THE UNIVERSITY OF ARIZONA
BIOSYSTEMS ENGINEERING
Controlled Environment Agriculture Center

21st Annual

Greenhouse Crop Production and Engineering Design Short Course

Online and On-site

March 7th, 8th, and 9th, 2022

Welcome to the 2022 Greenhouse Crop Production and Engineering Design Short Course

Dear Participants,

Our dedicated faculty, staff, and students at the UA-CEAC, as well as guest speakers along with our sponsors and exhibitors, welcome you to the 21st Greenhouse Crop Production and Engineering Design Short Course!

University of Arizona's Controlled Environment Agriculture Center (UA-CEAC) is a multidisciplinary program with engineers, scientists, students, faculty, volunteers, and industry collaborators sharing the same vision to develop controlled environment agriculture as an economically, environmentally, and socially sustainable agricultural option. The UA-CEAC is dedicated and continues to prepare the controlled environment agriculture (CEA) workforce of the future with its research, educational, and outreach/extension programs.

We put together an excellent three-day program with lectures presented by leaders in academia and the Controlled Environment Agriculture industry and supported by our industry sponsors and exhibitors. The 21st Short Course program consists of experts in their respective fields on plant nutrition, systems, sensors and controls, insects and pests, lighting, fertigation, automation, plant physiology and engineering, business development, urban agriculture, mushrooms, and others. They are all here to help you!

There are different kinds of CEA systems and technologies considered for crop production within controlled environments. Therefore, no single silver bullet system or solution fits all. The selection will depend on various factors, with the plants to be grown and their optimal environmental requirement being the central focus, but also including expected yield and quality, consumer expectations, market demand, climate, finances, growers' capabilities, and others. At the end of the program, you will not leave with the full knowledge of CEA aspects. However, you will have the essential information to guide you towards achieving success.

We are excited and looking forward to your active participation in this program.

Murat Kacira
Professor and Director, Controlled Environment Agriculture Center

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Acknowledgments and Thanks

OUR INVITED SPEAKERS:

Merle Jensen, Stacy Tollefson, Eric Highfield, Kai-Shu Ling, Roberto Lopez, Hope Jones, Chieri Kubota

OUR 2021 SPONSORS:

OUR 2021 EXHIBITOR:

OUR ORGANIZATION AND DEVELOPMENT COMMITTEE:

Ellen Worth, Murat Kacira, Gene Giacomelli, Barry Pryor, Triston Hooks, David Bogner, Aaron Tevik

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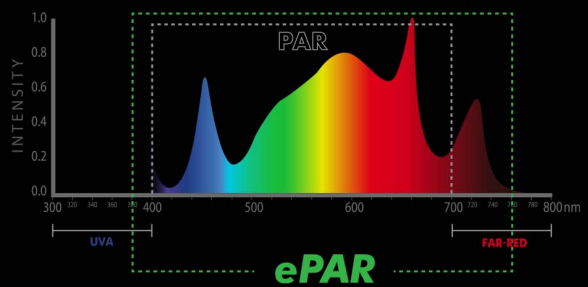

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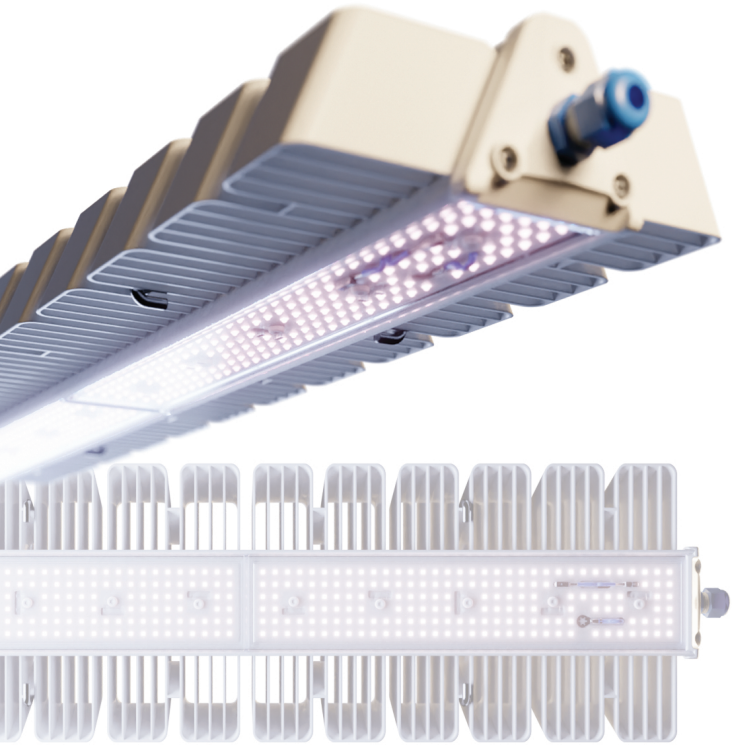

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MONDAY, MARCH 7TH

7:30 – 8:15 am	Check-in for on-site participants (1951 E Roger Rd. Tucson, AZ 85719)
8:15 – 8:30 am	Welcome and Introductions by Dr. Murat Kacira (CEAC Director)

FUNDAMENTALS OF HYDROPONICS & CONTROLLED ENVIRONMENT AGRICULTURE (CEA):

8:30 – 9:15 am	Controlled Environment Greenhouse and Hydroponics- Limitless Opportunity Dr. Merle Jensen- Professor Emeritus, School of Plant Sciences, The University of Arizona
9:15 – 9:25 am	Discussion of Previous Lectures, Q&A
9:25 – 10:10 am	Hydroponics, Medium Composition & Delivery Systems Dr. Triston Hooks- Professor, Biosystems Engineering, The University of Arizona
10:10 – 10:20 am	Discussion of Previous Lectures, Q&A
10:20 – 10:50 pm	Break/ Exhibitor Networking
10:50 – 11:05 pm	5 minute presentations from Sponsors
11:05 – 11:50 am	Managing Plant Nutrition for Crop Production Optimization Dr. Stacy Tollefson- Director of Cultivation, Aeriz
11:50 – 12:00 pm	Discussion of Previous Lecture, Q&A
12:00 – 1:00pm	Lunch Provided
1:00pm – 1:15pm	5 minute presentations from Sponsors
1:15pm – 2:00 pm	Greenhouse Design- Structures, Glazing, & Cooling Dr. Gene Giacomelli- Professor, Biosystems Engineering, The University of Arizona
2:00pm – 2:10pm	Discussion of Previous Lecture, Q&A
2:10pm – 3:30pm	CEAC Tour (2 stations)/ Networking

TUESDAY, MARCH 8TH

ENVIRONMENTAL CONTROLS & AUTOMATION IN CEA:

8:30 – 9:15 am	Monitoring Your Greenhouse Environment: Simple Tools to Technology Trends Dr. Murat Kacira- Professor, Biosystems Engineering, The University of Arizona
9:15 – 9:25 am	Discussion/ Q&A
9:25 – 10:10 am	Hands-Free Cultivation: Advances in CEA Automation Eric Highfield- Founder, High Yield Horticulture
10:10 – 10:20 am	Discussion/ Q&A
10:20 – 10:50 pm	Break/ Exhibitor Networking
10:50 – 11:05 pm	5 minute presentations from Sponsors
11:05 – 11:50 am	Detection and Management of Emerging Viral Diseases in Greenhouse Tomatoes Dr. Kai-Shu Ling- Research Plant Pathologist, USDA- Agricultural Research Service
11:50 – 12:00 pm	Discussion/ Q&A
12:00 – 12:10 pm	CEA Mission Award
12:10 – 1:00pm	Lunch Provided
1:00pm – 1:15pm	5 minute presentations from Sponsors
1:15pm – 2:00 pm	Fundamentals of Supplemental and Sole Course Lighting for CEA Dr. Roberto Lopez- Professor, Michigan State University
2:00pm – 2:10pm	Discussion/ Q&A
2:10pm – 3:30pm	CEAC Tour (2 stations)/ Networking

WEDNESDAY, MARCH 9TH

ALTERNATIVE CROPS/ GROWING METHODS IN CEA:

8:30 – 9:15 am	Hemp in CEA Dr. Hope Jones- Founder & CEO, Emergent Cannabis Sciences
9:15 – 9:25 am	Discussion/ Q&A
9:25 – 10:10 am	Strawberries Production and Technologies Dr. Chieri Kubota- Professor of Horticulture and Crop Science, Ohio State University
10:10 – 10:20 am	Discussion/ Q&A
10:20 – 10:50 pm	Break/ Exhibitor Networking
10:50 – 11:05 pm	5 minute presentations from Sponsors
11:05 – 11:50 am	Mushrooms in CEA Dr. Barry Pryor-Professor, School of Plant Sciences, University of Arizona
11:50 – 12:00 pm	Discussion/ Q&A
12:00 – 1:00pm	Lunch Provided
1:00pm – 1:15pm	5 minute presentations from Sponsors
1:15pm – 2:00 pm	Aquaponics in CEA Dr. Matthew Recsetar- Adjunct Lecturer, Biosystems Engineering, University of Arizona
2:00pm – 2:10pm	Discussion/ Q&A
2:10pm – 3:30pm	CEAC Tour (2 stations)/ Networking

CEAC
MISSION AWARD

Presented to

Nadia Sabeh

Dr. Greenhouse

For outstanding leadership and
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Controlled Environment Agriculture

March 8, 2022

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E- VERTICAL FARM

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G- MUSHROOM CULTIVATION DEMONSTRATION

Controlled Environment Greenhouse and Hydroponics- Limitless Opportunity

Dr. Merle Jensen
Professor Emeritus, School of Plant Sciences, University of Arizona

Dr. Merle Jensen has served as an academician and consultant to the industry for over fifty years, developing agricultural systems for businesses, communities, and aerospace application. He was one of the early pioneers in the development of agricultural plastics for greenhouses and brought one of the first Dutch Venlo glasshouses to the U.S. Early in his career, he did extensive research on tomato viruses and mineral nutrition for both horticultural and agronomic crops. He developed many of the cultural systems for controlled environment agriculture in over 60 countries, including drip irrigation, growing media, solar energy, energy alternatives, and conservation for greenhouse vegetable production. His programs of research served as a prototype for food support systems for aerospace applications.

Through his fund-raising efforts, he was able to establish the Controlled Environment Agriculture Center at The University of Arizona which serves today as one of the only such research/education center of its kind for university students in the U.S. He has served as a consultant to several major corporations and organizations, among which are the American and Chinese Academies of Science, The World Bank, Walt Disney World Co., Tennessee Valley Authority, Nature Sweet, Eurofresh Farms, and continues today with companies through Central and North America using the system approach in all aspects of greenhouse vegetable production.

Controlled Environment Greenhouse and Hydroponics- Limitless Opportunity:

Growing greenhouse vegetables is one of the most exciting and intense forms of all agricultural enterprise. Each component of controlled environment agriculture (CEA) is of equal importance, whether it be the structural design, the environment control, or the growing system. There are many types of hydroponic systems for growing row crops, such as tomatoes, cucumbers, and peppers. For leafy vegetables and herbs, NFT and deep flow hydroponics are common. This presentation will cover all the major production systems and the necessary accompanying components for success.

Notes

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Hydroponics, Medium Composition & Delivery Systems

Dr. Triston Hooks
Assistant Professor of Practice, University of Arizona

Dr. Triston Hooks graduated with a Ph.D. in Plant and Environmental Sciences from New Mexico State University in 2020, where he researched rangeland ecology and plant salinity tolerance. Additionally, he has worked as a Research Associate at Texas A&M AgriLife Research Center in Dallas, where his research focused on Urban Agriculture and Controlled Environment Agriculture (CEA) technology, including hydroponic systems and LED lighting. Dr. Hooks has conducted research on organic hydroponic production of lettuce and the application of ultra-violet (UV) light to enhance plant quality in greenhouse production systems. Dr. Hooks now serves as an Assistant Professor of Practice in the Department of Biosystems Engineering at the University of Arizona. He teaches Introduction to Hydroponics, Advanced Hydroponic Crop Production, Integrated Pest Management, and is an instructor for many of our offerings, including our CEAC intensive Workshops.

Hydroponics, Medium Composition & Delivery Systems:

Back to the basics – sort of! Let's talk about hydroponics, substrates, and nutrient solutions. These are the fundamentals for CEA production that most of us are familiar with. In this presentation, Dr. Hooks will take a closer look at these topics with an emphasis on plant physiology. The goal is to equip you with a better understanding of how plants function so that you can make smarter decisions for your hydroponic system and become a better grower.

Notes

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Managing Plant Nutrition for Crop Production Optimization

Dr. Stacy Tollefson
Director of Cultivation, Aeriz

Dr. Stacy Tollefson is the Director of Cultivation at Aeriz, an aeroponic cannabis company that grows in Phoenix and Illinois. She received her Ph.D. in Agricultural & Biosystems Engineering from the University of Arizona, where she was an Assistant Professor of Practice at the CEAC from 2014-2021. Her area of expertise is in hydroponic vegetable production, especially in the areas of plant nutrition and integrated pest management. While at the CEAC, she taught the Introduction to Hydroponics, Advanced Hydroponic Crop Production, and Integrated Pest Management for CEA courses, ran five hydroponic greenhouses, and an Urban Food Production Internship Program. She was the first to use the UA Hemp Research License to teach students about hemp production. She served on the 2016-2017 USDA National Organic Program's Hydroponic and Aquaponics Taskforce. Dr. Tollefson has experience consulting for hydroponic and aquaponic vegetable and cannabis operations.

Managing Plant Nutrition for Crop Production Optimization:

This presentation will focus on a variety of topics dealing with the nutrient solution including information about nutrient interactions with the system and plants themselves, as well as signs of common deficiencies.

Notes

Greenhouse Design- Structures, Glazing, & Cooling

Dr. Gene Giacomelli
Professor, Biosystems Engineering,
Extension Specialist in CEA,
University Of Arizona

Dr. Gene Giacomelli is a faculty member in the University of Arizona's Biosystems Engineering Department. and former & founding director of the CEAC. He received a Ph.D. in Horticultural Engineering from Rutgers University in 1983. He also has a Master's degree in Agricultural Engineering from the University of California-Davis and two bachelor's degrees in Horticultural Science and Biological and Agricultural Engineering from Rutgers University. Here at the University of Arizona, he teaches Controlled Environment Systems which is an introduction to the technical aspects of greenhouse design, environmental control, nutrient delivery systems, hydroponic crop production, and intensive field production systems. His research interests include controlled environment plant productions systems (greenhouse and growth chamber) research, design, development and applications, with emphases on: crop production systems, nutrient delivery systems, environmental control, mechanization, and labor productivity.

Greenhouse Design- Structures, Glazing, & Cooling:

Greenhouses are controlled environment crop production systems used to overcome difficulties in climatic conditions to optimize the production. Greenhouses use a free energy source, the sun. The design and structures selected depends on the climate, and depending on your region, you'll want to take advantage of the proper design, glazing or screens, and heating or cooling systems to overcome the limitations of your environment.

The productivity and quality in greenhouse production depends on the level of technology chosen, therefore understanding of the technology and its influences on the production can help investors to make better business plans and lead to success in the operation.

Notes

Monitoring Your Greenhouse Environment: Simple Tools to Technology Trends

Dr. Murat Kacira
Professor, Biosystems Engineering,
Director of UA-CEAC,
University of Arizona

Dr. Murat Kacira is the Controlled Environment Agriculture Center Director and a professor in the Biosystems Engineering Department at the University of Arizona. He received his B.S. degree in Agricultural Engineering from Cukurova University in Turkey and his M.S. and Ph.D. degrees in Food, Agricultural and Biological Engineering from The Ohio State University. His research involves automation, environmental control, alternative energy integrated CEA systems, and resource use optimization in controlled environment agriculture systems, including greenhouses and vertical farming-based plant factories with artificial lighting. He is a member of the American Society of Agricultural and Biological Engineers (ASABE), American Society of Horticultural Sciences (ASHS) and the International Society for Horticultural Science (ISHS). He serves as Chair of the Division Precision Horticulture and Engineering under ISHS.

Monitoring Your Greenhouse Environment: Simple Tools to Technology Trends:

Good crop and production system management in controlled environments rely on grower's skills, integration and use of appropriate tools and environmental monitoring and control system, making accurate measurements of key environmental and crop-specific variables, having access to meaningful data and information, and capabilities to interpret the data collected and communicate it with others timely. This lecture will focus on simple tools to technology trends on environmental monitoring in controlled environment agriculture systems for successful and resource-conserving farming in controlled environments.

Notes

Hands-Free Cultivation: Advances in CEA Automation

Eric Highfield
Founder, High Yield Horticulture

Eric Highfield is the founder of High Yield Horticulture, which provides a gambit of CEA consulting services, specializing in independent economic analysis, complete customized hydroponic nutrient formulation and yield optimization, project design, and commissioning services of hands-free fully automated hydroponic cultivation systems. His passion for soilless cultivation grew while earning his B.S. in molecular biology with a chemistry minor, and continued to develop further while in graduate school studying at the University of Arizona's Controlled Environment Agriculture Center.

His desire to facilitate local, sustainable food production eventually led him to explore automation. He began modeling automated CEA systems designed to be ideologically sustainable and economically sustainable and developed several fully automated baby leaf cultivation facilities. Highfield has become a leader in the industry by implementing and optimizing automated cultivation facilities for cut baby leaf greens. He has worked on several projects from conception to execution, creating hands-free, food-safe production.

Hands-Free Cultivation: Advances in CEA Automation:

Advances in automation have enabled the CEA production of cut baby leaf greens that is cost competitive with field-grown lettuce. In addition, this technology has created a new standard in food safety, enabling hands-free cultivation from seeding through retail packaging. We will provide an overview of the components that facilitate this high-performance production system, in addition to the challenges involved with operating one of the worlds most advanced production systems for leafy greens.

Notes

Detection and Management of Emerging Viral Diseases in Greenhouse Tomatoes

Dr. Kai-Shu Ling
Research Plant Pathologist,
USDA- Agricultural Research Service

Dr. Kai-Shu Ling is a Research Plant Pathologist (Virology) at the United States Department of Agriculture–Agricultural Research Service ((USDA-ARS). He received his Ph.D. in Plant Pathology (Virology) from Cornell University in 1995. He has been a Research Plant Pathologist at the USDA-ARS in Charleston, SC for 17 years leading a productive program in detection, characterization and management of emerging and important viral diseases of vegetable crops, including the emerging tomato brown rugose fruit virus and cucumber green mottle mosaic virus affecting greenhouse tomato and cucumber crops. He will offer some general guidance on viral disease diagnosis, field-based detection of common viruses, selection of effective disinfectants for sanitization and disinfection of workers hands tools and machineries as well as the importance in planting a disease-resistance cultivar. Dr. Ling has published over 100 peer-reviewed articles and served as a mentor for many international visiting scholars, postdocs and college students over the years.

Detection and Management of Emerging Viral Diseases in Greenhouse Tomatoes:

Tomato is a major vegetable crop in the U.S. and around the world. Greenhouse tomato production has increased significantly in recent years. The controlled environment, long growing season and intensive production practices have contributed to serious disease outbreaks caused by several seed-borne and mechanical transmitted viruses in tomato. The most important emerging viruses are tomato brown rugose fruit virus (ToBRFV), tomato mottle mosaic virus (ToMMV), pepino mosaic virus (PepMV), and several tomato-infecting viroids. In this presentation, I will focus primarily on a global emergence of ToBRFV, which has posted serious threat to greenhouse tomato production worldwide in recent years. This emerging virus breaks the popular resistance gene (Tm-22) in tomato. With no resistance cultivar available against ToBRFV, it is necessary to employ an integrated pest management (IPM) strategy to manage this emerging disease. These measures include timely on-site disease diagnosis using immunostrips, virus detection using sensitive molecular detection methods, planting high quality and certified virus-free seeds, sanitization and disinfection using effective disinfectants, and crop rotation to a non-host plant (such as cucumber). By implementing such IPM strategies, growers would be able to effectively manage these emerging viral diseases on tomato as well as other crops.

Notes

Fundamentals of Supplemental and Sole Course Lighting for CEA

Dr. Roberto Lopez
Assistant Professor, Dept. of Horticulture, Michigan State University

Dr. Roberto Lopez is an assistant professor and controlled environment/floriculture extension specialist in the Department of Horticulture at Michigan State University. His research focuses on propagation and production of young and finished plants in greenhouses, warehouse-based plant factories, and vertical farms. The primary objective of his research is to determine how light (quantity, quality, and duration), substrate and air temperature, and carbon dioxide in controlled-environment agriculture (CEA) production influences crop timing, rooting, yield, quality, flavor, nutrition, and subsequent performance.

Fundamentals of Supplemental and Sole Course Lighting for CEA:

When the daily light integral (DLI) is low, high-intensity supplemental lighting is often delivered to increase growth, yield, and quality of greenhouse crops. For operations that grow completely indoors, such as in warehouses, containers, and vertical farms, plant morphology, growth, and development can be substantially manipulated by the light spectrum provided by sole-source lighting. Roberto will discuss key considerations when installing and operating high-intensity lighting in greenhouses and indoors, including spectral composition, radiation intensities, and plant responses.

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Notes

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Hemp in CEA

Dr. Hope Jones

Founder & CEO, Emergent Cannabis Sciences/ Co-Founder and President, Superior Phenos, LLC

Dr. Hope Jones is Co-Founder and President of Superior Phenos, LLC, a cannabis biotech & hemp young plant production company based in Arizona and CEO of Emergent Cannabis Sciences, an international cannabis and micropropagation consulting company. Superior Phenos is a team of seasoned plant scientists and commercial professionals coming together to raise the cannabis industry standards of science, business practices and product quality. Dr. Jones is the former Chief Scientific Officer for C4 Laboratories - an Arizona cannabis analytical laboratory and previously served as the Director of Science and Micropropagation for a large cannabis cultivation and product manufacturer in the United States.

With her deep expertise in both hemp and cannabis, Dr. Jones is frequently requested to participate in and advise on cannabis and hemp policy and reform at both the state and national levels. She was named the Scientific Research Advisor to the state branch of NORML, (The National Organization for the Reform of Marijuana Laws) an American non-profit organization based in Washington, D.C. with similar branches around the world. Dr. Jones has also served as an advisor at the federal level to the USDA and the US government body responsible for Hemp regulation (US Farm Bill).

Dr. Jones is a graduate of the University of Arizona where she earned her B.S. in Plant Sciences and Ph.D. in Molecular & Cellular Biology and Plant Sciences. Her tenure at the University of Arizona's Controlled Environment Agriculture Center (CEAC) allowed her to develop extensive micropropagation skills and knowledge.

Hemp in CEA:

Plant diseases in your grow? Can't seem to find good clean stock material anymore? Now what? Tissue culture MAY be a solution and it is becoming foundational to the Cannabis sativa industry. This presentation will focus on essential concepts behind hemp sativa tissue culture, virus/viroid & pathogen elimination and the importance of a good IPM regime once you have clean stock again.

Notes

Strawberries Production and Technologies

Dr. Chieri Kubota
Professor, Horticulture and Crop Science, Ohio State University

Dr. Chieri Kubota is a professor in the Department of Horticulture and Crop Science, and Director of Ohio Controlled Environment Agriculture Center at the Ohio State University. Dr. Kubota received Ph.D. in Horticultural Engineering and M.S. in Horticultural Science from Chiba University, Japan. Dr. Kubota worked as faculty for 6 years in Chiba University, 16 years in the School of Plant Sciences at University of Arizona. Dr. Kubota joined the faculty at the Ohio State University in 2017. Dr. Kubota is a Fellow of the American Society for Horticultural Science (ASHS). In research, she has worked on issues in CEA crop production such as lighting technologies, water and nutrient management, and introducing new crops for CEA.

Controlled Environment Greenhouse and Hydroponics- Limitless Opportunity:

Growing greenhouse vegetables is one of the most exciting and intense forms of all agricultural enterprise. Each component of controlled environment agriculture (CEA) is of equal importance, whether it be the structural design, the environment control, or the growing system. There are many types of hydroponic systems for growing row crops, such as tomatoes, cucumbers, and peppers. For leafy vegetables and herbs, NFT and deep flow hydroponics are common. This presentation will cover all the major production systems and the necessary accompanying components for success.

Notes

Mushrooms in CEA

Dr. Barry Pryor
Professor, School of Plant Sciences,
University Of Arizona

Dr. Barry Pryor is a professor of Plant Pathology and Microbiology in the School of Plant Sciences, and a faculty member of the BIO5 Institute. He has been active in research related to plant pathology and mycology for the past 20 years with working experiences in academia and industry. His research incorporates classic mycological methods with modern molecular techniques to study the etiology and epidemiology of vegetable, tree, and field crop diseases; the effects of fungal aeroallergens on childhood asthma; fungal diversity in native ecosystems; and the development of gourmet and medicinal mushroom production as components of sustainable food systems. An emerging area of research explores the use of ligninolytic fungi in microbial fuel cells for novel industrial and biotechnological applications. He has taught both undergraduate and graduate level courses in mycology, plant pathology, and agriculture at the University of Arizona and participates in extension activities through lectures on plant disease management and mushroom cultivation in controlled environment agricultural systems.

Mushrooms in CEA:

Commercial production of edible mushrooms is valued at $25B worldwide, is growing at 10-15% annually, and nearly all production occurs in controlled environment facilities. The rapid growth of the mushroom market is due in part to the public's recognition of the dietary value of mushrooms. Mushrooms are high in vitamins and minerals, yet are not high in calories, which is valued in a society that regularly consumes calorie-rich food. Having all nine essential amino acids in roughly the same proportion found in eggs, mushrooms are also a first-rate, top-quality, protein source. Moreover, mushroom have long been known to promote health and longevity and incorporating mushrooms regularly into the diet is promoted by most nutrition experts. In this presentation, Dr. Pryor will highlight challenges and innovation in modern commercial mushroom production systems that can be integrated into your indoor growing space.

Notes

Aquaponics in CEA

Dr. Matthew Recsetar
Professor, School of Plant Sciences, University Of Arizona

Dr. Matthew Recsetar (Rex) is a native of Chicago and attended the College of William and Mary, where he attained his B.S. in Neuroscience. After graduating, he changed directions and achieved a Master's in Natural Resources with a focus in Aquaculture and Fisheries from the University of Arizona. This experience set the path for his interest in aquaponics, which led him to Arkansas, where he worked as an Extension Aquaculture Specialist from 2012-2016. In Arkansas, he worked with some of the largest fish farms in the U.S. and became the state expert on aquaponics, for which he put on demonstrations and workshops for schools, extension agents, and the general public, as well as consulted individuals and businesses throughout the state. In 2016 he sought to increase his knowledge and return home to Arizona to get his Ph.D. in Biosystems Engineering. During his time back in Arizona, he developed classes on aquaponics design and aquaponics engineering, which he currently teaches. Dr. Recsetar advises several UA grad students and researches nutrient dynamics in aquaponics systems, decoupled aquaponics, and improving filtration efficiency. On the side, he does consulting for commercial aquaponics operations through his company ZonaPonics.

Aquaponics in CEA:

Aquaponics is a complex method of growing fish together with plants. The main difference between growing with aquaponics and hydroponics is that fish waste essentially replaces inorganic salts as the nutrient source for plants. This not only allows for true organic plant production, but further minimizes water waste. While in the past, aquaponics was largely used in small-scale settings by hobbyists, schools and single greenhouse operations, it has slowly made its way into large-scale commercial production with increased use of technology and control. Issues with scaling in aquaponics made it difficult to pursue on a large scale but research into nutrient dynamics and management as well other innovations has made this a more desirable endeavor.

Notes

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Thank you for attending our program! If you have any questions, please email arizona.ceac@gmail.com or call us at 520-626-9566.

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