SCRI: PIP-CAP NEWSLETTER

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Volume 2: Issue 1

Global Strawberry Production

Where are our Alumni?

Why Indoor Propagation is crucial for the Mid-Atlantic

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IN THIS ISSUE

Small scale strawberry plug production is used by some growers to get the cultivars they need at the correct time. Read about how indoor propagation in the Mid-Atlantic region addresses this on page 5.

Read about Pooja Tripathi's work increasing runnering and daughter plant production, using chilling in controlled enviroingments.

Five of our very own PIP-CAP members were recognized at ASHS's annual conference. Read about it on page 13.

DIRECTOR'S LETTER

Dear colleagues and friends,

I've recently undertaken a new endeavor: combating the proliferation of online misinformation and promoting scientific literacy in the social media space. This mission resonates deeply with me and is profoundly fulfilling. Without public understanding and appreciation of science, truth becomes obscured, lost in a fog of deception, a bleak landscape dominated by self-serving narratives. Those profiting from falsehoods will readily manipulate public opinion.

Science—our shared profession—is humanity's most potent instrument for uncovering truth. This very power explains why it's so frequently targeted by those who thrive on deceit. History bears witness to science's repeated suppression by the powerful, used to bolster flawed ideologies. A hallmark of a free and equitable society is the unassailable authority of science to ascertain truth. Whenever scientific integrity is challenged, we can confidently assume an attempt to bury inconvenient facts.

Undeniably, we are living through such a period. Not only have certain scientific fields been marginalized, but scientists are being summarily dismissed from government positions, and some vital agricultural research funding is being halted or terminated. The future remains uncertain.

However, this newsletter stands as a testament to the remarkable scientific strides this group has made in recent months and years. This project is coming together, and we've show impact on several levels. Be it with the lives we've touched over the past years, people who trained under your guidance and became leaders themselves. Or be it with tangible outcomes for growers and scientists, showcased at the latest ASHS conferences. Our - your—the team's—contributions have been exceptional. I am proud of that - Despite the attack on science, and despite the moral frustration that sometimes overwhelms me. And I hope that the requested no-cost extension will allow us to continue this vital work until September 2026.

Sincerely,
Mark Hoffmann

Mark Hoffmann
Project Director

CHALLENGES & POTENTIAL FOR THE MID-ATLANTIC

Article and images by Peter Nitzsche
Department of Agriculture and Natural Resources
Rutgers University, New Brunswick, NJ

The plasticulture system of strawberry production has been utilized in Florida and California for many years. The Mid-Atlantic region predominately used a matted row system until the early 1990's when the plasticulture system was introduced and it has grown in adoption ever since. Mid-Atlantic production creates a challenge for nurseries because strawberry plug plants are needed earlier in the late summer or early fall (August September) than other production regions in the south.

Another challenge for Mid-Atlantic plug production is cultivar selection. Most growers in the region market their strawberries directly through community farm markets, farm stands and pick your own harvest. Strawberry yields are often lower than other major production regions and costs of production are higher, so farmers need to charge a premium for this locally grown fruit. To get this premium price, growers need to select cultivars with higher flavor than cultivars grown, shipped and sold at a lower price in local supermarkets. Mid-Atlantic farmers also need to select cultivars that are adapted to the region which might not be the same as cultivars grown in other major production areas.

The final challenge has been on faced by growers throughout the United States. Over the last few years several outbreaks of viral and fungal diseases including new diseases such as Neopestalotiopsis have caused major

Fruit of Rutgers Scarlet strawberry a Mid-Atlantic adapted variety with limited availability as plugs plants.

disruptions to the strawberry plug supply chain. Just like farmers in other regions Mid-Atlantic growers have experienced losses when strawberry plugs were planted that appeared to be clean but later discovered to be infected with disease.

All these challenges have the potential to be resolved with precise indoor propagation of strawberry plugs. Indoor propagation should allow for greater control over diseases which are more prevalent and harder to manage in the field. With more control of environmental factors indoors the timing of plug production and availability should be less of a factor than outdoors where the nursery is more subject to the weather conditions. Finally, it is likely that indoor nurseries would be able to custom produce a wider selection of strawberry cultivars that would be preferred by Mid-Atlantic farmers.

ADVANCING THE U.S. STRAWBERRY NURSERY INDUSTRY

Article and images by Daniel Tregeagle and Yue Shan
Department of Agricultural and Resource Economics
NC State University, Raleigh, NC

Strawberry propagation in California currently relies heavily on outdoor fields.

This article summarizes an overview paper of the California strawberry nursery industry, currently in the final stages of preparation for submission to a peer-reviewed journal, which details the industry's current structure, operations, and economic significance. These findings aim to inform industry stakeholders, researchers, and policymakers about the current landscape and prospects of the California strawberry nursery sector.

Strawberries are a high value part of the United States' specialty crop sector, with a farm-gate value of around $3b per year. California contributes approximately 80–90% of the nation's strawberry production (Holmes, 2024). The state's Mediterranean climate, characterized by moderate temperatures, enables a long production season from March to November (Wade et al., 2024). The entire process of strawberry propagation and production in California takes 5 years in multiple locations, including four major stages: meristem, foundation, increase, and commercial. As of 2022, California's strawberry nurseries cover 1,627ha of land. Among them, 80% (1,295ha) is high elevation nurseries, and the remaining 20% (324ha) is low elevation nurseries (Holmes, 2024). According to the recent cost and return study by UC Davis, the cost per strawberry plant is 0.15 dollars. Given the fact that over 1.5 billion strawberry plants are produced every year (Holmes, 2024), the total value of the strawberry nursery industry in California is approximately 225 million dollars.

There are still many unknows about the California strawberry nursery industry. For this project, we used an exploratory case-study methodology (Boland, 2020; Yin, 2017) that integrates information from peer-reviewed sources with qualitative insights gathered through two field visits in June 2022 and February 2024. The first visit focused on field observations and informal conversations, documented through detailed notes, while the second involved semi-structured interviews with representatives from three strawberry nursery firms. The audio-recorded interviews were transcribed and coded using NVivo, following the qualitative analysis framework of Miles & Huberman (1994) to synthesize the perspectives of nursery representatives. The study highlights the industry's

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existing challenges, including pest and disease pressures, the potential phase-out of methyl bromide, labor shortages, and the impacts of climate change. A potential solution to address these challenges is the adoption of controlled environment (CE) technology, which offers greater precision in nursery management through climate-controlled settings. Furthermore, the paper explores both the opportunities and challenges associated with implementing CE technology, considering economic viability and technological feasibility. The remainder of the article presents a comprehensive summary of the findings, offering insights for industry stakeholders, researchers, and policymakers.

Despite its economic significance, the U.S. strawberry nursery industry faces a complex set of challenges. Interviews with three nursery operators highlighted ongoing concerns about both foliar and soil-borne pathogens such as Phytophthora and Fusarium, which pose significant threats despite the continued availability of methyl bromide (MB) under the "Quarantine and Pre-Shipment Exemption." One representative emphasized, "The number one challenge is just making sure your soil's clean...if you really had a problem in the soil, a big problem, Phytophthora or Fusarium...would be economically challenging to manage." Although some operators have explored alternatives like anaerobic soil disinfestation (ASD), the scale of current operations limits broader experimentation. Labor shortages further compound these issues, particularly given the manual nature of propagation tasks. Additionally, the reliance on multi-location, open-field production introduces climatic vulnerabilities and raises costs related to transportation and infrastructure—factors that some interviewees identified as key barriers to efficiency and sustainability.

Controlled environment (CE) technologies offer a potential path forward, but industry perceptions are nuanced. Nursery representatives acknowledged CE systems could reduce disease risk, ensure consistent quality, and eventually replace parts of the increase or foundation stages. "Theoretically, everything that we do in a foundation block, you could do that in an indoor greenhouse-type environment," noted one grower, although they cautioned that infrastructure costs and scale requirements remain prohibitive. Another interviewee described CE as an "ideal" setting where "plants thrive," with the caveat that greenhouse pest issues can escalate rapidly if not managed precisely. Importantly, the industry remains uncertain about the any potential timeline for MB's phase-out; as one respondent put it, "If we didn't have the fumigants, we'd be highly motivated to start making changes." Currently, the use of CE technology is primarily limited to the meristem stage, but several operators expressed openness to broader adoption—particularly for conditioning stages in cooler mountain regions where CE could help deliver both chilling hours and disease control. By comparison, countries like the Netherlands have already integrated CE systems across multiple stages to produce pest- and disease-free mother plants, offering a potential model for U.S. growers. As interest in CE grows, addressing capital costs, pest management protocols, and legacy infrastructure constraints will be key to enabling wider industry transition.

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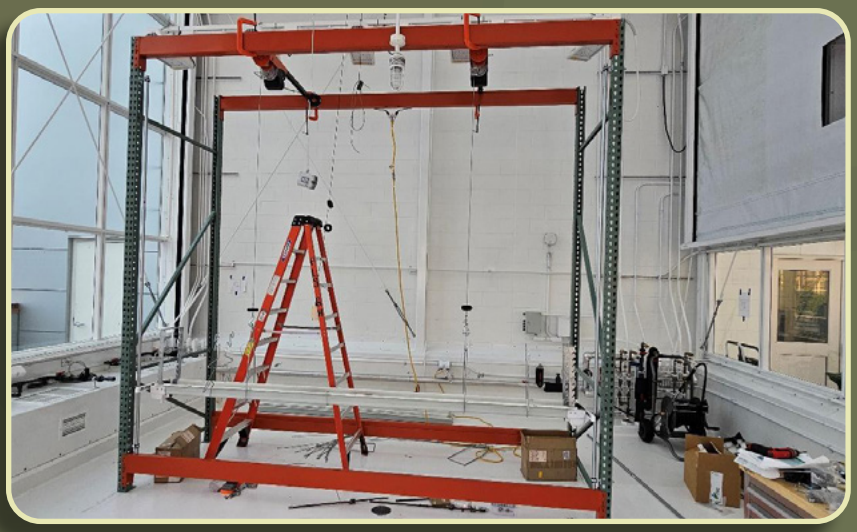
BUILDING AN INDOOR NURSERY

Article and images by Ibraheem Olasupo, Abigail Bope, Ricardo Hernandez, and Mark Hoffmann
Department of Horticultural Science
NC State University, Raleigh, NC



The hanging gutter system is one of the modern techniques through which strawberry propagation can be carried out in controlled environments to produce clean strawberry daughter plants. Here, we show how the propagation system is installed and operated in a precision greenhouse at North Carolina State University.

Above: Installation of the rack, supplemental light sources, hoists, and the hanging gutters. Below: Installation of drainage hose Right: Installation of: (i.) remote-controlled system to control the hoisting mechanism of the gutters; (ii.) Drip fertigation emitters

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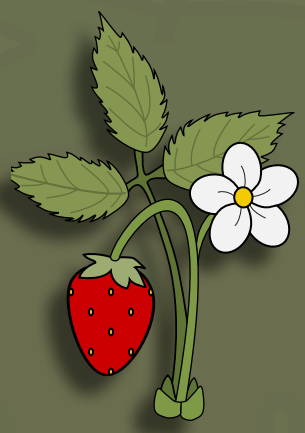
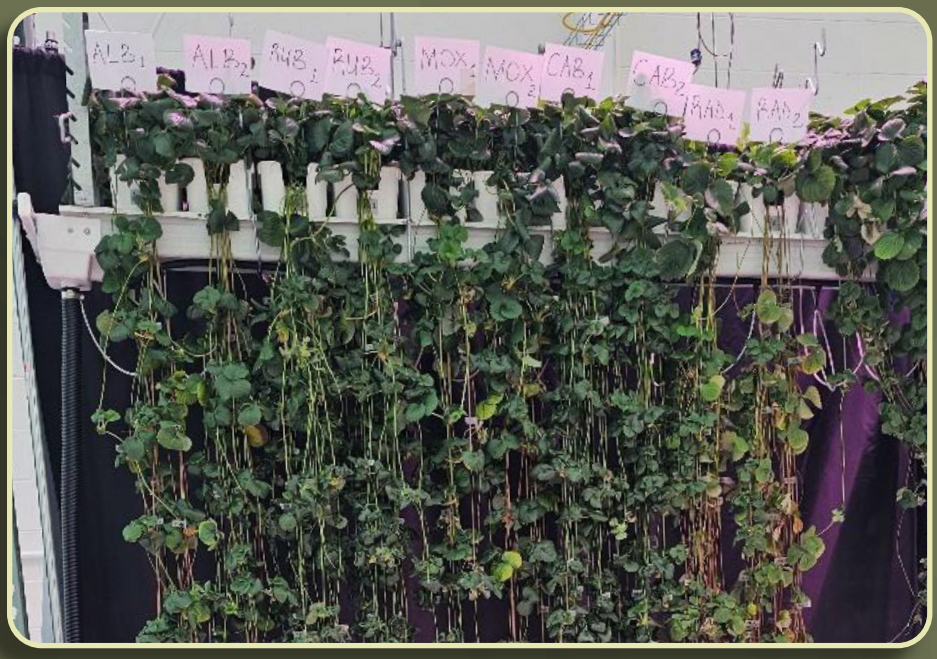
Left: Filling of pots with propagation substrate. Middle row: Planting of tissue culture strawberry plants (young mother plants) in the hanging gutter system.

Right: Strawberry daughter plants (tips) ready for harvesting.





3RD ANNUAL MEETING

The PIP-CAP group taking a tour of the Cal Poly SLO Strawberry Facilities.

Article and images from Alexa Artis
Department of Horticultural Science
NC State University, Raleigh, NC

The 3rd Annual Meeting for SCRI:PIP-CAP took place this past November 13-14 in San Luis Obispo, California, bringing together researchers, industry professionals, and students to discuss our advancements in controlled environment strawberry propagation.

The event kicked off with a welcome breakfast featuring muffins and coffee, allowing everyone to get casually reacquainted. Dr. Gerald Holmes officially opened the meeting, followed by a project overview from Dr. Mark Hoffmann. The morning continued with brief presentations from each objective group: Plant Physiology I & II, Genetics, Economics, Field Evaluation, and Extension.

Dr. Ricardo Hernandez presented virtually sharing updates on optimizing conditions for mother plants to produce strong, well-rooted daughter plants. His team is running six different experiments focused on light variations and plant density. We also got updates from the Boldt Lab on nitrogen levels for runnering and the Jackson Lab's research on substrate composition and container size.

Dr. Chieri Kubota shared their findings on chilling and storage protocols, highlighting some promising results for chilling 'Albion' strawberries. Additional research updates came from Dr. Caren Chang, Dr. Daniel Tregeagle, Dr. Mark Hoffmann, and Peter Nitzsche.

We had an enlightening Q&A session with Hillary Thomas, Mike Nelson, Jeremy Pattison, and Michael Schwieterman. Their insider knowledge of the issues we are researching was the highlight of our conference for many. We discussed the pillars of PIP-CAP: cost-efficiency, disease pressure, the price of labor, as well increasing regulatory framework issues. Receiving positive feedback on the usefulness of the genomic database we are building was great to hear as well, as our whole purpose is to make business easier for the strawberry nursery industry. Attendees then enjoyed sandwiches from Lincoln Deli before hearing 10-minute presentations from Pooja, Moein, Michael, Ibraheem, Calyssa, Samantha, and myself.

The afternoon featured a tour of the Cal Poly SLO Strawberry Center, housed in the Technology Park on campus. We explored key research areas, including:

- The Entomology Lab, which studies parasitic pests affecting strawberry plants.
- The Pathology Lab, where researchers showcased common diseases like Cladosporium and Fusarium wilt.

CONT'D

- The Automation Lab, where mechanization research is improving efficiency in the California strawberry industry.
- and the Leaning Pine Arboretum, a scenic outdoor space with diverse plant collections.

That evening, participants strolled through the weekly Downtown SLO Farmers Market, enjoying the lively atmosphere, holiday music, and a variety of vendors.

The second day featured in-depth presentations expanding on the research shared the previous day.

- Moein Moosavi-Nezhad discussed updates from the Hernandez Lab on strawberry propagation.
- Dr. Jennifer Boldt provided further insights from her lab's studies.
- Dr. Ricardo Hernandez shared findings from the Jackson Lab via video.
- Dr. Cheiri Kubota detailed storage and transportation research.
- Dr. Caren Chang presented genetic sequencing advancements via video.
- Dr. Mark Hoffmann gave field translation updates.
- Dr. Jayesh Samtani introduced a draft article on growing degree days and yield impacts.
- Dr. Ibraheem Olasupo discussed artificial chilling effects on indoor-propagated plug plants.
- Dr. Daniel Tregeagle presented economic research on controlled environment propagation via video.
- Peter Nitzsche provided updates on extension efforts.

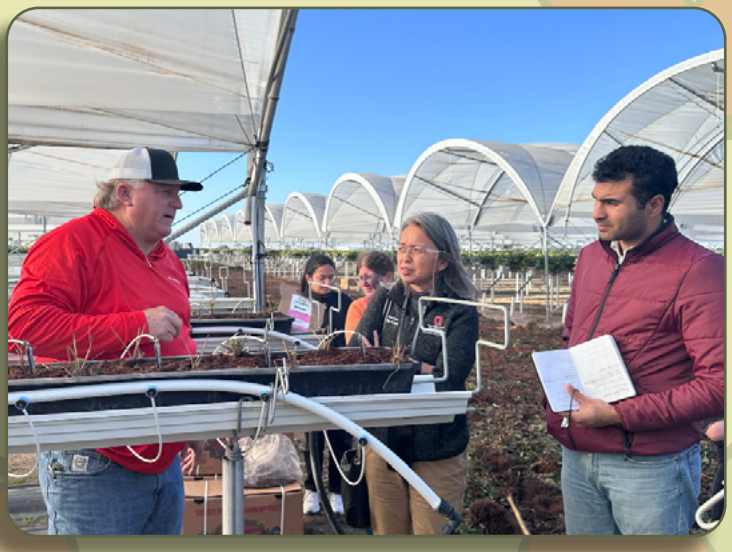
While some of our group enjoyed tacos from Efren's, a local favorite, a few other attendees visited Field 25 to see recently transplanted plantlets grown 2,700 miles away in Raleigh, NC, by Dr. Ibraheem Olasupo.

The highlight of the day was the Grower's Tour in the Santa Maria region led by Randy Widerburg, where attendees explored various strawberry production operations:

- Eat Sweet Farms: 100 acres of high tunnel, conventional production.
- Rancha Laguna: 10 acres of conventional tabletop production.
- Mar Vista Berry Farms: 120 acres of organic and 500 acres of conventional production.

The two-day event hwosted meaningful discussions, knowledge exchange, and firsthand experiences in strawberry research and production, setting the stage for the next stretch of PIP-CAP. You can watch our recap video of the event on YouTube.

Attendees listening to Doug Thomas, a grower from Crown Nursery.



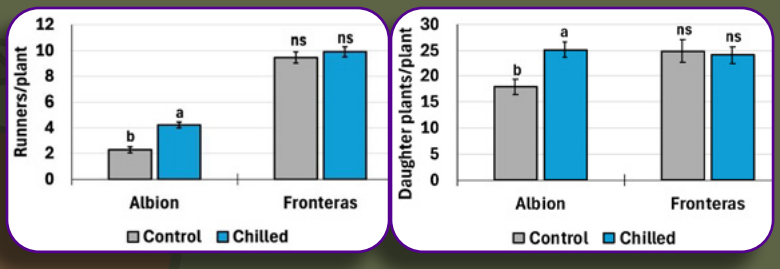
Randy Widerburg, a Pest Control Advisor, showing Cheiri Kubota and Moein Moosavi-Nezhad the table top production system at Rancha Laguna.

EFFECTS OF ARTIFICIAL CHILLING

Article and images by Pooja Tripathi and Chieri Kubota
Department of Horticulture and Crop Science
The Ohio State University, Columbus, Ohio

At the Ohio State University, we are working to study the effect of artificial chilling on runnering and daughter plant production in a controlled environment. Chilling is known to enhance vegetative vigor and runnering of strawberry plants in a conventional open-field propagation system. When strawberry plants are grown in an open field, they receive chilling from naturally declining temperatures in autumn and winter as well as supplementally in cold storage to fulfill their cultivar-specific chilling requirements. When plants are grown in an indoor system such as a greenhouse, propagation is targeted for late summer planting and the natural chilling is absent. Our research focuses on the effect of artificial chilling on vegetative vigor, runnering and daughter plant production in an indoor propagation system.

Over the past 3 years, we examined artificial chilling prior to runnering and its effect on mother plant vigor and runner/daughter plant production using two major cultivars in the U.S., long-day type 'Albion' and short-day type 'Fronteras'. Plants used in the experiments were grown from rooted runner tips in a growth chamber at 16-h photoperiod; day/night 28/23 °C air temperatures for seven weeks. After chilling (1,050 h for 'Albion' and 450 h for 'Fronteras'), plants were transplanted in a greenhouse (16-h photoperiod; 26° C/23 °C day/night temperatures) to initiate runnering. To compare, some transplants (non-chilled control) were moved directly to the greenhouse without chilling after being grown in the growth chamber for seven weeks.



The number of runners/mother plant and daughter plants/mother plant at 12 weeks after transplanting.

Strawberry plants growing in a raised gutter system in greenhouse at 9 weeks after transplanting..

Results showed that chilling significantly enhanced runnering in 'Albion' (but not in 'Fronteras'), increasing the number of runners by 86%, daughter plants by 40% and total runner length by 41% compared with non-chilled plants. However, chilling had no effect on mother plant vigor in both cultivars. We found that artificial chilling enhances runnering and daughter plant production in 'Albion'; however, it can be only implemented in an indoor production system if it is economically feasible. We did a preliminary cost analysis to calculate the operational utility cost of artificially chilling strawberry transplants. We found that the cost of artificial chilling is less than 1.71% of the potential value of additional daughter plants obtained by chilling in 'Albion'. This shows that artificial chilling is economically feasible in indoor propagation of 'Albion'.

As we did not see any effect of chilling in 'Fronteras', we are currently investigating alternative approaches of chilling to enhance runnering in 'Fronteras'.

2024 ASHS HIGHLIGHTS AND AWARDS

Article and images by Lizeth Vigil
Department of Horticulture Science
NC State University, Raleigh, NC

The PIP-CAP program made a remarkable impact at the American Society for Horticultural Science (ASHS) Annual Conference, held in Honolulu, Hawaii from September 23-27, 2024. This year's conference, a premier event for horticulture and specialty crop research, showcased the latest innovations in science and technology. Researchers, scientists, industry professionals, academics, government representatives, and students gathered to share ideas, exchange knowledge, and explore new horticultural techniques.

The conference featured a wide range of activities, including technical sessions, oral and poster presentations, keynote speakers, interactive workshops, special topic sessions, and a themed colloquium—all aimed at advancing the science of horticulture.

A highlight of the event was the Controlled Environment Agriculture (CEA) competition, where several PIP-CAP students, both current and former, earned well-deserved recognition. Their presentations, all focused on strawberry propagation and production, exemplified the cutting-edge research being conducted in the field. As the PIP-CAP project approaches its final year, it's inspiring to see how the hard work of past and present students has contributed to the continued success of the program. Many of the students have carried their research forward to other universities, furthering the growth and development of controlled environment agriculture.

These achievements underscore the exceptional contributions of PIP-CAP students to the field of controlled environment agriculture and their role in shaping the future of horticultural science. The program's impact continues to grow as students push the boundaries of research and innovation in this vital area of agriculture.

The students honored at the conference included:

Moein Moosavi-Nezhad (Honorable Mention, Oral Presentation): "Unraveling Strawberry Stock Plant Architecture, Morphology, and Tips' Spatial Distribution under Three Photoperiods to Facilitate Future Propagation System Design: A Comparative Study on Monterey as a Long-day Cultivar."
Brandan Shur (Honorable Mention, Oral Presentation): "Stratified Wood Substrates for Optimizing Growth of Greenhouse-Grown Strawberries and Blueberries."
Michael Palmer (Second Place, Oral Presentation): "Impact of Diurnal Chilling on Vegetative and Floral Development of Strawberry (Fragaria x ananassa) cvs. 'Albion', 'Chandler', 'Monterey', 'Sensation' Tray Plants in a Controlled Environment."
Samson Humphrey (First Place, Oral Presentation): "Impact of Elevated CO2 and Two Daily Light Integrals on the Production Efficiency of Strawberry (Fragaria × ananassa 'Monterey') Daughter Plants."
Ibraheem Olamide Olasupo (oral presentation): Impact of Artificial Chilling on Yields of Indoor-Propagated Strawberry Plants in California, Florida, and North Carolina

PIP-CAP ALUMNI

Emma Volk: UC ANR Field Advisor, Ventura County
Emma was Research Assistant in the Dr. Mark Hoffmann Lab. She did lead the charge to develop the first greenhouse nursery in 2021. This nursery provided started plants for many experiments and labs for almost one year. The current NCSU greenhouse nursery was established under the care of NCSU Post-Doc Dr.Ibraheem Olasupo.

Dr. Erin Yasufo: Plant Scientist, Oasis Grower Solutions
Dr. Yasufo was a Post-Doctoral researcher with Dr. Jennifer Boldt at the USDA-ARS. She investigated the impact of Nitrogen concentrations on strawberry physiology. Her work has been published in HortScience in 2025.

Dr. Jung Hoon Han: Research Scientist, South Korea
Dr. Jung Hoon Han graduated with a PhD from Dr. Daniel Tregeagle. He analyzed interviews that were hold with California strawberry nurseries. Dr. Han was also part of the California industry in 2022.

Dr. Xi Lou: Professor, Shandong Agriculture University, Tai'an, China
Dr. Lou was a Post-Doctoral researcher in Dr. Zhongchi Lou's lab at University of Maryland. She developed melting assays for an array of genes involved in runnering and flowering along the octoploid, ground work that is used in Dr. Caren Cheng's lab today. Dr. Lou is today a Professor at Shandong Agriculture University in Tai'an, China. Dr. Hoffmann visited Dr. Lou in September 2024. The story is reported in this newsletter.

Samson Humphrey: PhD Student, University of Knoxville, TN
Sam was the first graduate student on the project. Samson worked in Dr. Ricardo Hernandez's lab and graduated with an MS in 2024. Besides investigating the impact of CO^2 concentrations on runner development, he also led the charge on developing a label system for runners. This system is currently deployed in a phenotyping study at NCSU. Sam won several awards for best oral presentations, and his work has been published.

Brandan Shur: PhD Student, Virginia Tech
Brandan graduated with an MS from Dr. Brian Jackson's lab at NCSU. He investigated, among other things, the impact of soilless substrates and container size on runner performance in strawberries. Brandan has received the graduate student fellowship from the NC strawberry association.

PIP-CAP ALUMNI

Ava Forystek: PhD Student, Cornell University
Ava graduated with an MS from Dr. Courtney Weber's lab. She evaluated yield of indoor propagated plug plants of long-day cultivars in summer production systems. Her data are part of a larger publication currently being developed by Dr. Ibraheem Olasupo.

Lian Duron
Lian graduated with an MS from Dr. Celina Gomez lab at Purdue University. She investigated optimized storage conditions of strawberry daughter plants as well as rooted plug plants.

Samantha Simard: Research Assistant, Strawberry Center Cal Poly SLO
Samantha graduated with a MS from Cal Poly SLO under direction of Dr. Gerald Holmes. She investigated plating times of plug plants as well as the performance of chill vs. non-chilled CEA propagated plants. Her data are part of a larger publication currently in preparation by Dr. Ibraheem Olasupo.

Dr. Yue Shan: Post-Doctoral Researcher, NCSU
Dr. Shan graduated with a PhD from NCSU under the direction of Dr. Heidi Schweizer. She is now working to develop CEA strawberry propagation budgets under the direction of Dr. Daniel Tregeagle.

My quest to ascertain the origin of strawberries, outside of the United States, has yielded unexpected and profound results. I've developed strong partnerships, broadened my perspective, and uncovered exciting opportunities that will generate significant opportunities and benefits for North Carolina and my professional endeavors.

This upcoming account may seem typical for the seasoned industry veterans. For you, I merely reiterate the familiar. However, I trust that some readers will come to discover new insights, as I certainly have.
I'm driven by a desire to analyze and contrast the strawberry landscapes of the United States and China, seeking points of convergence and divergence. My investigation will also illuminate production methodologies observed during research trips to Spain and the Netherlands, enriching the comparative analysis.
In stark contrast to the US, the Chinese strawberry market is dominated by direct-to-consumer sales. However, retail sales are on the rise, with grower co-ops, often centered around a village or a region, collectively selling strawberries to retailers. Strawberry production is also less centralized in China than it is in the US. Larger strawberry provinces can be found across the Eastern Shore of China, with Hebei, Shandong, Jiangsu, Shanghai, Zhejiang and Fujian Provinces acting as prominent Winter and Spring strawberry production regions. Guangdong province, further south and the most populated province in China, has a vibrant winter production of strawberries, but springs are typically already too warm and humid. However, Yunnan Province, a popular tourist destination in South-

WHO IS GROWING YOUR STRAWBERRIES? & HOW?

Article and images by Mark Hoffmann
Department of Horticulture Science
NC State University

Figure 1: My current knowledge of strawberry production in China.

western China, has become particularly interesting for larger scale summer strawberry production, showing the direction of a potential increasing retail strawberry market in China (Figure 1).
The main strawberry season is in the weeks and months leading up to Chinese New Years, typically celebrated in late January or early February. Premium, sweet, large Japanese red and white cultivars reach prices between 100-150 Yuan ($14-20) for a pack of 12-20. These premium strawberries are packed as a gift, and sold at the begin of the fall planting season (Figure 2). They are the main source of profit for most Chinese strawberry growers on the Eastern Shore. After Chinese New Years, second tier strawberries are sold for a fraction of the price, and are typically sold in clamshells or buckets. For most of the Eastern Shore, strawberry season ends with the hot and humid weather that is typical for the summer in this region.
Most fall plantings are grown in raised plastic culture under plastic tunnels (Figure 3). In more southern regions, often two layers of plastic are used, while in more northern regions a combination of thick fabric and higher plastic tunnels are common. Plastic is changed every year. Minimal pest and disease control is done inside the tunnels, and soil fumigants are not used. Most growers have a combination of pick your own and pre-pick operations.

Figure 2: White strawberry cultivars in premium (left) and second tier package (right).

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Growers vary in size, smaller growers have probably one acre, while larger operations have up to 50 acres.

The main disease issues in China are similar to what we experience in the US, with *Fusarium wilt* and Anthracnose being the top problems. Anthracnose comes with the material, generated in local nurseries, often in the same province. Cultivars differ between regions, and most growers use Japanese cultivars as their main product. Chinese breeding programs, however, are catching up and have released several promising cultivars recently that are being tested in small and larger scales across the country.

Figure 3: Left: A greenhouse production in Shanghai Province with a double layer of plastic. Right: A greenhouse production in Shandong Province with a single layer, but thick fabric rolled up on top of the greenhouse to protect from night frost.

The main selling points are flavor and size for Winter and Spring production. Customers want large, conical shaped, flavor full berries, often with Brix levels of 12 or higher, to be sold at premium prices. This affects growing practices, as many growers want to keep king flowers and flower trusses, while during prime seasons sometimes weeding out tertiary or even secondary flower trusses.

The European market is closer to the US model, relying on longer supply chains and more centralized production and retail sales. Morroco has become one of the major European production regions for Winter and early Spring. Southern Spain in the Huelva region picks up the slack in early Spring, before it slowly moves up North to Central Spain, Italy, and finally France, Germany, Belgium and Netherlands (Figure 4).

Figure 4: Left: Typical tunnels in the Huelva region in Spain. Right: Fresh planting in Huelva, Spain in November 2024.

The Dutch greenhouse strawberry production is a unique system, often selling excess energy into the electric grid of the Netherlands, often not an insignificant contribution to profit. Theoretically, they can produce all year long but their main window is between Fall and late Spring. A big shift is currently happening in the Dutch industry, with the introduction of low-chill cultivars for hanging gutter production (Figure 5), as well as the increase of ever-bearing cultivars for summer production in the Netherlands.

So, US-bred genetics are used all across the world due to favorable traits. For example, the introduction of low-chill material in the Netherlands, or the use of 'Sweet Charlie' for breeding in China.

Still, in most other regions I visited, consumers accepted a premium niche for strawberries, be it Tier 1 niche in Europe or the Premium gifts in China. These niches were one reason strawberry growing was profitable in those regions. The development of a similar premium niches for the US market could be a game changer for strawberry growers here in the US as well. I hope this article was insightful for at least some of you. As I will continue to travel to explore the world of berries, I hope to report more insight in the future.

Figure 5: Low chill preparatory cultivar 'Inspire' in a Dutch greenhouse.

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The California Strawberry Industry: Current Trends and Future Prospects

by Gerald Holmes

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Fruit production, plant production, genetics, technological advancements, food safety practices, and dedication to sustainable practices make California the most important strawberry production area in the world.

Supplemental Low-Irradiance Mono/Polychromatic LED Lighting Significantly Enhances Floral Biology of the Long-Day F1 Hybrid Strawberry 'Soraya' (Fragaria x ananassa Duch.)

by Edward Durner

DOI: https://doi.org/10.3390/ijpb15040082

This research developed a systematic method to assess the effects of supplemental, low-irradiance LED lighting on strawberry flowering and vegetative biology.

Adjusting the Percentage of Nitrate in Nutrient Solution to Optimize Strawberry Stolon and Daughter Plant Production

by Erin Yafuso and Jennifer Boldt

DOI: https://doi.org/10.21273/HORTSCI18245-24

Our objective was to identify the optimal percentage range of nitrogen (N) supplied as nitrate (%NO^{3-}) in a nutrient solution to maximize strawberry stolon and daughter plant production.

Effect of Photosynthetic Photon Flux Density on Strawberry Runner Tips Propagated Indoors

by Lian Duron and Celina Gomez

DOI: https://doi.org/10.21273/HORTSCI18388-24

The objective of this study was to compare growth, physiological responses, and yield of strawberry runner tips propagated indoors under different photosynthetic photon flux density (PPFD) treatments.

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Light Research
Indoor Propagation and Entrepreneurship

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Visiting Hawai'i

Images from Lizeth Vigil

Last year's ASHS Conference took place in Honolulu, Hawai'i. Attendees got to enjoy the joys of horticultural science right alongside one of the most beautiful landscapes.