a mission prior to the astronauts' arrival so the system is waiting and ready to build.

Back on Earth: Takeaways

Let's head back to our home planet, shall we? How do these out-of-this-world farming experiments impact us on Earth? "We are learning about microgravity, but also about growing plants in environments with humans and with environmental conditions that aren't optimized for plants (e.g., low humidity and very high CO2)," says Gioia at NASA. "We are also learning about good combinations of LED lights and fertilizer for different crops. We share information regularly with the controlled environment agriculture community and also we learn from new findings in horticulture research and apply them to our space research."

As we stated earlier, too, these experiments focus on efficiencies—growing fast crops for maximum yield with the least amount of watering and fertilizer required. All that data can be used to help Earth-based hydroponic and other controlled environment growers hone their crops for better results. That's something Gene at the CEAC can attest to—their research has led him to think about production and harvest in terms of a formula: grams of edible food per kilowatt hour. This compares the amount of food produced to the amount of energy (mostly for lighting) required to grow the food. For example, his Lunar Greenhouse grew 26 grams of edible food per kilowatt hour. "Since we put in the new LED lights, we got up to 50 grams per kilowatt hour," he adds. "In this case lettuce, specifically.

"If someone tells me in the future about new systems, the question I ask would be how many grams of edible food per kilowatt hour so I can compare."

The labor required for any type of lunar or Mars greenhouse module will have to be minimal, as well. Gene says currently they enter the Lunar Greenhouse once a week to harvest and transplant lettuce, that's it. "NASA doesn't want astronauts to be farmers," he says, adding their greenhouse is run via the environmental controls with minimal maintenance.

Another aspect of the NASA research focuses on studying stress responses in plants, or in other words, how they turn genes on and off. "This fundamental plant biology knowledge could lead to more drought- and disease-tolerant plants, which is good for both Earth and space," write the folks at NASA in a publication called "Growing Plants in Space."

Wieger's research in the Netherlands also has some important ramifications for farming and CEA throughout the world: "We are not there yet, but there are some aspects that in the new future may improve crop growth on Earth," he says. "We are working with simulants, coming from a desert and desert-like situation. What we are actually learning is how to grow crops in desert sand and this may help agriculture on Earth by making desert-like situations green again."

All of this research to head to distant parts of the galaxy also makes for a brighter future right here on Earth.

Helping the World Grow

Horticulture industry members who participate in the Farmer-to-Farmer program transform families and communities in developing countries.

by **DAVID KUACK**

Farmer-to-Farmer volunteers work with people in developing countries to help them improve productivity, access new markets, build local capacity, prevent climate change and conserve natural resources. ● Farmer-to-Farmer volunteers trained small holder farmers in Jamaica to grow organically, how to receive organic certification and how to get their products to market.

Volunteers for Economic Growth Alliance (VEGA) has a network of more than 100,000 highly skilled volunteers that partner with the U.S. Agency for International Development (USAID) to spur economic growth in developing countries.

VEGA, which has been operating since 2004 and is based in Washington, D.C., is a consortium that brings together 29 member non-governmental organizations. These organizations include Cultivating New Frontiers in Agriculture, Land O'Lakes International Development and Winrock International, as well as organizations affiliated with educational institutions such as Arizona State University and Purdue University.

"VEGA's membership is made up of a range of different types of organizations, but all of them come together through VEGA to focus on economic growth as a real driver for international development," said Angela Canterbury, managing director of communications and advocacy at VEGA. "The concept behind the type of person-to-person diplomacy, peer-to-peer training that we do through VEGA is to teach individuals, families and business people the skills they need to improve their own livelihoods. It transforms families and it transforms communities. We think the partnership we have with the U.S. government in delivering really effective foreign assistance is unique in a lot of ways. We add value through American ingenuity, skills and the generosity of volunteerism, which very much puts forward the best of American values in these partnerships.

"VEGA partnerships have generated economic growth in 46 countries through 58 different programs. The alliance has saved at least $31 million taxpayer dollars through volunteer time alone. VEGA is good value for the U.S. government and the U.S. taxpayers and it really delivers results."

BENEFITS FOR VOLUNTEERS, COUNTRIES

All of the VEGA programs are conducted outside of the United States in the developing world.

"We have something we call 'Volunteer Impact 360,'" Angela said. "Even though these programs take place in other countries, volunteers come back with skills that benefit their careers and communities. These volunteers bring back stories of relationships that they made, and inspire neighbors and colleagues to also volunteer. Sometimes it leads to more trade and business opportunities for people here and abroad. ▶

As Easy As 1-2-3

1. Fit the pinion

2. Snap the housing

3. Push the rack

The new EZD 52 rack & pinion

- → Quicker installation
- → Quicker change
- → Compatible with existing types

Find out more at Cultivate'17, booth 1429

Reader Service Number 208

www.lockdrives.com

LOCK BEWEGT // LOCK MOVES

"Most of the assignments are short term—generally less than a year. The average assignment is three to four weeks. VEGA volunteers are embedded into full scale development programs. However, it often is the case that relationships that are made go far beyond the assignment."

Feed the Future is the U.S. government's global hunger and food security initiative and has programs in several countries. Feed the Future is an Obama Administration initiative that was put into law in 2016 by Congress through a bill called the Global Food Security Act.

"Feed the Future comes with a lot of lessons learned and best practices for how to implement really effective foreign assistance," Angela said. "Part of that is measuring success and measuring impact of technical assistance. Some of these programs also utilize the peer-to-peer training that is core to VEGA."

Angela said the programs VEGA is involved with are focused on economic growth, ranging from agriculture, financial services, local capacity building, supporting small- and medium-size businesses, youth employment and women's empowerment.

"There is a whole range of different types of economic growth programming and food security is a large part of our programming," she said. "Food security is the baseline. Creating food security is the first critical step to building economic growth around the globe. Everyone needs to eat. The people who we work with in other countries need the skills we've cultivated over centuries, but also face unpredictable circumstances delivered by Mother Nature, just like farmers in the United States."

VOLUNTEERING FOR F2F PROJECTS

People interested in volunteering for F2F projects should fill out a volunteer interest form at farmer-to-farmer.org. You can also call (202) 223-7012 or email f2f@vegaalliance.org.

FARMER-TO-FARMER PROGRAM PARTNERSHIPS

VEGA manages the Farmer-to-Farmer Special Program Support Project (SPSP), a component of the worldwide Farmer-to-Farmer (F2F) program, which promotes sustainable economic growth, food security and agricultural development worldwide. F2F was initially authorized by Congress in the 1985 Farm Bill. It was designated as the John Ogonowski and Doug Bereuter Farmer-to-Farmer Program in honor of one of the program's pilots killed in the September 11, 2001 terrorist attacks, and former Congressman Bereuter, who initially sponsored the program.

"Typically, every five years, Congress reauthorizes this program through the U.S. Farm Bill," said Angela. "Reauthorization is coming up again in 2018. Over the course of 30 years, the program has mobilized more than 16,700 volunteers and sup-

One of the Farmer-to-Farmer projects helped Jamaican farmers to develop a natural farmers market to serve as an outlet for organic products. ● Measurable results from Farmer-to-Farmer programs include increased crop yields and bringing new crops to market.

ported nearly 12,000 organizations in 112 developing countries, assisting more than 1.2 million people with peer-to-peer technical assistance."

American F2F volunteer experts work with people in developing countries who seek to improve productivity, access new markets, build local capacity, prevent climate change and conserve natural resources.

MAKING A DIFFERENCE THROUGH F2F PROJECTS

F2F program director Laura Alexander said VEGA and the organizations involved with the F2F program are always looking for new recruits.

"VEGA and the other implementing organizations look for volunteers with specific skills and experience based on the projects, the targets and the impact that is desired," she said. "There is a very wide range of expertise that is sought. Knowledge about horticulture, production, the supply chain, engineering, marketing, business skills—there is a whole range of expertise that is needed to operate an agri-business.

"The volunteer exchange is really important and results in very special individual experiences. There are measurable results from these programs, such as increased yields and bringing new crops to market. There is an additional value in the relationships created between volunteers and the organizations they support."

Laura said one of the projects funded by SPSP is establishing an organic farming program in Jamaica.

"There has been a lot of demand from the tourist industry, visitors to the country, as well as Jamaicans, for organic agricultural products," she said. "This project has trained small holder farmers to grow organically. Volunteers worked with the farmers on how to receive organic certification and how to get their products to market.

"They created a natural farmers market called Ujima to serve as an outlet for organic products. Producers started a biweekly market with eight vendors three years ago. Since then, the market has expanded to 27 vendors with more looking to participate. They have plans to expand to a weekly market because of the demand. They are also considering moving to a larger location. Volunteer technical assistance helped make this project a success. A lot of agricultural experts volunteered to teach organic farming practices, but they also had marketing experts who advised them on starting the farmers market."

Another F2F SPSP project involves sanitary and phytosanitary (SPS) issues in Ghana.

"Their horticultural products are in very high demand especially in Europe," said Laura. "But because of SPS issues, an export ban was placed on certain agricultural products. The F2F project works directly with small holder farmers to improve their agricultural practices to reduce SPS issues. The project is also working extensively with the government of Ghana to implement a traceability system to build confidence in export certification systems."

DAVID KUACK is a freelance technical writer in Fort Worth, Texas; dkuack@gmail.com.

Strawberry Yields

Reduce total nitrogen and increase your strawberry harvest.

by **MARK F. FREEMAN**

Most growers recognize that an increase in fertilizer can increase yield. Although there's a point of diminishing returns and an eventual threshold with crop risk, there are endless crop recommendations that show increasing fertilizer applications can increase a grower's profits. Common sense does weigh in when they recognize that some of these recommendations are also driven by fertilizer companies. In addition, regulatory constraints on runoff are becoming prevalent as districts continue to get more stringent, many of them carrying large penalties for abuse.

Continuing evidence of nutrient use efficiency (NUE) being improved through applications of both synthetic and organic supplements has stimulated the emergence of another category of tools to the grower that may eventually be called "biostimulants." Currently, these products are only legally referred to as Beneficial Substances according to the Association of American Plant Food Control Officials until they complete the arduous process of developing subcategories.

Efficient practices for growers evolve season by season and nutrient use is only one aspect. The steady increase of greenhouse and tunnel production for food crops throughout the world shows how much growers will invest in production systems that are more efficient. These systems typically incorporate high technology irrigation and frequently also include new substrates for soil and possibly containers.

This article focuses on containerized strawberry production systems that are expected to be part of the high-efficiency future with labor-saving robotics and predictable harvests that only controlled environment agriculture can create.

Yield trials

Containerized strawberry yield increased 46% over grower standard with half the total nitrogen in a recent research study conducted by Holden Research and Consulting in Ventura, California. This study showed that these results were achieved with only three soil applications and three foliar applications of products based on the proprietary Oilseed Extract (OSE) technology used in Nature's Source Professional 10-4-3 and Nature's Source Organic Plant Food 3-1-1.

Three foliar applications of OSE were performed using Nature's Source Organic Plant Food 3-1-1 mixed at approximately 750 ppm N (1 gal. per acre in 50 gal.) on both OSE-treated crops. Initial treatment was three weeks after planting with the following applications another three weeks apart. The soil applications of OSE were applied through the drip irrigations with Nature's Source Professional 10-4-3 at either 2 gal. per acre—half rate—or 4 gal. per acre.

Grower standard (UTC treatment) was based on the pre-plant controlled-release

Table 1: Nature's Source Materials in Strawberries–Ventura County, Fall 2015
Cumulative Marketable Production by Pick Day

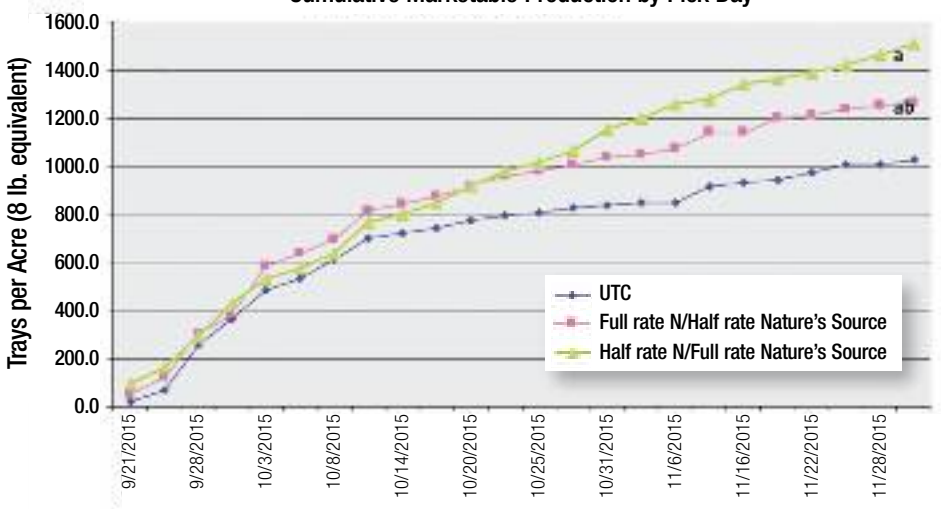
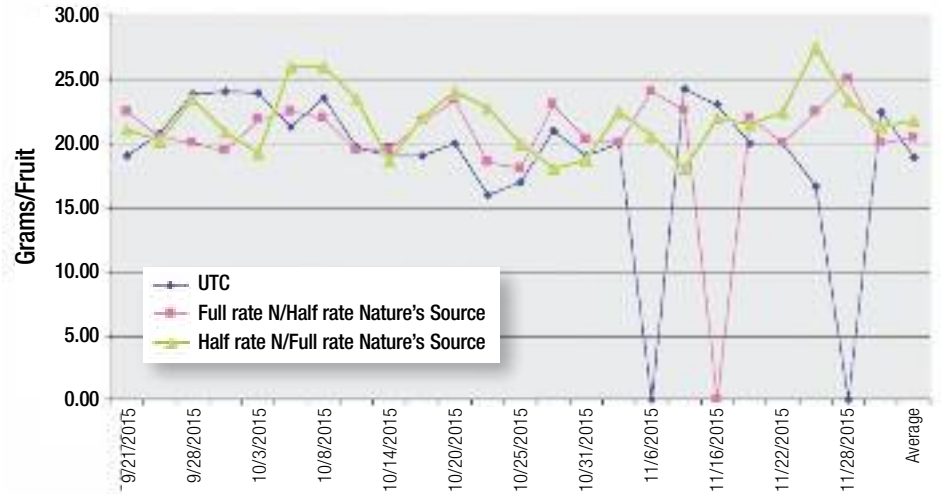


Table 2: Nature's Source Materials in Strawberries–Ventura County, Fall 2015
Mean Weight per Marketable Fruit



fertilizer (CRF) 22-7-10 rate of 500 lbs. of nitrogen per acre. The UTC treatment also included CAN-17 applied at 5 gal. per acre seven times through the crop cycle approximately three weeks apart. The half rate is 250 lbs. of nitrogen per acre of CRF with CAN-17 applied seven times at 2.5 gal. per acre.

Table 1 exhibits cumulative production extrapolated to trays per acre. The half rate of nitrogen program with OSE had a total of 1,507 trays compared to the grower standard untreated control (UTC) total of 1,027 trays—a 46% total yield increase. The center line within the chart exhibits the full rate of nitrogen and the impact of a reduced rate of OSE.

This reported yield increase was strongly related to increased average berry size, which was 21.8 grams using the half rate of nitrogen with OSE compared to 18.9 grams in the grower standard—an increase of 15% in average berry size (Table 2). Although larger berries can typically bring a greater price, this market value increase was not included within this study's calculations.

Containerized strawberry production practices are still being developed and growers who plan to implement these systems must maximize the yield potential by using the latest technology in nutrition to complement their major investments. The return on these investments is heavily dependent upon labor savings, which has already driven breeders to select traits for strawberry varieties with longer peduncles so the berries present better for harvest. Plant nutrition technology, like OSE, amino acids and other extracts, will play a role not only in increasing yield and berry size; they will become integral tools stimulating specific plant responses like elongating peduncles at the proper timing.

The Beneficial Substances, or future "biostimulants," will certainly become new essential elements to crop nutrition.

MARK FREEMAN is National Specialty Ag Market Manager for Ball DPF, LLC. More tech resources and case studies can be found at www.naturessourceplantfood.com.

Learning Curve

Great Lakes Growers in Burton, Ohio, is ahead of the curve when it comes to hydroponic lettuce and herb growing.

Story & photos by **JENNIFER POLANZ**

Great Lakes Growers started out in 2011 in a glass lean-to off a barn nestled in the Amish Country village of Burton, Ohio. Make no mistake, though, this company was no fly-by-night operation. Co-owned by Tim Ryan (who has an MBA and international business experience) and John Bonner (who has extensive horticulture experience), it was destined for bigger things, which came quickly as the company grew its customer base from one Chagrin Falls, Ohio, restaurant to more restaurants and now grocery stores.

Great Lakes specializes in a variety of lettuces and herbs, and has moved to an 85,000-sq. ft. greenhouse in Burton, 75,000 of which is growing space. They grow about 25 different items—some living and some fresh cut—for their customers, which includes grocery chains like Costco, Giant Eagle and Heinen's. For grocery stores, they have products like Living Lettuce, which is packaged in single and dual clamshells, and Living Herbs, which are sleeved with water to keep them fresh.

If the name John Bonner sounds familiar it's because he's been in the floriculture/horticulture industry his whole life. His grandfather, John Gander, started BFG Supply (one of the largest distributors in the industry), and his father and mother, Dick and Ellen Bonner, started Dillen Products, which is a brand under HC Companies. John made a name for himself as the general manager of Eagle Creek Wholesale Growers, founded by his sister Jill Cain. This is the first time, though, that John has donned the grower hat and he's brought over some floriculture concepts to the hydroponic lettuce and herb business.

SPACING FOR PROFIT

One of those concepts John has brought from floriculture is spacing young plants tighter together, then moving them farther apart as they grow. In many hydroponic operations, plants are only spaced once or twice throughout their growing process. At Great Lakes, lettuce and herb seeds are started in Oasis blocks—276-cell trays for herbs and 104-cell trays for lettuce. They're started in a young plant zone for anywhere between 10 and 17 days, then the cubes are broken off by workers and stuck by hand in NFT troughs.

They start with tighter spacing and John says with that extra step of spacing tighter for a week in the beginning and moving them as they grow, he can fit an extra 700,000 plants per year. All told, they space seven different times throughout the course of growing until they finish on 10-in. spacing.

John Bonner stands in front of finished heads of lettuce at his hydroponic growing operation Great Lakes Growers in Burton, Ohio. ● The semi-automated, custom-built NFT system at Great Lakes Growers is made of aluminum to withstand UV light and the mechanics of growing. It's supported by a Priva environmental controls system. ● John Bonner shows the root system of one of the lettuce plants, which are started in Oasis 104-count blocks.

TRIAL AND ERROR

Much of what John has learned has been through trial and error, and researching extensively. For example, they were capturing rainwater to use for irrigation, but sensors showed the pH was low after a drought, making it difficult to irrigate with it even after the filtration process. They now use well water that goes through UV filtration and a reverse osmosis system. The pH and E.C. are monitored through once-a-week tests sent out to a lab and via the Priva environmental controls system.

John and Tim also opted to replace all of the high-pressure sodium lights with LEDs from Philips Lighting, an undertaking they didn't enter lightly. First, they tested the lights in one segment of the greenhouse to see how they did. Once they were satisfied with those results, they did a whole house retrofit. "We see a higher production rate and the quality is better," John notes. "There's less stress on the plants and production is better in the winter."

They made an investment into the NFT gutter system, as well, which is custom-built for them and made with aluminum featuring some automation.

"It holds up better under the UV light and mechanics," John adds. "It was a little more money to build it, but in the long term, I think it'll serve us well."

LOOKING AT THE FUTURE

John notes that their growth has been rapid, starting in 2011 in that lean-to and growing to the 85,000-sq. ft. operation they are today. They're getting close to 100% selling out their production, too, which means it might be time for another expansion.

That means they're right where John wants to be, with a solid customer base and a product line that doesn't only depend on one season.

"It's more even," he says about hydroponic lettuce and herbs vs. floriculture plants. "That's probably the best thing about the two. It's better in that way."

Great Lakes Growers continues to build its brand presence in grocery stores and restaurants, now selling to Northern Haserot, a customer that sells to some of the finest restaurant in the Midwest. They also continue to be on the lookout for new lettuce and herb varieties to grow, creating a special research and development segment of the greenhouse. Right now, he's looking at how different varieties of the same types of lettuce grow in the various seasons, hoping to switch off varieties in winter and summer to have a consistent product.

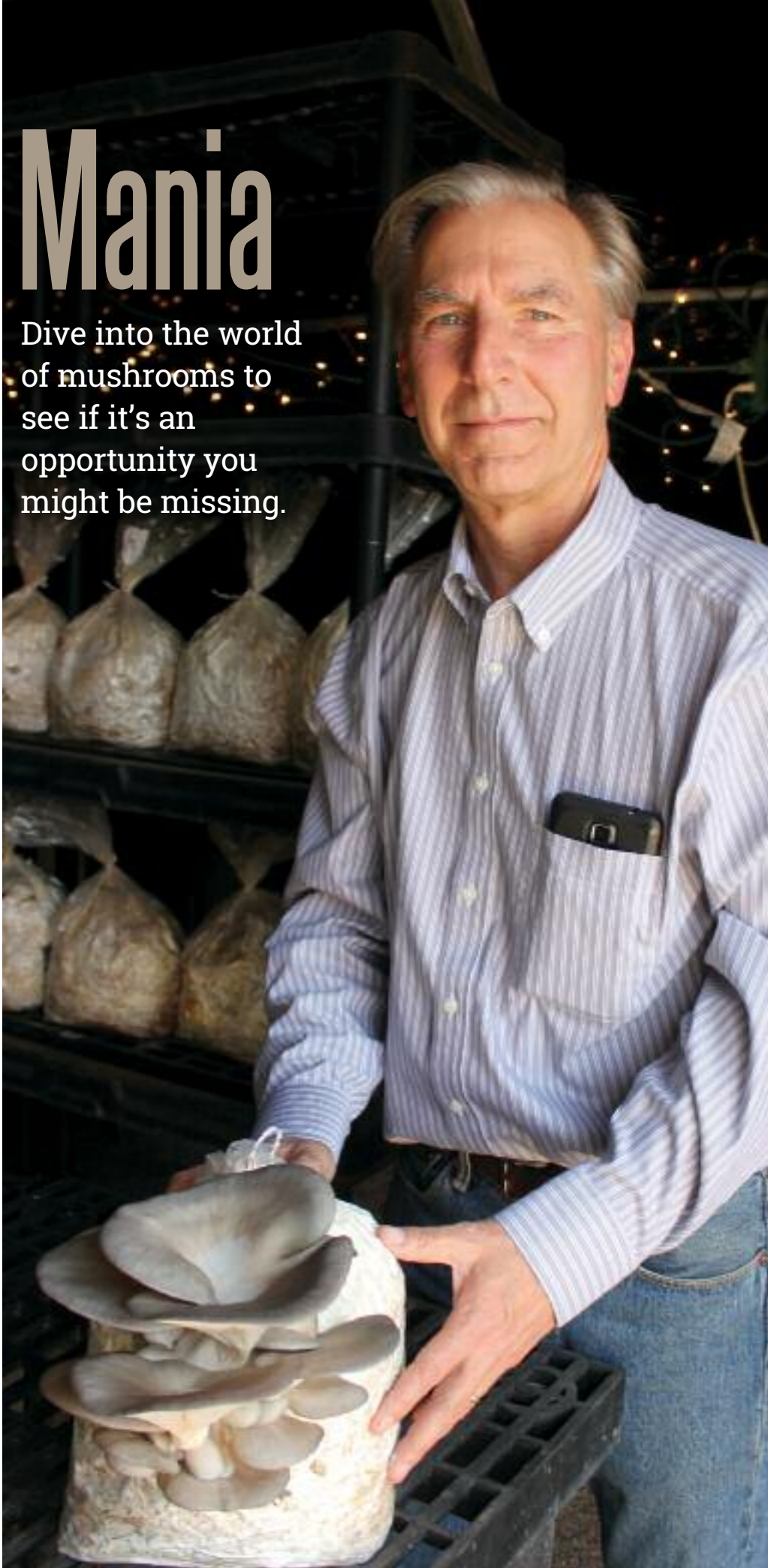
In the end, it comes down to maintaining quality and matching production with weekly sales.

"Growing lettuce when the weather is perfect is easy; when it's not good it's challenging," he says, adding it's all been a learning curve. "The even cash flow is a welcome positive relative to the world of flowers. However, the most exciting and probably best part of this business is the demand for super high quality, super fresh, super clean locally grown produce in the region.

"It is driving our product innovation initiative and that ultimately will drive our growth."

Mushroom Mania

by **LEE ALLEN**



Dive into the world of mushrooms to see if it's an opportunity you might be missing.

No longer is fungi a dirty word as mushrooms, both Agaricus (white button, as well as brown crimini and portobello) and exotic (oysters, shiitake, lion's mane and others) are finding a greater presence in kitchens and on consumer dinner plates. Often called "Nature's Hidden Treasure," poet Emily Dickinson once referred to them as "the elf of plants."

Mushrooms have seemingly been around forever. According to hieroglyphics of 4,500 years ago, Egyptians referred to them as "the plant of immortality." Lauded for their flavor, pharaohs decreed mushrooms as food for royalty and kept the entire supply for themselves, allowing no commoner to touch them. In many parts of the world and under different names, many believed mushrooms had properties that could produce super-human strength and lead the soul to the realm of the gods.

Whatever you choose to call them today, consumption is steadily growing as are the numbers of growers wanting to secure a piece of that expanding marketplace.

A GROWING OPPORTUNITY

The professionals at MushroomExpert.com report the average American consumes 2.2 lbs. of mushrooms per year, while other industry experts say that number is closer to 2.8 lbs., and the American Mushroom Council guesstimates even higher at 4 lbs. annually.

And while Pennsylvania is recognized as the 'shroom capital in the East, Tucson, Arizona, is vying to become the heart of mushroom mania in the western U.S., following up on its recent UNESCO designation as the first city in North America to be recognized as a City of Gastronomy.

The most recent statistics from the American Mushroom Institute via the Department of Agriculture show mushroom sales volume covering the 2015-2016 U.S. crop approaching 950 million pounds, with those sales valued at $1.2 billion. Pennsylvania, particularly commercial growers in Chester County, accounted for two-thirds of the total sales volume, followed by California and a hard-charging Arizona industry.

"There's no incongruency with growing mushrooms in the desert," says Dr. Barry Pryor, who spearheads the fledgling Arizona Mushroom Growers Association. "We're uniquely positioned to capture a share of the growing marketplace."

Explaining that while Pennsylvania and California focus on field mushrooms in open beds of compost seeded with spawn (akin to meadow

Clockwise from left: ● Barry Pryor is spearheading the formation of the Arizona Mushroom Growers Association. ● Tucson Chef Janos Wilder prepares to whip up some bacon mushroom tacos. ● Andrew Carhuff of Arivaipa Creekside Farm displays vertically grown oyster mushrooms. ● Pink oyster, or "bacon," mushrooms are a popular item from the Sonoran Mushroom Company. ● Another popular specialty mushroom is the blue oyster.

All photos this page: Lee Allen/ARIZONA FREELANCE

mushrooms that grow in cow pastures), indoor growers in Arizona will focus on a variety of exotics. "If Pennsylvania can grow mushrooms in the winter, we can grow them in the summer and year-round," he says.

WHAT TO GROW

The industry as a whole tends to spotlight button mushrooms because they're robust. They have a picking/transportation/shelf life of about three weeks and can therefore be shipped around the world. In contrast, specialty mushrooms are more sensitive and have a reduced shelf life of about five days before degeneration, so the opportunity for local production abounds.

"We can easily produce our own indoor-grown specialty mushrooms, cost-effectively, and of a superior quality," Barry says. "Our footprint in Arizona can become really important because mushroom growing is a controlled environment activity and the nationally recognized University of Arizona's Controlled Environment Agriculture Center is here to help in research. It's a natural marriage in a Pacific Rim market where we can be a world-class research center."

It also helps because the world's largest spawn producer, Sylvan ▶

Spawn, recently put together a large research center and a cutting-edge production facility east of Reno, Nevada, again in the middle of a desert to serve the growing industries in China and Japan.

So, without any industry hype, how big could Arizona's mushroom market be? "Upwards of $50 million annually, depending on how the marketplace responds to local grower efforts," Barry notes.

The big dog on Arizona's porch is the family-owned Sonoran Mushroom Company based in Tucson, currently producing 1,000 lbs. of specialty mushrooms a month. Ground has been broken for an expansion on their existing site that will quadruple square footage production by year-end along with contemplated plans for yet another location adjacent to the interstate highway, which would allow quick product transport to the massive Phoenix Valley market.

TIPS OF THE TRADE

Mushrooms, like humans, breathe oxygen and exhale carbon dioxide, so the space where they're grown needs to allow for airflow regulation and moisture control. Sonoran Mushroom spent a lot of time and money in making sure they did things right.

"Our system is different than anyone elses and it's highly productive," says grower John Jacobs, Sr. "It's confidential, proprietary information, but our preparation is different as is our substrate and our growing environment. The difference between doing this as a hobby and doing it correctly is hundreds of thousands of dollars in research and preparation."

The company grows to organic certification requirements and is currently going through the certification process, anticipating their mushrooms will be fully accredited as organic very soon.

"We grow in climate-controlled clean room conditions requiring strict control of CO2 and light and temperature levels in a trade secret process to produce mushrooms in commercial quantities," says John Jacobs, Jr. who applies his MBA in International Business to the marketing and publicity side of the pesticide- and herbicide-free oyster mushrooms—in particular their pink oyster species they promote as looking like and tasting like bacon.

"The resemblance is uncanny. It's a niche market within a niche market and because a lot of our customers follow a vegan/vegetarian lifestyle, they're a great smoky-flavored meat alternative," he said.

Other growers throughout the state are smaller, but just as passionate. Clinton White and friends operate a 4-year-old urban farm in Scottsdale, growing fruit and vegetables and, "whatever else we feel like growing." Included in the "whatever else" category are oyster mushrooms as their staple crop ("because of their easy-growing and dependable growth cycles"), along with hot weather production of lion's mane, turkey tail, reishi and wood ear.

"We produce about a thousand pounds a month," Clinton says, who adds they're already working on expansion plans.

Andrew Carhuff and partner Nicole Devito grow oyster and shiitakes on their 5-acre plot adjacent to Arivaipa Creek's cottonwood trees in rural Dudleyville. Their former Old Pueblo Mushroom Growers business moved from a small Tucson shed and morphed into Arivaipa Creekside Growers with two mushroom houses (one a converted garage frame covered with poly) that keeps company with their outdoor greens garden.

"Our goal is to turn our mushroom operation into a diversified farm where we use mushroom production compost and rainwater harvesting to grow green crops," says Andrew, a former chef who likes to marinate and grill his larger oyster mushrooms.

Mini Mushroom Magnate

When you're 7 years old, most kids dream about being an astronaut, a fireman or a cowboy.

Not Te'Lario Watkins II of Blacklick, Ohio. "I want to be President," he says, while covering his options by selecting "businessman" as a second career choice.

The sky's the limit for the Licking Heights West Elementary School student who parlayed a Cub Scout project growing basil and cat grass into a lucrative enterprise growing and selling mushrooms under the banner of Tiger Mushroom Farms.

"This has been an amazing experience," says the budding mycophile. "It all started from a single oyster mushroom kit. Now I'm in the process of expanding my business, experimenting with other mushroom varieties." After working with several 'shroom options like cremini, portobello and white button mushrooms, the oyster variety won out.

"The other kinds require the use of manure and I didn't want that in my house," says his mother LeVanya.

Once the spores started popping about and there were just too many mushrooms for the family table and to share with friends, they decided to go commercial.

The family, mom and dad (both retired teachers) join with older daughter Kennedy to caretake rows of shelving in the family's basement where a crop of sawdust blocks laced with fungi spores grows in the dark, dank environment.

As the concept began to grow, Te'Lario, Sr., a former science instructor, took over supervision of the mushroom cultivation, managing the harvesting and packaging, while mom undertook marketing duties and developing expansion plans for the farm.

After packing the product in quart-sized containers bearing the official Tiger Mushroom Farms label, they sell the fresh and dried mushrooms, mushroom seasoning and a dry soup mix at area farmers markets, restaurants and stores.

Although their official teaching certificates are retired, the Watkins parents are still teaching life lessons. First, they tied homework and a love of cultivation together. Hoping to inspire a studious streak, they offered Te'Lario the incentive—do your homework and you get to work with your plants. Now that the business is taking off, the young entrepreneur and his sister are allowed to keep one-fourth of their proceeds while the rest goes into their college savings accounts.

One of the reasons for the Tiger Farms success is that Te'Lario is an outgoing type.

"He's never met a stranger," says his mom. And he doesn't mind sharing his business acumen with others, like delivering PowerPoint presentations at Rotary club functions, and to elementary and middle school students.

The irrepressible youngster took some mushroom samples to an appearance earlier this year on the NBC show "Act Like a Success—Junior Edition" with Steve Harvey where he brought along his business plan to share with the studio audience. He also asked the host for some free tips on "how to become a zillionaire" and said that when he hit that pinnacle he wanted to buy a big house with a hologram basement. (www.youtube.com/watch?v=zFQ2nul5bJA)

Big dreams from a little guy. Bill Gates, Warren Buffet and Steve Jobs would be envious.

SOLEXX™ is your best defense against extreme weather

When unexpected cold weather hits, minimize your heat loss and plant damage with Solexx. Solexx twin-wall greenhouse covering has the best insulation value in the industry. The insulation (R-Value) performance of Solexx is over 25% better than double poly film and polycarbonate.* To find out more about Solexx and how it will reduce your energy costs call 1-877-476-5399 or visit **www.adaptiveplastics.com.**

Solexx™

10-YEAR 10 WARRANTY

Reader Service Number 212

*R value for 3mm Solexx 2.5, 6mil double poly 1.7 and 8mm twin-wall polycarbonate 1.6. Solexx is a trademark of Adaptive Plastics, Inc.

ADAPTIVEplastics

Advances in Indoor Growing

It's the fifth year for Indoor Ag-Con (and our first), so we traveled to sunny Las Vegas to see what's cooking in the world of indoor growing.

by **JENNIFER POLANZ & JENNIFER ZURKO**

Indoor Ag-Con, now in its fifth year, is an interesting blend of conference and trade show highlighting hydroponics, aquaponics and cannabis growing. Because of its indoor nature, technology and lighting were some of the major topics of discussion, as well as food safety, financing and new developments on multiple fronts. We (your intrepid editors Jen Zurko and Jen Polanz), spent two days talking with vendors, listening to speakers and hearing the concerns, challenges and successes of indoor growing. Here are just a few of the concepts we came back with.

FOOD SAFETY

This is something we'll likely cover more in the *Inside Grower* newsletter and in the pages of this supplement in the future. Speaker Sarah Taber is a food safety scientist and regulatory consultant who regularly performs audits for horticulture and aquaculture growers. She gave a fascinating presentation about food safety and lean systems, noting, "There's no way to talk about one without talking about the other."

As more and more hydroponic and aquaponic operations come online, she recommends getting all food safety measures in place *before* growing and shipping. She specifically mentioned a 2006 outbreak of E. coli on spinach where it took seven years to recover sales for those growers.

Fortunately, she says it's not too difficult to create a culture of cleanliness. She says to place sinks close to where people work and encourage them to wash their hands more often. Have someone checking constantly to ensure soap, paper towels, a trash can with liner and lid are always available. Practice safety with chemicals ("the label is the law") and make sure any equipment used is designed for food handling. That means any lubricants used in the machines should be food grade.

She adds that technology and artificial intelligence, two concepts mentioned consistently throughout the conference, will be the No. 1 way to reduce the pain points of horticulture handling and labor: the human element. The use of new technologies and AI can reduce the amount humans touch the food, which goes a long way toward reducing dangerous outbreaks.

NEW CROPS FOR INDOOR GROWS

Of course, cannabis was a major theme of discussion both during the conference and on the trade show floor, but growers also were interested in other unique crops to explore. During a session dedicated to the topic, speaker Dr. Deane Falcone of Massachusetts-based Fresh Box Farms mentioned stevia as a potential indoor crop. However, the rest of his presentation focused on the opportunities indoor growers had to manipulate existing crops through environment. One of the most striking observations was the ability to change the taste of arugula (the exact same plant) through changes in the lighting spectrum, resulting in a spicy crop and a mild crop with the same plant.

Meanwhile, Richard Fu of Agrivolution discussed ice plant *(Mesembryanthemum crystallinum)* as a plant that's growing in popularity in Asian countries like Japan, Taiwan, China and South Korea. Native to Africa, it has a crunchy, juicy bite and a briny, salty flavor to it, Richard notes. He added the plant has multiple health benefits, including efficacy in controlling blood sugar, promoting cell growth, improving the flow of lipids and preventing fat accumulation, and high antioxidizing effect that aids in anti-aging and fatigue recovery.

Oddly enough, Ian Justus, senior manager of controlled environment production for the strawberry giant Driscoll's, spoke briefly about glasshouse blackberry production as the berry crop that's growing the fastest indoors. The company has discovered a new plant called Victoria that has shaved one year off production, allowing the greenhouse version to be competitive on costs. The genetics are proprietary and allow for multiple high-yielding crops. He called it a "wall of fruit" and says every lateral branch has fruit on it, which are picked every couple of days.

On strawberries, he says the opportunity is in providing pesticide-free, locally grown strawberries that are guaranteed in quality. However, the challenge remains in finding locations that are optimal for greenhouse-grown strawberries to avoid costs associated with regulating indoor environments to make up for outdoor climates.

DATA COLLECTION

The discussions surrounding data were fascinating at this conference. What we took away from this is there's never been a time when growers had more detailed data about their plants and they'd like to keep that data private. It was a concept that came up multiple times where growers pushed back from sharing the information they're gathering through their environmental control systems and other technology. There are now companies that work with growers to analyze their data (privately, without sharing it) to speed up the process of growing efficiently and to enable greater prediction capabilities for yield. One such company is Agrilyst, a Brooklyn-based tech company that has algorithms that analyze grower data for optimal growing conditions. Founder and CEO Allison Kopf spoke during the conference about working with environmental controls and how to know if you need one.

"Around 10,000 square feet is where you really need a control system," she noted. "Once you hit that size, it's important to have that control."

That control helps growers regulate lighting, irrigation, climate, labor and the plants themselves. Because that data is so important, Yurij Duda, GM of Argus Controls, recommended growers research the history of the company, hear other users' experiences and understand their customer support before making a commitment.

"Avoid fly-by-night operations," he said. "Make sure it can interface with a wide range of sensors and interfaces that are available today."

OPTIMIZING THE GROW

One of the biggest takeaways from this conference is the concept that plant genetics and optimizing growing environments through technology are going to push the indoor growing industry farther than anything else in the next several years. When it comes to genetics, plant genome mapping will allow researchers to "focus on unlocking genetic potential," according to Matthew Crisp, CEO of Benson Hill Biosystems. To that end, combining research on genotypes with optimizing environments will create new opportunities for yield, flavor, texture and nutrition, depending on how the environment is manipulated.

Optimizing that environment could mean changing the spectrum of lighting, which could produce more crop cycles and better predictability for yield and quality. Or it could mean temperature, humidity and even irrigation levels/timing. In other words, this is definitely not your father's farm. IG

One of the new products we saw was something so simple, but definitely worth having if you have LEDs in your warehouse or greenhouse: Method Seven eyewear. Under certain spectrums of LEDs with the naked eye, everything looks yellow or purple (center); the special lenses on the glasses balance the light for proper color and clarity so that workers can scout for insects and diseases easily (right). It's also a health issue—many people who work under LEDs for a long period of time see spots for hours afterwards, and even suffer from seizures. That's Jen Polanz modeling a pair. They even make lenses for cameras (which is how we took the photo on the right) and eyewear for traditional HPS lights, too.

Indoor Farms of America had an impressive booth with a truck that showed how portable their growing systems are. The growing panels allow you to grow aeroponically, aquaponically or hydroponically and can be stacked vertically if you're growing in a high-ceilinged warehouse or next to each other in a container. The panels are ideal for leafy greens, beans or strawberries.

The theme for this year's show was steampunk, which combines historic elements with new technologies. The organizers heard about the steampunk dinosaurs made by the people who make props for Burning Man (if you don't know what it is, Google it) and asked them to make this 19-ft. T-rex for the show. People who suggested a name for the T-rex through the Twitter handle #namethemascot were entered into a drawing to win two tickets to the next Indoor Ag-Con show of their choice (Philadelphia, Singapore or Las Vegas). They also had little plastic dinos filled with succulents as centerpieces for the lunch tables.

Symptoms of Common Nutrient Deficiencies in Hydroponic Arugula

by **NEIL MATTSON & TANYA MERRILL**

In hydroponic production, the fertilizer solution must provide all of the plant's essential elements as a growing substrate that's either not present or merely provides physical support and access to water and oxygen. Monitoring plants to look for visual symptoms is an important tool that can be used to detect plant nutrient deficiencies.

Arugula, or rocket *(Eruca sativa),* is an increasingly popular hydroponically grown leafy green for salads. Currently, there are few resources in literature regarding photographs and descriptions of common nutrient disorders in hydroponic arugula. Therefore, the objective of this study was to grow arugula in nutrient solutions deficient of individual macro- and micro-nutrients to document visual symptoms of nutrient deficiencies, and the timeline and progression of their development.

MATERIALS & METHODS

Arugula seeds were sown in 1-in. (200-cell) rockwool cubes that were previously soaked in reverse osmosis water for five minutes and then drained and soaked and drained in a Sonneveld's nutrient solution for lettuce. Seedlings were placed in a greenhouse at 68 to 72F (20 to 22C) with ambient light and hand watered daily (or as needed) with the Sonneveld's nutrient solution.

Figure 1

Figure 2

Table 1. Control nutrient solution used during the experimental period. Single elements were removed to impose the nutrient deficiencies.

Element	Name	ppm
N	Nitrogen	210
P	Phosphorus	31
K	Potassium	235
Ca	Calcium	200
Mg	Magnesium	49
S	Sulfur	64
Fe	Iron	4.0
Mn	Manganese	0.5
Zn	Zinc	0.1
B	Boron	0.5
Cu	Copper	0.10
Mo	Molybdenum	0.01

Two-week-old seedlings in rockwool were placed in the lid of 1-gal. buckets filled with the Sonneveld's solution. Each bucket had air bubbled in from plastic tubing with an air stone on the end, which was connected to an aquarium air pump. There was one plant per bucket. After the plants had been established in hydroponics for one week, the nutrient solutions for each bucket were replaced with either a control solution prepared in reverse osmosis water (Table 1) or the control solution minus one nutrient element of interest (-N, -P, -K, etc.).

Every other day, reverse osmosis water was used to raise the solution level in each container back to 1 gal. Every week, the nutrient solution in

BOOST PROFITS BY CREATING YOUR IDEAL

GROWSPAN GREENHOUSE

FOR NEARLY 40 YEARS GROWERS SUPPLY has been supplying commercial growers with GrowSpan Greenhouse Structures, the most versatile line of commercial greenhouses

BUILT TO LAST - GrowSpan greenhouses are built with triple-galvanized, American-made steel frames and numerous covering options. You can be sure your growing structure will be complimenting your business for years to come.

EXPERT CONSULTATION - We staff Greenhouse Specialists with extensive industry experience. They can provide valuable advice to ensure you get the structure that perfectly fits your operation and growing needs.

FINANCING AVAILABLE - Speak to your GrowSpan Greenhouse Specialist today.

DIVISION OF FarmTek
Growers supply

VISIT WWW.GROWSPAN.COM OR CALL 1.800.476.9715
TO FIND OUT HOW WE CAN HELP WITH ALL YOUR GROWING NEEDS

each container was completely replaced with new solution. Plants were monitored every week and visible symptoms of nutrient deficiency (with reference to the control plants) were noted. There was one plant for each nutrient deficiency condition; the experiment was repeated over time for a total of three replications.

Nitrogen (N)
Nitrogen deficiency resulted in plants developing purple veins and stems (Figure 1), and uniform chlorosis (yellowing) of old leaves, which was observed after two weeks of deficient conditions. Plant size and leaf area were severely restricted as compared with control plants (Figure 2). Chlorosis of leaves further progressed to early necrosis (browning) of old leaves by week 3, as well as early bolting (flower stalk formation).

Phosphorus (P)
Phosphorus deficiency was first evident as purpling beginning along leaf margins, evident three weeks after deficient conditions. Over time, purpling of leaf margins progressed inward and leaf edges turned necrotic. Plants were much smaller and with less unfolded leaves than control plants (Figure 3).

Potassium (K)
Within two weeks of deficient conditions, old leaves exhibit marginal necrosis and middle leaves exhibit some upward cupping. As the deficiency continues, marginal necrosis of older leaves becomes more severe and progresses further into the leaf, and by week three, some scattered interveinal chlorosis and necrosis is present on older leaves (Figure 4).

Figure 3

Figure 4

Calcium (Ca)
Symptoms of calcium deficiency within one week of deficient conditions were chlorosis and necrosis beginning towards the base of young leaves (Figure 5). Young leaves are strap-like. Roots become markedly brown within two weeks of Ca deficiency. Death of the apical meristem (growing point) is apparent by three weeks of Ca deficiency.

Magnesium (Mg)
Magnesium deficiency presents itself initially as faint interveinal chlorosis on old leaves within two weeks of deficient conditions. As the deficiency advanced, interveinal chlorosis progresses to more severe interveinal chlorosis with scattered necrotic spots (Figure 6) and also begins to work its way up the plant affecting more recently expanded leaves.

Sulfur (S)
Within two weeks of sulfur deficiency, plants exhibited uniform chlorosis across the entire leaf blade with recently mature and younger leaves uniformly affected (Figure 7). As symptoms progress, the yellowing becomes more severe with young and recently mature leaves developing marginal necrosis; older leaves are less affected.

Figure 5

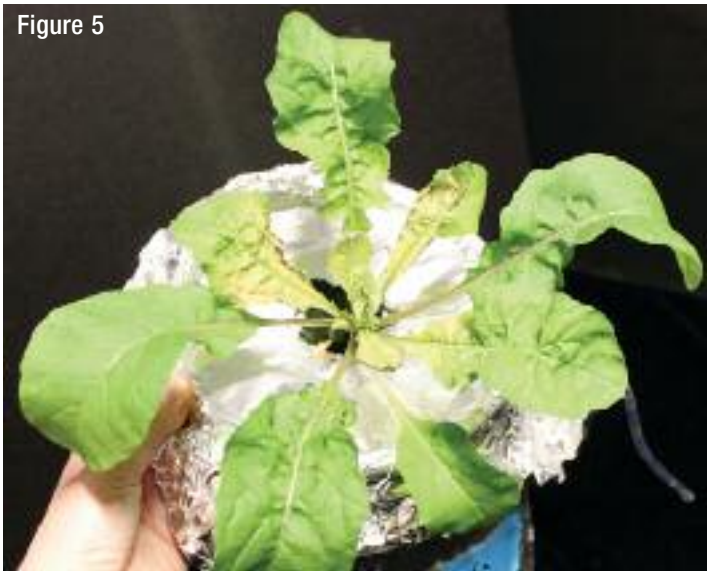


Figure 6

Iron (Fe)
Iron deficiency resulted in interveinal chlorosis and minor necrotic spots across upper (young) leaves within two weeks of deficiency. Over time, interveinal chlorosis and numerous small necrotic spots between veins became more severe (Figure 8).

Boron (B)
Boron deficiency was first evident as chlorotic/necrotic leaf margins of the youngest leaves, which was first noticeable after three weeks of deficient conditions. As the deficiency progressed to week 4, young and recently mature leaves exhibited irregular interveinal chlorosis (Figure 9). New growth was rosette-like and very compact.

Figure 7

Figure 8

Table 2. Average tissue analysis range of field-grown arugula in research test plots in summer. Tissue samples taken from most recently mature leaves. (From H.A. Mills and J. Benton Jones, Jr. 1996. Plant Analysis Handbook II. MicroMacro Publishing, Inc.)

Macronutrients (%)		Micronutrients (ppm)	
N	2.86-3.97	Fe	187-215
P	0.61-0.72	Mn	38-44
K	4.80-5.16	B	20-25
Ca	2.40-2.46	Cu	3-5
Mg	0.28-0.29	Zn	40-45
S	0.52-0.55	Mo	5.7-5.9

DISCUSSION

While visual diagnosis is an important tool, it should be noted that many nutrient disorders are similar in appearance. Therefore, laboratory leaf tissue analysis is necessary to verify symptoms. Laboratory tissue analysis (Table 2) can help identify a nutritional problem after it's occurred. A more proactive approach, which will help you avoid economic losses from nutritional disorders, is to do a periodic laboratory nutrient solution analysis. Based on the nutrient solution analysis, the fertilizer regime can be modified to ensure adequate supply of nutrients.

It should be noted that the timeline for development of symptoms may vary based on your environmental conditions. In our experiment, plants were well-fertilized before we began the deficient conditions. Therefore, the symptoms may have taken longer to develop than if they'd been lacking from the beginning.

In many cases, nutrient deficiencies may be due to environmental or biotic causes rather than a lack of nutrients in the fertilizer solution. For example, high pH (>6.5) reduces solubility of iron, manganese, boron, etc. and can lead to nutrient deficiencies. Disease or insect damage may also look like nutrient disorders. Therefore, the plant must be examined carefully to ascertain the true cause of symptoms.

NEIL MATTSON, nsm47@cornell.edu, is Associate Professor and Greenhouse Extension Specialist and **TANYA MERRILL** is a former undergraduate at Cornell University.

Figure 9

New Products June 2017

Stuppy Inc.

Whether you're a new or seasoned grower, do it all with Stuppy's Rainbow Plus Greenhouse, a versatile, gutter-connectable workhorse of a greenhouse whose design has been perfected over 30 years. Expand in any direction indefinitely. Grow virtually any crop. Even meet building codes.

Reader Service Number 217

Lock Drives Inc.

The EZD 52 makes installation and disassembly ingeniously quick and easy. Due to its unique design, the EZD 52 can be installed around the drive shaft. The housing slides radially onto the pinion and the drive shaft, snaps into position and holds the two halves of the pinion together. Customer benefits are quicker installation and replacement. **Reader Service Number 220**

PanAmerican Seed

SimplySalad are precision multi-seed pellets that are easy to grow and offer very quick crop times. Check out new Cress, a rosette-forming plant that stays in a neat and tidy bunch, and Arugula, which can be harvested at a young leaf size for a mild, nutty flavor. Both are ideal for fresh market farmers or hydroponic systems.

Reader Service Number 218

Ludvig Svensson Inc.

Svensson's Luxous 1147 FR Climate Screen provides 2% more light without losing out on energy savings and humidity transport capabilities. Growers can achieve a better growth climate in the winter when vegetable prices peak with a screen that can be closed for more daytime hours. A little extra light makes a big difference, leading to earlier and more production. **Reader Service Number 219**

Griffin

Perfectly suited to tiered production of CEA crops, the Transcend Infinity Linear light bar brings full-spectrum, LED technology in a slim, daisy-chainable format. Unique phosphor technology results in long-life fixtures with optimized spectra. 4-ft. fixtures generate 116 µmol/sec, using only 58W. IP66 waterproof, highly efficient (2.0 µmol/J), five-year warranty and 65,000-hour lifetime. **Reader Service Number 221**

Index of Advertising Partners

GrowerTalks Magazine salutes these fine businesses for their support and involvement in bringing *Inside Grower* to you!

Company Name	Page #	Phone	Reader Service #	Website
Adaptive Plastics	27	877-476-5399	212	www.adaptiveplastics.com
Argus Control Systems, Ltd.	9	800-667-2090	203	www.arguscontrols.com
Atkore International	7	800-882-5543	202	www.atc-mechanical.com/gatorshield
Atlas Manufacturing, Inc.	21	800-346-9902	209	www.atlasgreenhouse.com
Griffin	11	800-323-7253	204	www.griffins.com
Griffin	23	800-323-7253	211	www.griffins.com
Growers Supply	31	800-476-9715	214	www.GrowSpan.com
Lock Drives USA	17	877-562-5487	208	www.lockdrives.com

Company Name	Page #	Phone	Reader Service #	Website
Nexus Greenhouse Systems	3	800-228-9639	201	www.nexuscorp.com
Oasis Grower Solutions	19	855-585-4769	210	www.oasisgrowersolutions.com
Premier Tech Horticulture	2	800-667-5366	200	www.pthorticulture.com
Rough Brothers	35	513-242-0310	215	www.roughbros.com
Scotts Canada	11	819-396-2293	205	www.scotts.com
Stuppy Ghse. Mfg., Inc.	15	800-733-5025	206	www.stuppy.com
Westbrook Greenhouse Systems, Ltd.	36	800-263-0230	216	www.westbrooksystems.com

Please refer to the Product Information Card in your June 2017 *GrowerTalks*

Insert the product's Reader Service number in the box in the lower right-hand corner. Mail it in, and we'll make sure the information is sent your way!

ENOUGH SAID

LET'S TALK ABOUT YOUR NEXT GREENHOUSE. 800.543.7351

STRUCTURES • EQUIPMENT • DESIGN • INSTALLATION

RBI
ROUGH BROTHERS, INC.
GREENHOUSES
www.roughbros.com






Optimize your potential.

Westbrook Greenhouse Systems has been an industry leader for decades, not only because of our innovative spirit and technologically advanced facilities, but because we're growers ourselves. We understand what's needed and we've developed our products from a grower's perspective. Your perspective.

We begin by listening. Learn how we can provide you with a custom growing environment: 1-800-263-0230.

Westbrook
GREENHOUSE SYSTEMS LTD.

westbrooksystems.com

Reader Service Number 216