A publication of the International Society for Horticultural Science

Chronica Horticulturae

Horticultural highlights

A tissue culture and breeding perspective to boost the ornamental industry • Is this the end of exclusive arrangements for the sale of fruit produced by a licensee of a protected plant variety? • Innovation in vertical farming • Trends and issues in the world of vegetables

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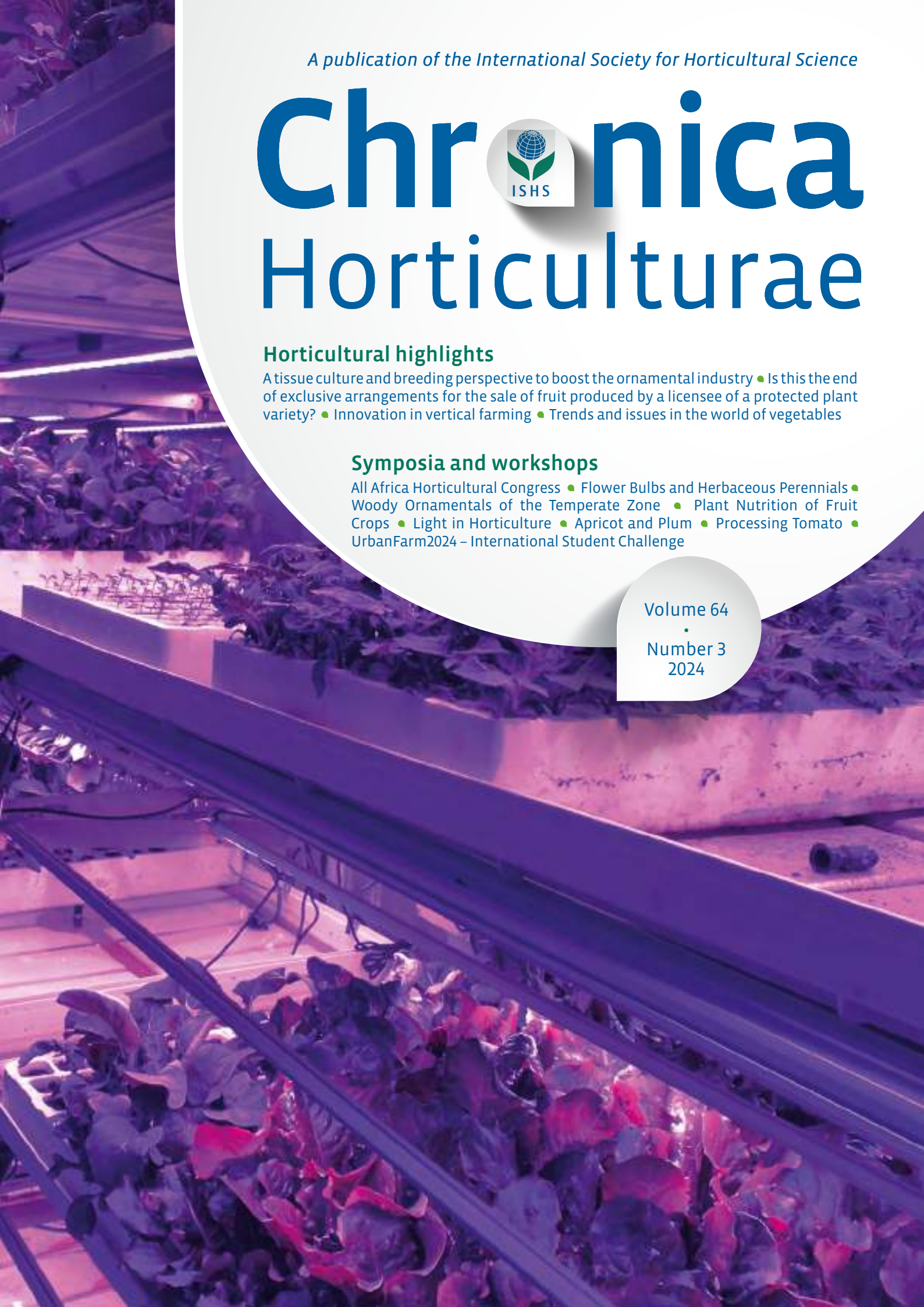

Chronica Horticulturae

A publication of the International Society for Horticultural Science, a society of individuals, organizations, and government agencies devoted to horticultural research, education, industry, and human well-being.

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Scripta Horticulturae is a series from ISHS devoted to specific horticultural issues such as position papers, crop or technology monographs and special workshops or conferences.

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Pubhort is a service of ISHS as part of its mission to promote and to encourage research in all branches of horticulture, and to efficiently transfer knowledge on a global scale. Additional information can be found at **www.pubhort.org**

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Cover photograph: Internal view of the container farms at Salus Space (Bologna, Italy). See article p.14.

› From the cockpit

Peter J. Batt, Editor, *Chronica Horticulturae*

› Peter J. Batt

For all our friends and colleagues returning from their summer vacations in the northern hemisphere, I trust you are well rested, as we have a bumper edition of *Chronica Horticulturae* for you to navigate. On this occasion, the News & Views from the Board come courtesy of Lukas Bertschinger and Yao-Chien Alex Chang.

As we outlined in our Annual Report to members in the last edition (*Chronica Horticulturae* 64(2), 4–15), the Board is implementing a range of new individual membership categories and associated with that, a number of new and improved membership benefits. From September 1, depending on age and employment status, we will offer four individual membership categories: students, early career professionals, professionals and a new retired members category. In addition, we offer both new and existing members an opportunity to pay their membership in advance for up to five years, with an attractive 10% discount. We will also offer a discount for those who renew their membership prior to its expiry, and to further reduce the financial burden for members from the transitional economies, for each membership category we are offering a reduced rate.

In conjunction with Maria Campbell (CABI), Yao-Chien Alex Chang, the Board member responsible for Publications, outlines our new partnership with CABI. From September 1, 2024, new submissions to our peer refereed journal, the *European Journal of Horticultural Science* (*eJHS*), will open on the CABI Digital Library using ScholarOne. From this date, ISHS will no longer accept new submissions for either *eJHS* or *Fruits*, but we will continue to process those papers already submitted. Under the new agreement, *Fruits* will cease to be published from 2025, but all back content will be migrated to CABI. To accommodate this decision, the aims and scope of *eJHS* will be expanded to include a more global focus. ISHS members will continue to receive a discount on the article processing charge (APC) and wherever possible, we will waive the APC for authors from low-income countries utilising the Research4Life discounts and those that ISHS has negotiated with CABI.

Within this edition we have four outstanding articles. In an interview with Marco Wopereis, Director General of the World Vegetable Center (WorldVeg), we discuss a multitude of issues related to competitiveness, sustainability and resilience. As one of the 15 global research centers within the CGIAR consortium, WorldVeg has adopted an end-to-end (paddock to plate) approach in working with smallholder farmers in Asia and Africa. On the demand side, through a number of innovative arrangements that bring groups of smallholder farmers together, having achieved some economies of scale, quality and consistent supply, farmers are able to directly engage with downstream customers. For the farmers, these collaborative marketing arrangements generally lead to improved household income, while consumers are assured of a more consistent and reliable supply of fresh fruit and vegetables, which ultimately leads to improved nutritional outcomes. However, it's on the supply side where WorldVeg has its greatest impact. With access to the world's biggest gene bank of vegetable seeds, WorldVeg is actively engaged in the development of superior breeding lines that allow commercial plant breeders to more rapidly adapt to climate change as well as provide resistance to the increasing range of pests and diseases that are attacking vegetable crops. On the climate mitigation side, through their development partners, an enormous amount of work is being undertaken to reduce the excessive use of external inputs like chemical fertilisers and pesticides. The benefits of this work are enumerable: not only does it reduce the costs of production for farmers, but it's better for the environment, and with the reduced use of pesticides, it's better for the consumer.

However, what is of most interest is the manner in which WorldVeg operates with the commercial sector. Through a consortium of about 50 seed companies in the Asia Pacific region, WorldVeg is able to offer a limited exclusivity over their breeding lines, but after two years have elapsed, those breeding lines become freely available to others. By choosing to work with the consortium, not only do the improved seed lines get to the farmers' fields, but as the seed companies are actively working with the farmers, they are able to communicate emerging research needs to WorldVeg, helping them to prioritise their activities. Furthermore, through the consortium, WorldVeg is able to raise the funds necessary to address a number of priority areas such as improving heat stress tolerance in tomato and pepper or to tackle diseases such as that caused by chili leaf curl virus.

Two other articles also deal with plant breeding. Danny Geelen, Jean Carlos Cardoso, Martina Juranić, Marzena Parzymies, Stephanie Saade and Margherita Beruto report on the results of a focus group discussion undertaken during the V European Horticultural Congress in Bucharest. Their discussion touches on many of the challenges plant breeders face in developing attractive, colorful, long-lasting and more resilient ornamental plants. As many ornamental plants have very large genomes – they are often polyploids, many of them are outcrossed and they are highly heterozygous – these characteristics complicate the use of molecular breeding tools. The molecular analysis of desired traits is still in its infancy and will require more studies. However, the main obstacle in implementing approaches such as the CRISPR-Cas technology, is the lack of an appropriate regulatory framework. Recent advances in regulating new genomic techniques (NGTs) by the European Commission distinguish between two categories of NGT plants: Category 1 NGT Plants: plants that could occur naturally or through conventional breeding (point mutations, etc.) and Category 2 NGT Plants: which require risk assessment and authorization under existing GMO legislation.

Pursuing a related issue, Federico Caruso reports on the results of a recent decision in the Italian Supreme Court that may have significant implications for the licensees of protected plant varieties. In the case of fruit crops, it is not unusual for a private breeder to 'lease' a protected plant variety to authorized growers who are required to sell the output only to licensed distributors. However, the Supreme Court has ruled that this practice is null and void because it is contrary to public interest principles expressly indicated in the relevant European provisions and as recognized by the Court of Justice of

the European Union (CJEU). As a result, these club licensing agreements may need to be revisited, for a breeder's rights are exhausted once growers pay the royalties or lease fees: in other words, there is no obligation to sell exclusively to licensed distributors.

In the final article, Laura Carotti, Giuseppina Pennisi and Francesco Orsini discuss recent innovations in vertical farming. Vertical farms, or as they are often called plant factories with artificial lighting (PFALs), are indoor plant growing systems completely isolated from external conditions, where all the environmental parameters (light, CO_2, relative humidity and temperature) are constantly controlled. This level of climate control has the potential, when correctly managed, to significantly increase the yield and quality of the output. However, such control comes at considerable cost: the capital investment is significant, they consume a large amount of energy, and they require specialized labour. While new technologies such as LED lighting, manipulating the spectral composition of the light and the duration of lighting can positively impact plant growth and development, the use of artificial light and high planting densities result in a lot of heat being produced. How this surplus heat is utilised has a significant impact on the profitability of the enterprise.

Continuing with the theme of innovation and technology, we take this opportunity to introduce you to our newest corporate member: CH Biotech. With its headquarters in Nantou, Taiwan, CH Biotech has pursued three core strategies: to reduce plant stress, to enhance nutrient efficiency, and to utilize plant growth promotion technology, while in parallel, addressing some of the major challenges brought on by climate change, the increasing demand for food, and a heightened emphasis on food quality and environmental conservation. With these in mind, CH Biotech has successfully developed a series of plant growth regulators and high-efficiency fertilizers that are highly effective, precise and low-carbon. Many of these innovative products have been derived from agricultural waste or crop residues. This approach not only provides natural materials for the formulation of specific products, but it also helps to reduce global warming caused by improper disposal or combustion.

In the Spotlight, we celebrate the achievements of one of our honored ISHS members. For over 40 years, Alan Lakso has been working with colleagues at Cornell University to better understand fruit crop physiology, primarily on apples and grapes, with an emphasis on integrating crop physiology with environmental effects and cultural practices (thinning, pruning, training, canopy management). Much of his pioneering work has been focused on fruit development and the factors that support it or inhibit it. Alan attributes much of his success to a combination of research, industry engagement and the opportunity to teach bright young students. He offers these words of advice: be a dependable and generous collaborator; treat students, post-docs and support people as professional collaborators; be humble, for we must accept that we are often wrong and therefore, in undertaking our research projects, we should not seek to protect our hypotheses. Rather, if we try our hardest to refute our own hypotheses and we are unable to do so, we know we have a good hypothesis; and finally, recognize that creativity in science is important to make breakthroughs. His attendance at multiple ISHS symposia has enabled him to learn from the experience of others and to forge enduring lifelong relationships with colleagues, while the papers published in *Acta Horticulturae* have proven invaluable in staying up-to-date with current research activities.

We also recognize the achievements of some of our brightest emerging researchers. Patrick Mdemba reports on his efforts to improve the yields and quality of table grapes through the precision application of nitrogenous fertilizer, Thiago Campbell looks at the impact of nitrogen translocation on the biennial bearing of apple, while Fransisca Carrasco-Cuello looks at the role of calcium nutrition in improving the fruit quality and storage of peaches. Andrea Strano explores the impact of LED lighting on the quality and storage of kiwifruit, while Maria Mastoraki looks at the impact of far-red light on fruit yield and quality of tomatoes. From the ornamental plant industry, Charlotte Hubert-Schöler reports on her studies to assess the essential oil content of different *Mentha* spp. Sara Yasemin examines the morphological, anatomical and physiological response of pansies to increasing soil salinity, while Esther Geukens explores the resilience of different genotypes of box leaved holly to high soil pH and the incidence of root rot. Laurine Lambelin reports on her efforts to identify the gene markers for resistance in roses to black spot, while Zhihua Guo explores the mechanisms for the molecular regulation of ethylene biosynthesis in pears. In tackling some of the issues associated with plant breeding programs, Alessandro Giulio Tagliabue discusses strategies to increase the germination rate of seeds derived from new hybrid plum crosses. Finally, we congratulate the winners of the VI International Student Challenge UrbanFarm2024. Ten groups of students from 25 different countries took part in the challenge. On this occasion, teams were asked to design the external areas of a new prison that is being built in Trelleborg (Skåne) by the Swedish Prison and Probation Service Kriminalvården. These spaces are to be utilized in the education and rehabilitation of inmates, facilitating their reintegration into society. The winning team was Lingonträdgard, which was composed of Samuel Martintoni, Shubham Bam, Shannon Cronin, Hasara Kumaragama, Allison Sermarini, Emily Kroll and Goutham Nidhi. Their proposal focused on the indoor production of vegetables using an aeroponic system, and the outdoor production of various types of fruit, which were subsequently used to make jams that could be consumed by the inmates.

A concerted drive to increase and retain membership

› Lukas Bertschinger

Lukas Bertschinger, Treasurer, in charge of strategy to strengthen membership and outreach

Historically, membership of our Society is largely contingent upon the number of symposia that we organize. Not surprisingly, the more symposia that we organize, the larger our membership base. We also find that membership traditionally peaks every four years when we convene, with our partners, the International Horticultural Congress (IHC). However, over the past 2-3 years, our membership base has seen a gradual decline. From the results of the past membership survey conducted almost 18 months ago, the primary reasons for the decline in membership were the high cost and financial hardship. As our past members indicated, in submitting their abstracts for presentation at one of our many symposia or congresses, the costs of their participation were often charged to their institutions or research projects, but the subsequent renewal of their membership was a personal cost that many, particularly from the developing countries, simply could not afford. For others, the reasons for not renewing their membership were that they had either left the industry or retired. While we must accept some turnover, particularly among graduate students who choose to pursue other career pathways, we need to do more to support and indeed retain our membership.

The membership survey revealed that the most important reasons for joining ISHS were the opportunities membership provided in developing international research contacts; the opportunity to participate, at a discounted registration rate, and to present at one or more of the 30+ specialized ISHS symposia held every year; the opportunity to publish the results of research and development projects in *Acta Horticulturae;* and the ability to download full text articles from *Acta Horticulturae*[1]. While this is encouraging, as it aligns with our core business, the Board has recently adopted a targeted marketing strategy to increase and retain individual, corporate, institutional and country membership.

Supported by the results of the recent strategic business review, ISHS will now be offering four distinct options at the Individual Membership level (Table 1).

For our student and early career members, in addition to the existing *Young Minds Award* program and the full range of benefits available to our professional members, ISHS aims to progressively implement a number of dedicated benefits such as:

- attractive career support through mentoring;
- a job platform, linking recent graduates to industry opportunities;
- a collaboration platform for academic exchange programs and internships;
- global support through the recently established Young Minds Committee.

For all Professional and Retired Individual members, the benefits of membership include:

- 20 full text article downloads from *Acta Horticulturae*;
- access to the online ISHS membership directory;
- no abstract submission fee for ISHS symposia, regional congresses in Africa, Asia and Europe, and the International Horticultural Congress (IHC);
- a discounted registration rate for attendance at any one or more of the 30+ ISHS symposia, regional congresses, and the IHC;
- a 25% discount on the article processing charge (APC) associated with the publication of papers within the *European Journal of Horticultural Science* (*eJHS*);
- unlimited access to past issues of *eJHS*, *Fruits* and *Scripta Horticulturae*;
- access to the PubHort platform;
- an opportunity to convene and organize a symposium, to initiate new working groups, or to participate in the management of the Society by chairing a Division or Commission.

As the results of the membership survey clearly indicated the need for a new membership category to meet the needs of our loyal and older members, we have introduced a new 'retired' member category. Our retired

■ Table 1. ISHS Individual Membership options.

Membership option	Description	Annual fee* (EUR)	
Student	Undergraduate and graduate, < 28 years old	30	20
Early-career professionals	< 10 years professional experience after terminal degree *and* < 40 years old, new members only, limited to 2 membership years, then moves into regular Professional Individual Membership	60	40
Professionals	Scientists, extentionists, horticulturists, other. This is the regular ISHS Individual Membership category and applies to most ISHS Individual Members.	100	80
Retired	Available to individuals no longer professionally employed or active *and* aged > 65 years old	80	60

*These rates are online-only. Discounted rates *automatically* apply to members from countries classified by The World Bank as lower-middle income or low-income countries. VAT will be added where applicable. ISHS also accepts payment in USD.

[1]The results of the membership survey were published in *Chronica Horticulturae* 63(3), 5–10 in 2023.

members will enjoy the full range of individual membership benefits at a reduced membership fee. In addition, at our regional congresses and the IHC, we will organize special events for our retired members to meet with colleagues and to renew personal friendships.

To overcome some of the financial problems members have expressed in relation to renewing their individual membership, ISHS is now extending the multi-year membership offer (2 to 5 years) with a 10% discount. For those not interested in renewing for multiple years, ISHS will be offering a 5% discount to members who renew their membership for the next membership year ahead of the expiry date of their current membership.

While all members will continue to receive an electronic copy of our quarterly newsletter *Chronica Horticulturae*, we are also utilizing this publication as a tool for recruiting new individual, corporate and institutional members.

We have also produced, through our communications consultant, three new brochures for each of the individual membership categories. A fourth brochure is currently being prepared to attract new corporate members. These will be utilized by conveners and staff engaged in promotional events such as international trade fairs, exhibitions, the three regional congresses and the IHC to enhance ISHS membership.

Our recruitment and retention strategies are built around four key messages:

- **Growing together.** ISHS membership unlocks a world of opportunities in horticultural innovation. Whether you are an existing member, or looking to join us for the first time, our expert international community promotes multidisciplinary collaboration and provides solutions to your strategic challenges.
- **Cultivate alliances.** Belong to the biggest, global horticultural network. Exchange with leaders in horticulture across the globe and expand your visibility and credibility within the international scientific community, to help drive and focus your own innovation and sustainability targets. Find and engage with collaborative partners in your and other related disciplines.
- **Be seen and heard.** Participate in ISHS congresses and symposia worldwide and publish your work in the peer refereed series of *Acta Horticulturae* symposium proceedings, or submit more comprehensive research papers to the *European Journal of Horticultural Science* (*eJHS*) to ensure your work gets maximum exposure and reaches a global audience through trusted ISHS platforms.
- **Stay connected!** Join a vibrant community of ambitious young minds, industry leaders and like-minded professionals across diverse disciplines in the field of horticultural science. Access career resources, job platforms and leadership opportunities within ISHS, and gain recognition through prestigious awards for your contributions to the advancement of horticultural science. Join ISHS today and help shape a more sustainable and impactful future in horticulture.

› CABI and the International Society for Horticultural Science agree to a journal publishing partnership from 2025

Maria Campbell [CABI] and Yao-Chien Alex Chang [ISHS Board – Publications]

CABI and the International Society for Horticultural Science (ISHS) are pleased to announce a journal publishing partnership from 1 January 2025. ISHS is the world's leading independent organization of horticulturists involved in research, science-based information exchange and collaboration to support sustainable innovation in horticulture. ISHS's publishing portfolio includes two open access, peer-reviewed journals, *European Journal of Horticultural Science* (*eJHS*) and *Fruits, The International Journal of Tropical and Subtropical Horticulture*. The partnership will facilitate the development of ISHS journal publishing activities and enable ISHS titles to join CABI's growing journal portfolio on the CABI Digital Library.

"We are delighted to work with CABI's experienced journals team to make our global horticultural research even more accessible," said François Laurens, ISHS President. "The CABI Digital Library offers an international platform, rich in horticulture and plant science, which is important to our mission of nurturing and deploying scientific knowledge to create a better world."

"We are very pleased to welcome ISHS, CABI's first society partner for journals," commented Erika Newton, Journals Publisher, CABI. "We work with a number of societies and always support our partners in consolidating and developing their publications according to their needs and aspirations."

CABI is a unique, inter-governmental, not-for-profit scientific research and publishing organization, supported by 48 member countries. Its mission is to improve people's lives by providing information and applying scientific expertise to solve problems in agriculture and the environment. A core objective is to increase the impact of science to practically address the Sustainable Development Goals (SDGs). CABI is a signatory to the UN SDG Publishers Compact and a member of the Association of International Research and Development Centers for Agriculture (AIRCA) and the United States Agricultural Information Network (USAIN).

Under the new agreement, *Fruits* will cease to be published from 2025, but all back content will be migrated to CABI. Consequently, the aims and scope of *eJHS* will be expanded to include a more global focus and tropical and subtropical content to better support the community that was previously served by *Fruits*.

Renato Paiva, Professor at Universidade Federal de Lavras in Brazil, will continue to lead *eJHS* as Editor-in-Chief. Professor Paiva is already familiar with CABI having previously authored a book chapter in *Dragon Fruit*.

"I am lucky to lead *eJHS* at this exciting moment in its development," commented

Renato Paiva, Editor-in-Chief, *eJHS*. "*Fruits* has long been a much-loved journal, but I look forward to bringing colleagues together to report and celebrate all aspects of horticulture in one place. *eJHS* will represent all ISHS members and global horticultural research."
Members of ISHS will continue to receive a discount on the article processing charge (APC). Furthermore, ISHS and CABI will continue to support authors from low-income countries utilising the Research4Life discounts and waivers that are available.
From September 1, 2024, new submissions to *eJHS* will open on the CABI Digital Library using ScholarOne. From this date, ISHS will no longer accept new submissions for either *eJHS* or *Fruits*, but will continue to process papers already submitted.
"*eJHS* is the official, peer-reviewed journal of the ISHS", said François Laurens, ISHS President. "Building on its past success, as we embark upon this exciting new phase of development, we encourage our members to support this new initiative".

Issues

A tissue culture and breeding perspective to boost the ornamental industry

Danny Geelen, Jean Carlos Cardoso, Martina Juranić, Marzena Parzymies, Stephanie Saade and Margherita Beruto

The V European Horticultural Congress (EHC2024), held in Bucharest from May 12-16, 2024, hosted the International Symposium on Ornamental Horticulture for the Service of Society. The symposium was structured around three sessions highlighting new strategies in the breeding of ornamental plants, holistic and sustainable approaches in the ornamental industry, and challenges for marketing and the consumption of ornamentals. To facilitate a research-industry approach on relevant topics, focus group events were organized within the framework of this symposium. In this article, we summarize the discussion on how tissue culture techniques and new breeding tools can enhance the ornamental sector. The focus group was moderated by Danny Geelen (University of Gent, Belgium) with four panelists: Marzena Parzymies (University of Life Sciences in Lublin, Poland), Martina Juranić (Wageningen University and Research, The Netherlands), Stephanie Saade (Crop Innovation Specialist at Keygene, The Netherlands) and Jean Carlos Cardoso (Federal University of São Carlos, Brazil).

Question 1. What are the main challenges in the field of ornamental micropropagation? What kind of research will be needed to address these challenges?

There is a wide gap between what academia are investigating and what industry needs. While industry is primarily driven by what the market demands, academia is led by the personal interests of the lead investigator, the availability of financial resources, and the capacity of the host institute. Currently, ornamental research is adopting the CRISPR-Cas technology for gene editing with the aim of creating varieties that have aesthetical value and are more tolerant of pests and diseases. However, such an approach requires a lengthy process of research and engineering, let alone the registration procedure and certification. The industry aims for an immediate solution as they want to implement it as fast as possible: a desire that is difficult to achieve given the long investigation time required and the high investment cost.

In addition, looking at the micropropagation process, there are still many issues that need attention. Industry reports that the presence of endophytic microbes can cause problems with contamination during in-vitro culturing. This is believed to lead to necrosis of the cultured shoots. These problems are strongly dependent on the species propagated and the locations where the culturing is executed. Physio-chemical studies related to the microenvironment in plant tissue culture are often understudied, although this may contribute to solving problems with in-vitro propagation. The need to have efficient disposable methods of in-vitro regeneration (i.e. organogenesis or somatic embryogenesis) may greatly support the further development of genome editing and transgenic applications. Under this context, the development of bioreactors is of considerable interest. While there are only a few companies producing such systems, further development of different types of systems will contribute to higher propagation rates and better shoot quality. In addition, the development of somatic embryogenesis is a valuable method that is complementary to conventional micropropagation. Somatic embryogenesis is highly suitable not only to implement genetic engineering, but also to improve the production of disease-free plants.

The panel further reported that industry initiates new laboratory activities independently from academic research to generate in house know-how and expertise. Such an approach can pay off in identifying somaclonal variants with beneficial properties. Tissue culture laboratories, in an industrial context, have an advantage in that they can address the questions and problems industry faces. These can sometimes be highly context dependent and are often related to improving the automation of processing or handling steps, or to simplify the methodology.

This separation between industry and academic labs has been going on for some time and will need to be addressed, as academic labs are educating trainees that will ultimately work in the ornamental industry. Improving the communication between industry and academia is therefore an important activity to stimulate synergistic interactions and cooperation.

Question 2. What are the main challenges in ornamental breeding?

Ornamental plants tend to have very large genomes: they are often polyploids, which lead to larger flowers and more compact growth, and many of them are outcrossed and are highly heterozygous. These properties complicate the implementation of molecular tools and the rationalization of the breeding process. The presence of transposons has been, and still is, exploited to create new variations in color and shape, which are highly desired by the consumer who wants to be surprised by new types and colors of flowers. However, the same transposons can make a genome highly unstable, which is undesirable because of the difficulties in producing true-to-type clones.

While some companies are commercializing a range of different species, others are specializing in only one or two. The handling and breeding of many species is an enormous challenge and is one of the reasons why ornamental breeding is behind that of vegetable crops. The industry aims to create novel varieties with an attractive appeal, which depends on chance and the breeders' insight into what the market wants. However, it is more difficult to select plants that are easy to process and are more resilient to stress. The molecular analysis of such traits is still in its infancy and will require more studies, something that may be of interest to academics.

Molecular approaches in ornamental breeding are mainly used to improve plant traits such as disease resistance or to select lines or genotypes that lead to a more sustainable production cycle. This includes compact size, faster initial growth and lower requirements in terms of input chemicals (fertilizer and pesticides). However, conventional breeding programs are more focused on ornamental features such as color, number and size of flowers and inflorescences, and better adaptability to the cultivation systems, such as flowering homogeneity. In addition to creating ornamentals with an attractive appeal, there is also a need for producing plants that maintain their attractiveness after they leave the retail store. The composition of the

market is shifting towards an older consumer who pays more attention to high quality plants. Such market factors will continue to drive trait selection and the breeding process. Although molecular approaches to improve breeding are slow and expensive, the general trend is that these will impact the ornamental industry sometime in the future. The main challenges are similar to those experienced with vegetable crops. This should provide an opportunity for academia to invest in research that studies plant transformation and regeneration. Here it is important to investigate the role of the explant, the environmental conditions, and the composition of the growing medium. When such studies are executed, it is paramount that reviewers take their task seriously and check whether the manuscript mentions what species genotype was used in the study, and whether the incubation conditions have been appropriately described. Innovations are also possible in implementing technology that is used in vegetable crops, such as grafting. In recent years, molecular scientists have discovered new factors involved in cell-to-cell communication and how this influences the interaction between tissues and cells. Such processes are likely to be important for an explant to regenerate and produce de novo shoots and roots. Ornamental scientists will need to follow up on these studies to assess whether these new discoveries can be useful.

Question 3. How will recently developed genomic technologies (CRISPR-Cas and genome sequencing) contribute to the ornamental industry?

The number of ornamental genomes sequenced has rapidly increased during the last decade (*Rosa chinensis*, *Phalaenopsis equestris*, *Chrysanthemum morifolium*, *Petunia hybrida*, *Prunus mume*, *Nelumbo nucifera*, *Aquilegia coerulea*, *Cymbidium* orchid, *Dianthus caryophyllus*, etc.), which is invaluable for enhancing ornamental traits, improving disease resistance, and understanding the evolutionary relationships among different species. These sequenced species are also largely the ones that have been genetically engineered, demonstrating the importance of the availability of a full genome sequence for implementing, for example CRISPR-Cas technology. The main obstacle, however, is still the lack of an appropriate regulatory framework. Recent advances in regulating new genomic techniques (NGTs) by the European Commission, adopted on July 5, 2023, distinguish between two categories of NGT plants: Category 1 NGT Plants: plants that could occur naturally or through conventional breeding (point mutations, etc.). They are subject to a verification procedure and will be treated like conventional plants, exempt from GMO legislation. Category 2 NGT Plants: these require risk assessment and authorization under existing GMO legislation. They must be traced and labeled as GMOs. The progression of this legislation has activated the industry to embrace CRISPR technology and prepare transgenic lines with beneficial properties. The key issue is which traits are economically most profitable. With enhanced communication between academia and industry, it will be important to promote the attractiveness of the ornamental industry and to convince policy makers of the importance of subsidizing ornamental research projects. It is likely that progress will be mostly with species for which transformation and regeneration technology has been reported. Even then, it is well known that strong variations in regeneration capacity complicate the engineering of different varieties.

› Discussion during the focus-group event held in the framework of the International Symposium on Ornamental Horticulture for the Service of Society at EHC2024.

Question 4. What are the opportunities to implement artificial intelligence and machine learning in ornamental tissue culture and breeding?

The popularity of artificial intelligence and machine learning is omnipresent and ornamental research will not escape from this trend. AI and machine learning have the advantage of uncovering correlations between inputs and outputs that are not easily identified by classical statistical analysis. The methodology is unbiased in that it does not require any assumptions or hypothesis. It reveals the correlations simply by pointing out which input factors relate most strongly with a desired output factor. Tissue culture regeneration and breeding are highly complex processes that are influenced by many environmental factors which are difficult to control, and by the enormous genetic diversity of ornamental species. Artificial neural network analysis and machine learning approaches are therefore a highly suitable approach for assessing the importance of factors, or combinations thereof, influencing tissue culture techniques.

However, AI and machine learning can only reach their potential when sufficiently large datasets are available, and this is precisely what is missing in ornamental research reports. The current publication standard does not request the deposition of all images taken from cultured explants and other plant materials. Single photos appear in publications to illustrate the results. The possibility to use AI and machine learning to discover new relationships between culturing conditions and shoot growth or organ formation should be viewed as an opportunity to change the conventional publication culture and editors of the specialized journals should be encouraged to request the deposition of recordings of all data collected during experimentation. Such data may not immediately be suitable for image-based analysis because they lack an algorithm or image recognition tools. The development of such tools is dependent on the availability of images and data, which should encourage the research community to collect and make the data publicly available.

The focus group discussion ended with an interesting conclusion that ornamental research will benefit from advanced informatic tools, which the research community will need to fully embrace. Furthermore, there is a call for young scientists to learn these novel informatic techniques and to develop the skills necessary for advanced data collection and organization.

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Is this the end of exclusive arrangements for the sale of fruit produced by a licensee of a protected plant variety?

Federico Caruso

With its decision issued on April 9, 2024, the Italian Supreme Court declared null and void the agreement executed between the well-known American table grape breeder, Sun World, and an Apulian grape grower, Mrs. Miglionico.

Sun World, as a private breeder, licenses its plants based on the popular club variety licensing system. Under this business model, Sun World's plant varieties, which are protected around the world by specific new Plant Variety Rights (PVR) registrations, are propagated by authorized nurseries. These propagated plants are then 'leased' to authorized growers who undertake to sell the harvest only to distributors licensed by Sun World, which owns all the trademarks linked to these varieties.

Mrs. Miglionico was authorized by Sun World to produce the Sugranineteen table grape, marketed under the trademark Scarlotta Seedless®. However, in this case, Mrs. Miglionico sold the grapes produced to a company run by her husband that was not an authorized distributor. As a consequence, Sun World started arbitration proceedings: a means of dispute resolution provided under the agreement to avoid court litigation. The arbitration panel appointed in Milan determined that there had been a breach of contract, and thus Mrs. Miglionico had to pay legal fees and damages, and the license agreement was terminated.

The grower then appealed the award of damages with the Milan Court of Appeal, which confirmed the initial decision.

Mrs. Miglionico then filed an appeal with the Italian Supreme Court to have the decision of the Court of Appeal dismissed. Mrs. Miglionico argued that the obligation to supply the grapes only to authorized distributors was null and void because it was contrary to public interest principles expressly indicated in the relevant European provisions and as recognized by the Court of Justice of the European Union (CJEU). More specifically, Mrs. Miglionico argued that Sun World had no right to require licensed growers to sell the harvested fruit only to authorized distributors since Sun World itself had no right to the fruit legitimately produced and harvested by Mrs. Miglionico under the plant lease agreement. Mrs. Miglionico's defense was based on the interpretation of the European Regulation on Plant Variety Rights (European Regulation No. 2100/94) given by the CJEU at the end of 2019 when the Court determined the Nadorcott case.

According to this judgment, a PVR holder has the right to authorize (and thus also to prohibit) third parties from carrying out activities such as production, multiplication, and sale involving the so-called "materials" of the plant variety, which includes all biological material that allows the propagation and reproduction of the protected plant. Such protection of PVR can be designated as "primary" protection since it is enforced directly on the material necessary to reproduce the protected variety. The PVR holder may enforce its rights also on the "harvested materials" (the fruit), therefore enjoying "secondary" protection only if the following two conditions are satisfied: (i) the harvested materials were obtained from illegitimately cultivated plants; and (ii) the breeder/PVR right holder did not have the possibility to enforce its rights on the "reproduction of propagation materials".

The CJEU also clarified that allowing the PVR owner to enforce secondary protection on the harvested materials (the fruit), regardless of the two above-mentioned conditions being satisfied, could prevent growers from accessing the market, thereby adversely impacting competition.

In light of the interpretation given by the CJEU, the Italian Supreme Court asserted that the agreement between Sun World and Mrs. Miglionico was null. The Court held that Sun World had licensed the propagation "materials" (i.e. the Sugranineteen vines) to Mrs. Miglionico and, therefore, there was no ground to enforce its rights on the harvested materials since they came from licensed and consequently legitimately used plants. Thus, the rights of Sun World were exhausted with respect to the grapes harvested and there was no obligation to sell the grapes produced exclusively to authorized distributors. Furthermore, such a contractual provision, in the view of the Italian Supreme Court, was contrary to the public interest and was therefore null and void.

This decision has significant implications for PVR holders who have implemented club licensing arrangements. Such agreements may need to be revisited, considering that breeder rights are exhausted once growers pay the royalties or lease fees.

However, as the fruit produced from protected varieties are usually also covered by trademark registration for marketing purposes, PVR owners who have registered trademarks for their varieties may still be able to control the distribution of harvested materials on the market through an appropriate trademark licensing system.

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Federico Caruso is an Italian lawyer at SIB LEX law firm specializing in Intellectual Property Law since 2013. He assists Italian and foreign companies in protecting and enforcing their Intellectual Property rights, with a specific focus on trade secrets, patents, and plant variety rights. Federico is particularly passionate about Intellectual Property in the life sciences, biotech, and agriculture sectors. His clients range from small breeders to large life sciences and pharmaceutical companies. He is also a regular contributor to specialized reviews in Intellectual Property Law. E-mail: Federico.Caruso@siblex.com

Spotlight on Honoured ISHS Members

› Alan Lakso

Position

Professor Emeritus, Cornell University, USA

ISHS honour

ISHS Fellow

Your involvement with ISHS [roles/positions]

I have been a member of ISHS for almost 50 years. Although I have not held any official ISHS offices, I have participated in over 30 ISHS symposia, helped organize another 3, and have been on the Scientific Committees of another 12-15. I have also reviewed papers for ISHS journals.

What encouraged you to select horticulture as a career?

I began university at UC Davis, USA, intending to attend Pharmacy School until I took a class in Viticulture and Enology. That was the end of Pharmacy School: I switched my BS to Biology with an emphasis on plant science. After completing my PhD in 1973 on temperature effects on organic acids in grapes, a faculty position in fruit tree management at Cornell University, USA, became available. I remained in that position, albeit with more emphasis on apple and grape physiology, for 41 years until my retirement in 2014. Being engaged in horticulture has been great, both for the science and for so many great colleagues I have met from all around the world. Horticulture allows us to do good science and to make it useful.

› Alan Lakso taking gas exchange measurements in an apple tree (2005).

Highlights of your career

The highlights of my career are the pleasure I derive in working with excellent colleagues and the satisfaction of discovery that can improve fruit growing practices.

I had the opportunity to work with a wonderful group of horticultural scientists, extension specialists and support staff at Cornell's NY State Agricultural Experiment Station (now Cornell AgriTech) in Geneva, NY. Everyone was committed to science to serve horticultural growers and happy to collaborate to attack complex problems. The combination of research, extension or grower outreach, and teaching of bright young students, was synergistic to understanding science and its application.

Beyond Cornell, my research career has been enriched by meeting and learning from professional colleagues from across the globe and forging many lifelong friendships in the process. This has been the result of attending so many ISHS international symposia. In addition, I've welcomed over 40 students or visiting scientists from around the world to my lab over the years.

Being a scientist is a rare privilege as we are allowed and mandated to discover things that no one else has. In my case, better understanding and translating plant science principles to improve fruit growers' practices has been very gratifying.

My main area of research has been fruit crop physiology, primarily on apples and grapes, with an emphasis on integrating crop physiology with environmental effects and cultural practices (thinning, pruning, training, canopy management). The central focus has been fruit development and the factors that support it or inhibit it. Over many years, we have monitored the growth patterns of thousands of fruit. In both apples and grapes, young fruit that are retained to harvest have continuously high growth rates while young fruit that have slow growth rates abscise. In collaboration with Dr. Duane Greene, this led to the development of a grower model for monitoring fruit growth as a direct bioassay of chemical thinners' efficacy within a few days, allowing timely retreatment if needed.

› Alan Lakso receiving the ISHS Fellow Award (2022).

Utilization of light for dry matter production of different training systems and within-canopy light distribution affecting fruit development has been another focus, with many studies of light effects on physiology. Using lasers to simulate sunbeams, we found that yields in apple orchards were primarily related to light interception by the rosette spur canopy in the first three weeks after bloom, while active long shoots support themselves. These studies have helped us to understand the need for localized light exposure of fruiting sites at critical times, guiding pruning, training and canopy management.

Studies of tree and vine seasonal dry matter production and partitioning were undertaken to understand biological versus fruit yield. A simplified carbon balance model, called MaluSim, was developed to integrate growth and physiological measurements taken only at intervals. While this was intended for fundamental research, my colleague, Dr. Terence Robinson, had done many chemical apple thinning trials that allowed us to realize that the carbon balance of the trees at thinning time indicated the sensitivity of the tree

to chemical thinners. Eventually, an online version of the model at Cornell was programmed to run on real-time weather data from networked weather stations in fruit production areas. Growers have found it to be a useful tool to inform their thinning practices for more consistent crop levels and fruit quality. Translating fundamental studies into practical applications has been particularly gratifying.

Water relations has been another area of emphasis due to the extreme variability of New York climates and soils. Due to the deep and erratic root systems in variable soils and weather, we had to focus on direct plant measures of the stress rather than depending on soil moisture. After thousands of pressure chamber readings, we dreamed of continuously monitoring the dynamics of plant water potential. Several indirect methods were tested, but the breakthrough was due to meeting a chemical engineer at Cornell, Dr. Abraham Stroock, who worked on the biophysics of water under tension in plants. This cross-disciplinary collaboration ultimately led to the development, testing and eventual commercialization of a microchip tensiometer to embed in plant stems to continuously monitor drought stress. The company we founded, FloraPulse, is led by Dr. Michael Santiago, Dr. Stroock's former student. The microtensiometers are being tested and used by researchers and growers in many countries on many crops.

How your participation in ISHS has facilitated/encouraged your career?

I was just learning about tree fruit physiology and management in my early years at Cornell when I saw the announcement for the First International Symposium on High Density Planting in England in 1976 (later it became the continuing series of International Symposia on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems). Attending that international meeting was critical to my program as I not only learned of the latest research in a dynamic field, but I was also introduced to many great fruit researchers who became lifelong colleagues and friends. Long discussions over several days were a great feature of these symposia, as well as their interesting locations and their industry focus. I found the *Acta Horticulturae* publications invaluable in keeping myself up-to-date.

What words of advice do you have for students/graduates/early career researchers?

With so many complex research problems such as climate change and sustainability, it is critical to find good faculty or extension/outreach collaborators with complementary expertise and motivations. Be a dependable and generous collaborator. However, in collaborative grant projects, wherever possible, keep separate budgets as not everyone is equally careful with their spending.

Treat students, post-docs in your lab and support people as professional collaborators with appropriate expectations. All too often we may depend on students or technicians with limited knowledge or experience for conducting experiments in the field. It is important to be sure they understand what they are measuring and what the data means, and to outline in advance what types of values they can expect to see. Then, if they see unusual values, they might make a note of it and possibly take relevant observations, such as variations in plant health, abnormal form, disease or pest injury, etc. This is very helpful in interpreting results later. Understanding what you are doing helps focus one's efforts.

Science requires humility. We must acknowledge that we are often wrong and thus re-evaluate our ideas based on new evidence. If we are pushing the envelope of new knowledge, I can attest that we will be wrong, or at least partly wrong, most of the time. While it may not be easy, it is important to accept. Unfortunately, social media is designed to exaggerate things while trying to look good, but such attitudes are deadly to good science which requires exactly the opposite. Hence, I worry about the apparent concern about "branding".

Our hypotheses are not our "babies" that need to be protected and supported at all costs. They are ideas that are proposed to be rigorously tested, and we should be our own harshest critics. If we try our hardest to refute our hypotheses and cannot, we will have a good hypothesis. Also strive for specific hypotheses that make predictions that can be clearly tested rather than vague "see what happens" approaches.

The philosopher of science, Karl Popper said: "[Great scientists] are men of bold ideas, but highly critical of their own ideas: they try to find whether their ideas are right by trying first to find whether they are not perhaps wrong. They work with bold conjectures and severe attempts at refuting their own conjectures." (Author note – great scientists are not just men!) Also "Good tests kill flawed theories; we remain alive to guess again." "Every genuine test of a theory is an attempt to falsify it or refute it." Be careful about confirmation bias. Too often, experiments or data are selected to support a hypothesis.

In addition to humility, creativity in science is also important to make breakthroughs. Nobel Laureate Albert Szent-Gyorgi wisely understood that creativity and discovery requires "...seeing what everybody else has seen, and thinking what nobody else has thought." To help do that, I have found a simple method to stimulate creativity: for each research question or set of results, develop three hypotheses based on different independent mechanisms. It is not always easy, but it helps avoid the trap of easy acceptance of the most obvious answer.

There are many new exciting technologies such as genomics and remote sensing for field research. However, new technology is no excuse for lack of knowledge of the plant; it usually requires a solid understanding of the plant to avoid misinterpretation of results. Beware also of studies of new technology that do not acknowledge limitations of the method. Horticultural plant systems are numerous and variable and do not have huge integrated databases to analyze. Consequently, be careful about depending on AI as it seems to be great at finding patterns in past results and data. But be skeptical about predictions in different conditions that it has not analyzed as our databases are very limited for this purpose.

Finally, do not ignore research that was undertaken before 1990. The technology was limited then but a lot of very good science was done.

› Alan Lakso checking the installation of a microtensiometer in a tree (2024).

Horticultural Science Focus

Innovation in vertical farming

Laura Carotti, Giuseppina Pennisi and Francesco Orsini

Introduction

In order to meet the needs of a growing population, agricultural productivity must increase while in parallel, using fewer resources and pursuing more sustainable outcomes. The expansion of urban and peri-urban agriculture is increasingly being recognized as having the potential to deliver more sustainable and fair food production systems (Vittuari et al., 2021). Urban agriculture includes such innovative production systems as vertical farms with artificial light (VFs) and rooftop greenhouses (Orsini et al., 2020).

VFs, also called plant factories with artificial lighting (PFALs), are indoor growing systems completely isolated from external conditions, where all the environmental parameters (light, CO_2, relative humidity and temperature) are constantly controlled (Orsini et al., 2020; Van Delden et al., 2021). In VFs, with the integration of sensors together with crop growth models, environmental conditions can be adjusted in real time, adapting them to the plant's growth and physiological conditions. This level of climate control allows for a better yield prediction compared to open field and low-tech greenhouses.

Although there are many different typologies for VFs, featuring different functions that range from small and mobile systems to farms for large-scale production, in this article, we refer to large scale vertical farms and container farms (Figure 1).

Vertical farms with artificial light

Most VFs generally have thermally insulated walls, a heating, ventilation and air conditioning (HVAC) system with an environmental parameters' control unit, a CO_2 supply system, a close-loop fertigation system and a LED lighting system (Vatistas et al., 2022). The presence of these technologies is the key factor in facilitating: 1) all year-round production; 2) recirculation and reuse of water and nutrients; and 3) the exclusion of pesticides from routine crop management practices (Orsini et al., 2023). As there are no limiting factors for plant growth, with the application of appropriate cultivation techniques, higher yields can be achieved than those that are possible in greenhouses or the open field (Van Delden et al., 2021). At the same time, the possibility to stress plants in controlled and precise ways during their growth cycle can lead to improved crop quality. All year-round production, potentially higher quality and reduced distance between producer and consumer – and therefore reduced transportation losses – should provide the consumer with improved access to fresher product. VFs can also guarantee better resilience to extreme climate events and pandemics (Van Delden et al., 2021). According to climate models, the frequency of these events is likely to increase as a result of climate change, thereby necessitating rapid adaptation strategies in the agricultural sector (Smith and Olesen, 2010; Thornton et al., 2014).

However, despite the positive impact that VFs may have in adapting to climate change and encouraging more sustainable food production systems, there are still a number of major constraints. For large scale VFs, the capital investment is significant, they consume a large amount of energy and they require specialized labor. Access to these resources can vary widely by geography and the level of innovation used and implemented.

Technological optimization for improved crop production process

The three factors that have the greatest impact on the profitability of VFs are: price elasticity, yield and energy use (Song et al., 2024). The last two factors also have the largest impact on the environmental sustainability of controlled environment agriculture systems, together with packaging, transportation and substrate (Martin et al., 2023; Song et al., 2024).

Figure 1. A) Internal view of AlmaVFarm, the experimental vertical farm of the University of Bologna (Department of Agricultural and Food Sciences, Bologna, Italy), example of a large-scale vertical farm (Copyright University of Bologna); B) external and C) internal view of the container farms at Salus Space (Bologna, Italy).

The high and advanced level of technology that is used in VFs has the potential to deliver increased yield and greater resource use efficiency (RUE), in particular in terms of land, water and nutrient use efficiency. Energy consumption, however, is high, leading to low energy use efficiency values when compared to other production systems (Orsini et al., 2020).

Considering the environmental impact from a broader perspective, VFs are often claimed to perform better than traditional agricultural systems. Nevertheless, only a few studies on this topic are available mainly due to the novelty of these systems (Martin and Orsini, 2023). It is also important to point out that the benchmark for comparison should be the high-tech greenhouse and not the open field (Stanghellini and Katzin, 2024). According to Martin et al. (2023), greenhouse gas (GHG) emissions related to lettuce production in a large vertical farm in Sweden (0.77 kg CO_2-eq kg^{-1}) were lower than the GHG emissions related to the production of lettuce in a greenhouse in the Netherlands (1.44 kg CO_2-eq kg^{-1}). Parkes et al. (2023), focusing on microgreens, reported that the GHG emissions for the production of these specialty crops in a VF in Portugal could range from 3.3 to 63.3 kg CO_2-eq kg^{-1} according to the operational conditions (CO_2 concentration, temperature and photoperiod) and the management of the VF enterprise. From the combination of knowledge in plant photobiology, artificial intelligence, system design, breeding and climate management, there is the potential to increase yield, RUE and therefore to reduce the environmental impact of these systems (Orsini et al., 2023).

LED lights are generally utilized in VF to provide light energy for plant growth. LED lights are smaller, have higher durability and a longer lifetime compared to other types of lamps (Paucek et al., 2020). LED light technology is evolving very fast, and today, the best LED light efficiency performance is between 3.4 and 4.1 μmol J^{-1}. Furthermore, LED lamps are characterized by a high modularity of spectral conditions, which can contribute to increased output and reduced energy consumption. Most recent photobiology research is focused on broadening the light spectrum used for plant growth and providing a dynamic lighting environment to best meet the crop needs, which vary according to the stage of growth (Meng and Runkle, 2020). For instance, fresh weight of lettuce has been shown to increase when 30 μmol m^{-2} s^{-1} of green radiation is supplemented with a red and blue background spectrum (235 μmol m^{-2} s^{-1}) (Razzak et al., 2022). Similarly, another study showed that adding 52 μmol m^{-2} s^{-1} of far-red radiation to a red and blue background (218 μmol m^{-2} s^{-1}) increased the yield of lettuce by +61%, thanks to the faster expansion in leaf area (Jin et al., 2021).

As already mentioned, light characteristics can also be modulated to achieve the highest possible quality. For example, an increase in light intensity or in blue radiation applied at the end of the growth cycle, before final harvest, can stimulate pigmentation in the leaves or improve the postharvest performance (Min et al., 2021; Kelly and Runkle, 2023). In addition to the optimal light spectrum, photoperiod control (the duration of light per day) can deeply affect several plant processes, such as flowering, morphological development and biomass accumulation, while also affecting the energy demand of the system. In the case of leafy greens, a photoperiod of 16 h d^{-1} (with a light intensity of 215 μmol m^{-2} s^{-1}, corresponding to a daily light integral of 14.4 mol m^{-2} d^{-1}) can increase biomass and optimize the use of light, energy and water, compared to longer photoperiods (Pennisi et al., 2020). Photoperiod can also be supplied to plants in a discontinuous way to adapt to the hourly pricing of the electricity market, providing an opportunity to shift the demand load thanks to the fluctuating lighting scheme (Avgoustaki and Xydis, 2021). There is some evidence that some crops can tolerate intermittent light exposure, reducing the energy consumption without any variation in terms of biomass and quality compared to plants grown with a continuous photoperiod (Avgoustaki et al., 2020).

With regard to irrigation, closed systems that allow recirculation of water and nutrients are normally used within VFs. These systems make it possible to achieve high performance in terms of water and nutrient use efficiency. For commercial production in VFs, ebb-and-flow systems are typically used, but the adoption of high-pressure aeroponic systems can also be used to improve water use efficiency (WUE) even further (Figure 2).

A recent study, comparing the growth of lettuce plants in an ebb-and-flow system and a high-pressure aeroponic system, reported how, in the latter case, WUE increased by 114%, without any negative effect on yield (Carotti et al., 2023a). Since aeroponics do not involve the use of any kind of substrate, it could also have the potential to reduce the overall environmental impact of VF systems, although comparative systematic studies on this aspect are still lacking. Regardless of the system used, recovering water from the internal air through a dehumidifier is a very efficient strategy to further increase the WUE in VFs. However, this strategy must be applied considering the trade-off between water consumption and the energy required to dehumidify the indoor growing environment.

The use of artificial light and high planting densities ensure that a lot of heat is produced inside VF systems, contributing to the high energy consumption to maintain optimal temperatures for plant growth. The extracted excess heat could be a source of heat for local district networks. In order to make production systems more circular

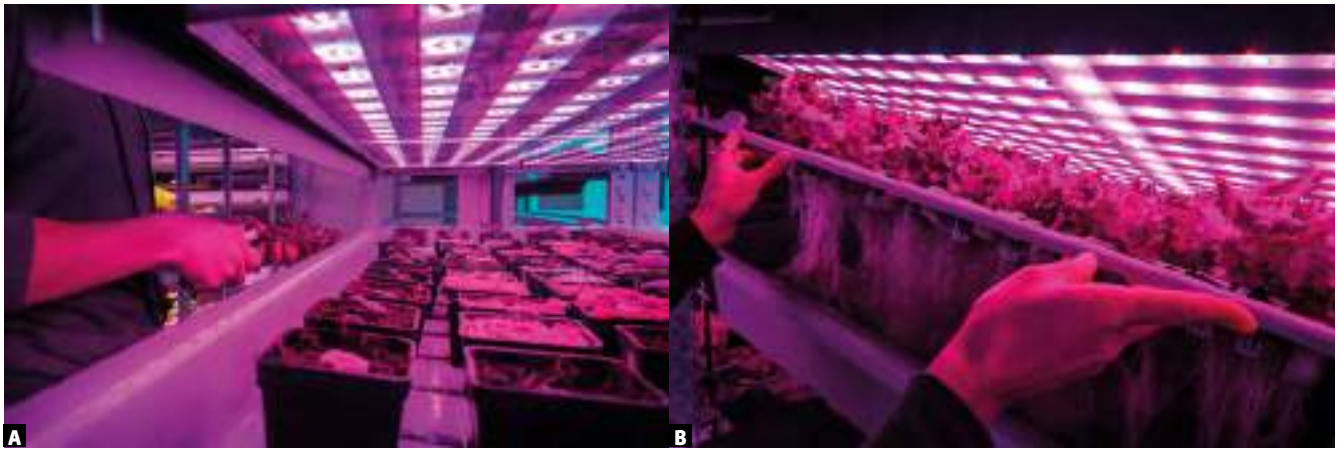

Figure 2. Example of two close loop growing systems. A) ebb-and-flow and B) high-pressure aeroponic system. Photo credit: Marco Raccichini.

by reusing resources, in this case heat, VFs can be integrated with urban building energy systems (Martin et al., 2022). There are already some functioning examples, such as the vertical farm Nära Sverige (https://www.narasverige.se/en). The company produces green lettuce, green kale and pak choi in a vertical system in the parking place of a residential building that reuses heat extracted from the vertical farm. A study based on a hypothetical VF in the Netherlands estimated that the synergistic integration of VF into building design could reduce the energy consumption of both units by 12 to 51% (Blom et al., 2023).

Besides the innovation in technology and in growing protocols, seed selection and breeding may further improve yield and therefore the sustainability of VFs. In VFs, complete control of environmental parameters allows producers to focus on phenotypic stability, one of the main goals of breeding in traditional cropping systems. Trait selection for rapid growth, enhanced growth in a low light environment, improved light use efficiency, as well as improved taste and flavour could become an important priority for the sector (Folta, 2019; Song et al., 2024).

New business models and social implications

To meet the demands of consumers, retailers and institutional users, new business models are being developed in the VF sector. As an example, in this case with small-scale modular systems, the enterprise provides fresh food to consumers located in restaurants, supermarkets and commercial and residential spaces, while VF companies retain ownership. This business-to-business strategy is an effective way to expand markets and to build awareness (Martin and Bustamante, 2021).

Today, food choices are influenced not only by the sensory pleasures, but also health and environmental aspects, that should become part of the business model (Hoek et al., 2017). Results of an online survey delivered to consumers revealed that the main driver for the acceptance of VF products by the consumer was the perceived sustainability. Sustainability in VF systems is generally perceived to be higher by consumers as the size of the cultivation system increases (Jürkenbeck et al., 2019). However, these results are not necessarily supported by scientific evidence.

With a view to provide appropriate tools for understanding these new production systems, education and training are elements at the center of several European and national projects coordinated by the University of Bologna. Among them, the H2020 FoodE project and the PRIN project VFarm have trained and aim to train different stakeholders, including students, citizens and companies on the topic of agriculture in a controlled environment. In the case of students, training also takes place through the application of innovative teaching methodologies that can address the need to actively engage students to optimize effective learning. For example, in a participatory activity that took place at AlmaVFarm – the experimental vertical farm of the University of Bologna – 39 Master students were involved in a group-work experimental activity. Data collected through a survey distributed at the end of the project showed that joining the participatory activities increased students' level of knowledge and confidence in the field such as innovative technologies for controlled environment agriculture and plant physiology. The activities also increased student interest in research and development (L. Carotti, pers. commun.).

Considering that the environmental conditions for crop growth in VFs can be precisely monitored, every plant species could potentially be grown in these systems (Figure 3). However, to date, production in commercial farms has mainly been limited to compact plants with a short growth cycle and plants that require low light intensity between 100 and 300 μmol m^{-2} s^{-1} (Vatistas et al., 2022). The specific management of light features, optimized according to the crops needs, could contribute to the year-round production of nutraceutical, functional foods and medicinal crops (Appolloni et al., 2021; SharathKumar et al., 2024).

VFs are also suitable for seedling production. The absence of pathogens, greater uniformity in the product and compactness are highly desired features for seedlings. Different studies have evaluated how photosynthetic photon flux density (PPFD) and light spectrum management may impact seedling yield at transplanting and how the conditions applied during this first stage of growth could then impact mature plants (Carotti et al., 2023b; Zheng et al., 2023).

Whether and how to make the cultivation of crops other than leafy greens in VFs more environmentally and economically sustainable, through the application of the optimal technologies and appropriate business models, is the next challenge. As reported by some authors in the case of staple crops such as wheat, even if cultivation in VF is not yet economically viable, it could be useful in case of extreme weather conditions (Asseng et al., 2020).

Finally, it is important to note that the sustainability and feasibility of these innovative systems depend on the geographic area. Paucek et al. (2023) sought to analyze the potential of VFs in 54 African countries through the assessment of 147 development indicators covering the three main pillars of sustainability (economic, social and environmental), enriched by four additional thematic areas: urban development, energy, food security, science and technology. The results of the work demonstrate that the countries with the best potential for implementing indoor VF are the Seychelles, South Africa and Egypt.

Figure 3. Research activities at the University of Bologna on innovative crops for vertical farming. Copyright University of Bologna.

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Trends and issues in the world of vegetables

An interview with Marco Wopereis, Director General, World Vegetable Center

Peter J. Batt (PB): **Marco. I want to kick off by taking a helicopter view of the world and what's happening today in vegetable land. What are the key issues that are impacting vegetable producers today?**

Marco Wopereis (MW): That's a very big question. It very much depends on context. If you look at an Australian vegetable producer, he or she would be very worried about geopolitical issues. The imposition of trade barriers and fluctuating exchange rates not only impact the cost of inputs, but also relative competitiveness in the market. Such a producer might also be concerned about costs and availability of labor and may want to invest in mechanization and automation.

Contrast that with the people we most work with, let's say smallholder vegetable producers in Nigeria selling in Lagos. They will worry about seed quality, pests and diseases, getting the product to market on time on a very bumpy road, and with no refrigerated transport, the product might not keep for more than just the morning. Furthermore, producers are often forced to sell what they have produced, rather than what the market wants. Both the Australian and Nigerian producers, however, will worry about climate change.

PB: **Recognizing that climate change is one of the key issues, what is the World Vegetable Center doing to address that?**

MW: There is a lot going on, particularly from the adaptation angle. Our genebanks in Taiwan and Tanzania house the largest collection of vegetable genetic resources in the world. The largest is in Taiwan where we keep seed accessions in walk-in freezers so they remain viable and available for future generations. We currently hold some 70,000 accessions, and this is growing, as we are actively collecting in Africa. Within this treasure box we are always looking to see if there are traits that can help us adapt to climate change, in particular for tolerance to heat, drought, flooding and salinity, as well as resistance to all kinds of pests and diseases that are now appearing at a faster rate.

We are using this material to develop breeding lines that are then picked up by seed companies. We have a consortium of seed companies in the Asia Pacific region that use our lines in their own breeding programmes, thereby providing an impact pathway to adapt to climate change. In Africa it's a bit different, as seed companies rarely have active breeding programs. They test material and we bring in finished lines and see how they adapt to local growing conditions.

On the climate mitigation side, there is an enormous amount of work starting up. The key point here is the excessive use of external inputs like chemical fertiliser and pesticides in production systems. Even in Africa, when we looked at peri-urban food systems, we were astonished by the amount of pesticides and chemical fertilisers used. This presents a huge carbon footprint that we need to bring down. One culprit in particular is nitrogen fertilizer, because if you use that inefficiently, it will lead to nitrous oxide emissions and that is very bad for the climate. To reduce the use of mineral fertiliser, we are encouraging farmers to use composting, vermicomposting, and crop rotation with legumes and green manures.

In Taiwan, we have initiated some long-term trials where we are measuring soil health and greenhouse gas emissions to see whether intercropping with legumes or the use of biochar, for example, can reduce greenhouse gas emissions from the soil. We are also trying to find ways to reduce tillage intensity in vegetable production, as frequent tillage destroys organic matter and releases carbon dioxide. We are finding that, for example, some hardy vegetables like okra may perform surprisingly well under reduced tillage and even in a no-till system.

And we are always thinking about how we can get more people to eat more plant-based diets. This will also help reduce greenhouse gas emissions, particularly with regards to methane. Adaptation is our mainstay. Our main product is seed, and developing varieties that are better adapted to climate change. However, what we increasingly need are 'super resilient' varieties, because, with climate change, abiotic and biotic stresses are becoming more intense and more frequent. Ideally, we need varieties that are resistant to multiple pressures and can thrive with fewer external inputs. The development of such super resistant varieties must go hand in hand with more sustainable crop management, drastically reducing the reliance on external inputs.

PB: **Given the emphasis that you have placed on plant breeding, to what extent is the World Vegetable Center engaged in genetic engineering or advocating genetic engineering versus more traditional plant breeding techniques?**

MW: In Taiwan we had large facilities for GMO work, but we have completely dismantled that, because from the consumer side, there is a reluctance to accept GM crops. However, we are researching the use of new technologies like gene editing, where no foreign material is brought into the plant, so the end result is no different from what you could get from conventional breeding.

Currently, all breeding lines that seed companies pick up have been developed through traditional, albeit sophisticated breeding technologies, using high throughput phenotyping, genotyping and big data analysis. With regard to gene editing, we are currently working with the National Taiwan University for example, to develop insect resistance in tomato whilst maintaining fruit size. The genes involved are linked, and it would take you a lot of time to break this linkage using traditional breeding. With gene editing it may be faster.

PB: **The challenge that this then creates for you, if you do come up with desirable progeny, is how are you able to protect that intellectual property?**

MW: Everything that we do is globally accessible. WorldVeg produces international public goods. However, we also work with about 50 seed companies in the Asia Pacific seed consortium, to whom we offer limited exclusivity over our breeding lines. We have a field day every year where companies come and can see which lines look interesting, and we give them a two-year head start on the competition. However, we can bring promising material from our Asia Pacific consortium directly to Africa. In any case, after two years these lines become available to others. People simply need to go to our website and request access to the material.

PB: **That's a really positive outcome. While it's still open access, through an innovative licensing arrangement you're able to give the seed companies an incentive.**

MW: Exactly. In the Asia Pacific region, if we don't work with seed companies our work

won't get to farmers. At least 30% of farmers buy their seed, so if we want the traits that we find in our genebank and breeding lines to get into the farmers' fields, we need to work with them. Furthermore, as seed companies are closer to farmers, they are better placed to tell us what we should be working on. They are our eyes and our ears, and they keep us on our toes.

We also co-develop special projects with consortium members. To date, we have had ten of these, entirely funded by seed companies, including four on bitter gourd. When we showed seed companies the diversity of bitter gourd we have in our genebank, as compared to the narrow genetic base of commercial bitter gourd cultivars in the field in Asia, through a scientific paper, everybody realised that it was important to bring that diversity into farmers' fields and that is actively happening now. Other special projects focus on improving heat stress tolerance in tomato and pepper and tackling diseases such as that caused by chili leaf curl virus.

***PB:* When we were chatting a moment ago, you talked about big data analysis. What role does artificial intelligence play in the vegetable industry?**

MW: We are starting to use AI to make sense of the big data produced by phenotyping and genotyping work. Our high throughput phenotyping system in Taiwan allows us to monitor day and night the plant growth in real time of several thousand plants, and that generates a huge amount of data. Using AI, our plant breeders can now see what genotypes really stand out with respect to flood or heat tolerance for example.

***PB:* The other major application of AI is in smart farming systems. But given the type of people that you work with, to what extent can smallholders in Asia and Africa utilize smart farming?**

MW: Right now, that's difficult because of the high cost of these technologies. However, high tech environments may have a place in Asia or Africa, near big cities for example, where there is a focus on particular products of interest to middle- and high-income consumers.

For most farmers we work with, vegetable production will continue to come from open field systems, more and more assisted by affordable protected cultivation techniques and drip irrigation systems to extend the growing season. Protected cultivation also allows farmers to have more control over the environment, making it more feasible to introduce new varieties and new technologies like grafting and crop rotations.

Right now, more than three billion people worldwide cannot afford a healthy diet that includes fresh fruit and vegetables. We have to work on both affordability and availability. From the data we have, global fruit and vegetable production is insufficient to meet the WHO dietary recommendation of 400 g of fruit and vegetables per person per day, and this has been since global records began. In 1965, sufficient fruits and vegetables were available for 17% of the global population, increasing to 55% in 2015. Supply varies widely between countries. In Africa, only 13% of countries have an adequate vegetable supply, compared to 61% of countries in the Asia Pacific region.

***PB:* You indicated earlier that WorldVeg has the largest collection of vegetable germplasm in the world. But is that enough?**

MW: In 2021, at the UN Food Systems Summit, we rang alarm bells about declining fruit and vegetable biodiversity. This is happening because of climate change, land use change, urbanization and because everybody seems to want to eat the same uniform, highly processed food. We launched a call for action to collect, conserve and use vegetable biodiversity from different parts of the world before it is too late. In Africa, we have identified biodiversity 'hotspots' and, with funding from Taiwan, we have collected more than 15,000 accessions in the past three years of some 25 species that can address malnutrition and resilience to climate change.

We collect traditional or 'opportunity' vegetables and their wild relatives because they can contain very important traits for future breeding. Only a fraction of the seed conserved in genebanks worldwide are vegetables, and that's crazy, given the number of species we know are out there. We have now developed a vegetable biodiversity 'rescue plan' for Africa, validated by the African Union Commission in April, that we will launch at the African Food Systems Forum in September. We hope this will become an example for other regions in the world. If we don't collect, conserve and characterize what we have, we will miss out on opportunities for economic, health and nutrition benefits that farmers and consumers need.

***PB:* From my own experience with smallholders, they constantly struggle with the cost of inputs. To keep those costs down, there are a range of sustainable technologies that are more appropriate for them to use. What sort of technologies is the World Vegetable Center currently promoting?**

MW: Because vegetables are highly perishable, we always try to work on both the supply and the demand side. It makes no sense to produce vegetables if there is no market for them. More and more we tend to work from end to end, but we can't do everything. Our strength lies in our seeds. We want to ensure that farmers have access to high quality seed that is well adapted to the soil and weather conditions, and to market needs. We work on good agricultural practices, but we also want farmers to produce what they can sell, and not be forced to sell what they happen to produce.

In Africa, we support small and medium size enterprises in processing and aggregation. We connect the dots by setting up vegetable business networks where some 30 or 40 farmers come together around an aggregator or a champion in the value chain. They might work together for a particular end market or focus on a particular product like tomato or chilli pepper, or they focus on traditional vegetables like African nightshade, amaranth or African eggplant. It's about producing what consumers want, aggregating, and getting the product to market as fast as possible, which avoids the need for storage that often entails significant losses.

In terms of technology, it's definitely higher quality seed. In Africa, most vegetable seed is imported and often not tested for local growth conditions. Through our consortium in Africa that I mentioned earlier, we test new breeding lines thoroughly with farmers and seed companies and select only the best lines that are well adapted to the local growing conditions. We also have breeding programs in Africa, such as on amaranth, African eggplant and habanero pepper. We are also investing in biocontrol and IPM technologies. We particularly want to reduce the overuse of pesticides because it's not only about affordability, but from the consumer side, it's also about acceptability and desirability.

Bringing together the demand side and the supply side in an end-to-end approach is becoming more important. The challenge here is how to get to scale. In a project, we might work with 5,000 producers in 200 vegetable business networks. We need to make sure these networks are sustainable and we need to get that knowledge out to others.

***PB:* So how do you get that technology to smallholders when the days of one-to-one extension are long gone. Surely it has to be through farmer groups or farmer field schools?**

MW: We are working with distribution platforms that directly connect consumers to producers and then get key messages out to smallholder farmers connected to these platforms. We have found that social media, videos and text messaging are very effective. We have done a study on the use of texts in Laos and Cambodia and published the results. It's working, but to be more efficient and scalable, it also requires field visits and demonstration days to cement the connection.

***PB:* In terms of connecting farmers to markets, which models do you find are most effective in terms of being able to mobilize growers and get them to work together?**

MW: We are doing impact studies on the effectiveness of our vegetable business networks. Some are being created around a farmer, others around an aggregator or a supermarket. I don't have an answer to your question just yet. It would be great to organize an international conference to share such experiences and see what works best and where. We have a wealth of information in Africa, but not so much in other parts of the world.

***PB:* The health and nutrition benefits that you speak of are so often overlooked in terms of these indigenous vegetable varieties. How do we rectify this?**

MW: We need to create demand. Unfortunately, we see more people eating cheap, highly processed food. Poor diet causes more deaths globally than any other risk factor. Most diet-related deaths are from too much salt, fat and sugar; and not enough wholegrains, fruits and vegetables. Add to this life-years lost to disease, and it adds up to a huge, expensive and debilitating health problem in every country in the world.

In big cities it is increasingly difficult to find nutritious food like fruits and vegetables. Accessibility is clearly an issue, but also desirability, and this requires marketing. We need to learn from fast food and processed food companies and market fresh fruit and vegetables in a much smarter way. Walk around Manila for example, and you will see constantly flashing panels urging you to eat all this bad food. We need public sector interventions to counterbalance the marketing power of the big food companies.

***PB:* Two other related issues that we have yet to touch on include food safety and food waste.**

MW: I already talked about consumer concerns with food safety. Tomatoes in a traditional market for example may contain many pesticide residues. So, we need to put into place systems that minimize reliance on chemical pesticides, and if we can do away with them altogether, that would be great. Options include biological control, biopesticides, or more controlled environment infrastructure. We can also facilitate testing, legislation and marketing of biocontrol products. Governments need to have systems for the rapid testing of pesticide residues to give consumers greater confidence. This often implies some type of certification, but I'm not talking here about expensive third-party schemes. Transparency around where the product comes from and how it has been produced can come from participatory guarantee systems (PGS), where producers and consumers come together and agree on a minimum set of standards.

Regarding vegetable food waste, in middle- and lower-income countries it's more about postharvest losses before products get to market. As consumers have low incomes, domestic food waste is minimal. Vegetables are highly perishable, but we can reduce postharvest losses from 40-50% to 10-20% with better storage, transport, packaging and processing. And if fresh produce can be brought quickly from the farm to the consumer with better logistics, packaging can be avoided altogether. This is good for productivity, good for pricing, and good for climate change mitigation as impacts on carbon footprints would be tremendous.

***PB:* Given that so many chemicals are largely applied for cosmetic reasons, what else can producers do to differentiate their product in the market?**

MW: Farmers must clearly indicate that their vegetables come from a particular area that endorses safe, responsible and environmentally-friendly food production. In Ethiopia for example, some of our champion farmers are using apps that show consumers how the vegetables have been produced. This too is like a guarantee system that builds trust.

In making fresh vegetables more acceptable to consumers, it's important to start young. We are currently working with school meal programs, in conjunction with the World Food Programme, to bring fresh vegetables into schools. We work with farmers using very safe production practices, and also support school gardens so teachers and children learn how to grow them.

Furthermore, we find that some farmers we work with find other markets. And many parents realise that they can grow vegetables in their back garden. It's extremely exciting to work with school meal programs, but again, scale is an issue. However, we hope to achieve a step change by working with ministries of health and education.

***PB:* When we talk about sustainability, we hear a lot about the three P's: people, profit and planet, but I'm becoming a very strong advocate of a fourth P: policy, because nothing will happen without political intervention or will.**

MW: We are working on an idea called Urban Fresh, a 'coalition of the willing' to make fruit and vegetables more accessible and affordable in cities. It requires bringing everybody around the table, without vilifying anybody, seeking to better understand each other's position. We can then collectively explore ways to make fruit and vegetables more affordable and accessible in cities like Manila or Hanoi. We're doing pilot studies to see how this might work, and engagement of municipal authorities is critical, so they understand how important it is that their urban citizens have access to healthy nutritious food. The public health costs in dealing with obesity and malnutrition are huge, so linking that to policy issues is paramount. If we get momentum behind the Urban Fresh idea, we will engage with the Milan Urban Food Policy Pact, which works with about 250 cities worldwide, all interested in providing healthy nutritious food to their citizens. Through the Pact, lessons learned and approaches we are testing in pilot studies will enable us to rapidly achieve scale.

***PB:* Doesn't the key role municipalities play add further support for the inclusion of that fourth P?**

MW: Our research framework indeed involves 3 P's: pull, push, policy. These three dimensions of a food system need to come together, especially for perishable commodities like vegetables. On the supply side, the 'push' involves working on availability and affordability of vegetables. On the demand side, the 'pull' works on accessibility and desirability, and the need to create 'space on the plate' for healthy nutritious food. Finally, there is policy.

When you think about horticulture in the countries we work in, governments are often enthusiastic about promoting exports, and that is fine, but this should not be at the expense of stimulating domestic production and consumption. Poor quality diets lead to massive problems with stunting symptoms in children around the world. According to UNICEF, one in four children under five years of age are severely deprived of healthy nutritious diets. These kids may never reach their full potential. Then there are the huge health problems associated with obesity, because of the over consumption of highly processed food. We must make sure that national policies and strategies are focused on stimulating domestic production and consumption of fruit and vegetables, and not just export. This is all the more important because most of these countries are experiencing rapid population growth and greater urbanization. WorldVeg is a relatively small player, with a huge mandate. We see ourselves as an 'open science center' that very much welcomes partners who can make a difference on the pull, push and policy side. We need all the help we can get to realize the tremendous potential of vegetables for healthier lives and more resilient livelihoods.

› Marco Wopereis

› About the author

Marco Wopereis joined the World Vegetable Center (WorldVeg) as Director General in April 2016. An agronomist with a Doctorate in Tropical Agronomy from Wageningen University, The Netherlands, he has global expertise in agricultural science and management, and previously served as Deputy Director General and Director of Research for Development of the Africa Rice Center (AfricaRice) in Benin, and as Director of the Annual Crops Department of the French Agricultural Research Centre for International Development (CIRAD) in France. He also worked in different capacities for the International Fertilizer Development Center (IFDC) in Togo, the West Africa Rice Development Association (WARDA, now AfricaRice) in Senegal and Côte d'Ivoire and for the International Rice Research Institute in the Philippines. Marco is a Dutch national, and is based at WorldVeg headquarters in Taiwan. E-mail: marco.wopereis@worldveg.org

Horticultural Science News

› ISHS Young Minds Award winner summaries

Below is a selection of research summaries from winners of ISHS Young Minds Awards for best oral and poster presentations at ISHS symposia. To view other exciting research summaries by other winners, please visit www.ishs.org/young-minds-award.

Management of table grapes through precision nitrogen fertilization

› Patrick Mdemba

Patrick Mdemba is currently a Master's candidate at the French Associates Institute for Agriculture and Biotechnology of Drylands, The Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Sde Boqer, Israel. He works under the supervision of Prof. Noemi Tel-Zur and Prof. Arnon Dag. His research is focused on "Fertilization of table grapes with nitrogen" at the Gilat Research Center, Agricultural Research Organization, Volcani Center, Israel.

Nitrogen fertilization is a vital component of vineyard management. However, field studies to gauge the nutritional demand of perennial crops are challenging, due to the high levels of nutrients already present in the soil before experimentation, thereby making it difficult to measure the actual effects of fertilization treatment. The objectives of this study were to examine the specific relationships between N nutrient level, grapevine growth, and productivity in two table grape cultivars: white ('Early Sweet') and red ('Crimson') during two consecutive seasons (2022 and 2023). For this study, an inert growing system using perlite was utilised to fully control nutrient availability through a fertigation system. The results indicated that leaf area index, evapotranspiration, and dry weight of pruned branches significantly increased with increased N application from low to high (10-100 mg L^{-1} N), and moderate supply (10-50 mg L^{-1} N) in 'Early Sweet' and 'Crimson', respectively. High N utilization efficiency (of more than 70%) was achieved between low and moderate N supply, while more than 60% of N supply was collected as leachates in higher N treatments (above 100 mg L^{-1} N). Nitrogen application levels were positively reflected in N concentrations in leaf samples with blade analysis providing more consistent results than petiole analysis. The number of primary clusters was significantly reduced with increased N supply in both cultivars. Increased N availability reduced sugar accumulation in developing fruits in both cultivars. The results of this study indicated that precise nitrogen management on 'Early Sweet' and 'Crimson' varieties can enhance growth, increase yield, and improve fruit quality. This approach also enables better N utilization, resulting in reduced production costs and minimal environmental contamination.

Patrick Mdemba won the ISHS Young Minds Award for the best poster presentation at the XIII International Conference on Grapevine Breeding, Genetics and Management in Turkey in August 2023.

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Use of LED lighting in postharvest and its effect on kiwifruit quality

› Andrea Strano

New varieties of red-fleshed kiwifruit have recently been introduced into the market and are widely appreciated by consumers. The use of LED lighting offers a novel opportunity to improve the postharvest quality during storage. The aim of this study was to determine if the postharvest application of exogenous light radiation affected the colorimetric characteristics of the fruit, fruit quality and postharvest biotic and abiotic disorders. After treatment under LED lights, all samples increased the amount of total soluble solids due to the dehydration of the fruit. LED treatment also showed a notable reduction in firmness, suggesting that extended exposure could accelerate the ripening process. The dry matter in LED-treated fruit decreased, supporting the theory that blue light can cause rapid sugar consumption during the ripening process. However, no significant differences were observed in the concentrations of chlorophyll A and B. In an analogous way, the total polyphenol and carotenoid concentrations remained statistically equal to the control. Each LED treatment also enhanced the red surface of the fruit but did not have a significant effect on colour intensity. In conclusion, LED lighting: i) accelerated the ripening process of the fruit and increased the sugar/water ratio; ii) the reduced dry matter percentage indicated that fruit sugars had been metabolised; iii) the colour assessment showed an increase in the pigmented surface percentage of the fruit but did not directly impact the colour intensity; iv) fruit softening was slowed down by UV-A, white and far-red radiation, but did not reduce physiological disorders. This study was funded by Zespri International Limited and European Union Next-Generation EU (*Piano Nazionale di Ripresa e Resilienza* - PNRR).

Andrea Strano won the ISHS Young Minds Award for the best poster presentation at the XI International Symposium on Kiwifruit in New Zealand in February 2024.

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(A)biotic stress in *Ilex crenata:* solving problems of soil pH and black root rot

› Esther Geukens

Ilex crenata or box-leaved holly has gained popularity for use as an ornamental shrub for topiary and hedges in Western Europe. *I. crenata* prefers acidic soils, which makes it less than ideal for the typically pH-neutral private garden. When grown in neutral pH soils, *I. crenata* experiences problems with nutrient uptake. A higher soil pH also creates favorable conditions for the soil-borne fungus *Berkeleyomyces basicola*, the causal agent of black root rot. This combination of abiotic and biotic stress poses a serious threat to *I. crenata* planted in gardens. More resistant and tolerant cultivars can be developed through breeding. Up to now, new cultivars of *I. crenata* have primarily resulted from lucky finds, but interest is growing in targeted breeding to improve tolerance or resistance to abiotic and/or biotic stress. In this study, rooted cuttings of 15 genotypes were planted in substrate with pH 4.1 and 7.5, and a spore suspension was mixed into the substrate to inoculate the roots with *B. basicola*. All treatments were compared to control plants in a low pH substrate without inoculation. Evaluated parameters were root and shoot weight, chlorophyll fluorescence and a root score based on the level of fungal root necrosis. Furthermore, a qPCR assay developed within this project was used to quantify fungal DNA in the plant roots. Our findings revealed that tolerance to high soil pH varied among the 15 genotypes tested, with one genotype showing significantly better tolerance. The genotypes also showed differences in tolerance to black root rot, but no genotypes showed resistance or a high level of tolerance. Furthermore, this study shows the efficacy of bioassays as a selection step in plant breeding programs. The better performing genotypes will now be used in crossbreeding and the pH and disease tolerance tested in the progeny using the same bio-assay.

Esther Geukens is a PhD student at Flanders Research Institute for Agriculture, Fisheries and Food and KU Leuven. She won the ISHS Young Minds Award for the best oral presentation at the V International Symposium on Woody Ornamentals of the Temperate Zone in Japan in April 2024. This research is funded by a Baekeland mandate (VLAIO).

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Breezing: a new dedicated Italian plum breeding program

› Alessandro Giulio Tagliabue

In a mature market, interest in offering new plant material is more important than ever before. Japanese (*Prunus salicina*) and European (*Prunus domestica*) plum species, including plum and apricot hybrids, have become the focus of renewed breeding programs to develop novel fruit ideotypes. Resistance to disease, especially plum pox virus (PPV) and brown rot, environmental adaptation and enhancing fruit quality are the most desired features. In 2022, a new private plum breeding program, "Breezing", started under the supervision of the University of Milan, Italy, with the aim of exploiting local Italian germplasm resources, as well as knowledge and techniques to develop promising materials. In making the first step, different crosses of *P. salicina*, *P. domestica*, and interspecific *P. salicina* × *P. armeniaca* were made, and an in-vitro protocol established to increase the germination rate of F_1 seeds, leading to the production of several cross-combinations in the field. Under this protocol, the program has managed to overcome the low germination (1.6%) generally associated with classical seed stratification techniques, raising rates to about 17%. The ability to produce and analyze the resulting offspring will allow plant breeders to better understand and elucidate the genetic determinants of traits of interest and to develop molecular markers for more cost-effective and rapid breeding programs for these species.

Alessandro Giulio Tagliabue won the ISHS Young Minds Award for the best poster presentation at the I International Symposium on Apricot and Plum in France in April 2024.

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Towards the identification of quantitative resistance mechanisms of rose to black spot disease

› Laurine Lambelin

Laurine Lambelin is a PhD student at the University of Angers, France, working with the Genetics and Diversity of Ornamental Plants team at the Institute of Research in Horticulture and Seeds. Her research is focused on the resistance of roses to black spot disease, caused by the hemibiotrophic fungus *Diplocarpon rosae*. Black spot is one of the main foliar diseases of garden roses. Resistant varieties have proven to be an efficient alternative to the use of fungicides, but the genetic basis for resistance is not well known, and understanding the underlying mechanisms of resistance is essential for the effective and durable deployment of resistant varieties. Analysis of an F_1 progeny from a cross between the susceptible genotype *Rosa chinensis* 'Old Blush' and a hybrid of *Rosa wichurana* (RW) showed that its resistance mainly results from the combined action of two quantitative trait loci (QTLs), located on linkage groups 3 and 5. Characterizing the interaction of each of these QTLs and their combination with *D. rosae* at the molecular level is crucial in cloning the underlying genes and identifying markers for their use in breeding. The first step in deciphering the mechanisms associated with these two QTLs is to narrow their confidence intervals. To do this, the F_1 progeny was expanded and genotyped with a reduced set of SNP markers, followed by further QTL detection. To better understand the action of each QTL and their combinations, individuals from the F_1 progeny have been selected that present either one of the QTLs or a combination of both. Based on their level of resistance and genotype, some of these individuals were chosen for RNA sequencing of the initial stages of the rose-*D. rosae* interaction. Comparison of their reactions at the transcriptomic level will give insights into the molecular processes underlying each QTL. Further examination of the genomic variants between the two haplotypes of RW will also be useful for identifying the mechanisms associated with black spot resistance. Since members of the RW species have been widely used in breeding programs, understanding how their resistance works will enable breeders to combine these QTLs with other sources of resistance, creating more durable black spot resistance in roses.

Laurine Lambelin won the ISHS Prof. Jens Wünsche Young Minds Award for the best oral presentation at the International Symposium on Ornamental Horticulture for the Service of Society at EHC2024 in Romania in May 2024.

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Assessing the impact of salinity on *Viola* × *wittrockiana:* exploring morphological, physiological, and anatomical parameters

› Sara Yasemin

Sara Yasemin recently completed her PhD at Cukurova University (Turkey), and is now working at Siirt University (Turkey) on abiotic stresses, plant responses and improved tolerance for ornamental plants.

To enhance plant tolerance to abiotic stress, understanding how they respond to stress is crucial for devising targeted strategies aimed at strengthening their resilience. The pansy, from the *Violaceae* family, is widely used as an ornamental flower, particularly during winter, in landscaping, outdoor decoration, and potted arrangements. For this study, Sara investigated the morphological, anatomical, and physiological responses of pansy (*Viola* × *wittrockiana* 'Pansy Inspire Plus F_1') under salt stressed conditions. At the end of the study, there was a noticeable decrease in several parameters, including the number of flowers, flower diameter, flower stalk length, root and shoot growth, as well as the fresh and dry weights of flowers as salinity increased. Additionally, both total and mean leaf area decreased. The visual score also sharply declined. Ion leakage remained stable until the third week, after which it increased in groups subjected to salt application. Additionally, relative water content decreased with increasing salinity. According to SPAD measurements and photosynthetic pigment analysis, leaf chlorophyll content increased in the presence of 50 mM NaCl. This study revealed that epidermis cells and sponge parenchyma sizes increased under salinity, while leaf palisade parenchyma size decreased. Epidermis, xylem, phloem areas, and stem diameter also decreased in the stem with increasing salinity. As a result, *V. wittrockiana* 'Pansy Inspire Plus F_1' was identified as being sensitive to salinity. With these findings, it is possible to implement some strategies to enhance the tolerance of pansy to saline soils by applying plant growth promoting rhizobacteria (PGPR), the external application of elicitors and nanoparticles, etc., or to apply gene editing technologies.

Sara Yasemin won the ISHS Prof. Jens Wünsche Young Minds Award for the best oral presentation at the International Symposium on Ornamental Horticulture for the Service of Society at EHC2024 in Romania in May 2024.

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Screening of a *Mentha* spp. collection for physiology and essential oil content under field conditions

› Charlotte Hubert-Schöler

Plants of the genus *Mentha* spp. have numerous applications in the pharmaceutical, cosmetic and food industries because of their essential oils (EO). A *Mentha* collection consisting of 20 different genotypes was examined to identify locally adapted and high yielding genotypes. For this experiment, 12 measurement dates were carried out bi-weekly from April to October 2023, with three harvest dates (1st harvest: July; 2nd harvest: August; 3rd harvest: October). Included were plant height, physiological reaction via hyperspectral measurements and calculation of vegetation indices (VIs; PSRI, MCARI 1 and REIP1) in addition to determining biomass and EO content at each harvest. The EO was also examined for three genotypes: *Mentha rotundifolia* 'Apfelminze', *Mentha* × *piperita officinalis* 'White Mitcham' and *Mentha longifolia* var. *asiatica* 'Asiatische Minze' over the course of the day. The genotype with the highest plant height at each harvest date was *Mentha rotundifolia* 'Apfelminze'. In comparison, *Mentha smithiana* 'Rote Minze' showed the lowest height. For the second and third harvest dates, *Mentha* × *piperita officinalis* 'White Peppermint Spearmint' had the lowest plant height. Additionally, the genotypes were distinguishable via their Vis, and their dry biomass varied significantly. For the second harvest *Mentha smithiana* 'Rote Minze' had the lowest dry mass and *Mentha rotundifolia* 'Apfelminze' the highest. There were also significant differences in EO content between genotypes and harvest dates. EO rich genotypes were *Mentha arvensis* × *spicata* 'Japanische Heilminze' and *Mentha arvensis* var. *piperascens* 'Japanische Tigerölminze'. In Germany, in addition to established cultivars like *Mentha rotundifolia* 'Apfelminze', *Mentha* × *piperita* 'Fränkische Blaue' and *Mentha* × *piperita* 'Multimentha', there are other genotypes that are well adapted to the Central European climate. These genotypes produce high biomass and EO yields. In addition to the quantity of EO, further research into the composition of the EOs of different genotypes is needed.

Charlotte Hubert-Schöler won the ISHS Prof. Jens Wünsche Young Minds Award for the best oral presentation at the International Symposium on Genetic Resources in Horticulture: Screening, Propagation, Use, and Conservation at EHC2024 in Romania in May 2024.

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Unveiling the impact of far-red light on carbohydrate allocation and yield in dwarf tomato cultivars

› Maria Mastoraki

Maria Mastoraki, a PhD candidate at the Horticulture and Product Physiology group of Wageningen University and Research in the Netherlands, is investigating the impact of far-red light on carbohydrate partitioning in dwarf tomato plants. Supervised by Dr. Ep Heuvelink and Professor Leo Marcelis, her work focuses on understanding how photosynthetically fixed carbon is allocated to different plant organs – a critical factor in determining crop yield and quality. In tomato cultivation, efficient carbohydrate partitioning to fruit is vital for optimizing both yield and nutritional content. Maria is exploring the potential for far-red light, a naturally occurring component of the light spectrum, to enhance carbohydrate partitioning. She conducted experiments with three dwarf tomato cultivars, adding far-red light to a white light background at different developmental stages: vegetative, flowering and fruiting. Each stage was carefully monitored to observe changes in plant physiology and morphology. Key parameters measured included dry matter partitioned to fruit, overall yield, pericarp cell histology, and the accumulation of soluble sugars in fruit. The findings suggest that strategically applying far-red light can significantly improve fruit yield and quality. By understanding the optimal timing and conditions for far-red light exposure, growers can enhance carbohydrate partitioning to fruit, leading to better commercial results and higher quality produce. This research provides valuable insights into the mechanisms behind carbohydrate allocation and offers practical solutions for improving tomato cultivation.

Maria Mastoraki won the ISHS Young Minds Award for the best oral presentation at the X International Symposium on Light in Horticulture in the Republic of Korea in May 2024.

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The transcription factor PbbHLH164 is destabilized by PbRAD23C/D.1 and mediates ethylene biosynthesis during pear fruit ripening

› Zhihua Guo

The phytohormone ethylene plays a pivotal role in climacteric fruit ripening. However, the knowledge on molecular regulation of ethylene biosynthesis remains limited in pears. In our study, a new basic helix-loop-helix transcription factor, PbbHLH164, was identified based on the transcriptome analysis of developing and ripening fruit. Transient expression in pear fruits and genetic transformation in callus demonstrated that PbbHLH164 can promote ethylene synthesis by directly binding to the promoter of 1-aminocyclopropane-1-carboxylate synthase, *PbACS1b,* leading to the increase of ethylene production and an acceleration in fruit ripening. PbbHLH164 was found to physically interact with a ubiquitin-associated protein PbRAD23C/D.1, and this interaction attenuated the ability of PbbHLH164 to enhance the activity of the *PbACS1b* promoter. Notably, PbRAD23C/D.1 was involved in the degradation of PbbHLH164, and this degradation was inhibited by a ubiquitin proteasome inhibitor MG132. Unlike PbbHLH164, PbRAD23C/D.1 exhibits higher expression levels in developing fruit compared to ripening fruit. These results suggest that the increase of ethylene production during the ripening of pear results from the up-regulated expression of PbbHLH164 and the down-regulated expression of PbRAD23C/D.1. Our findings provide new insights into the molecular regulation of ethylene biosynthesis during fruit ripening.

Zhihua Guo won the ISHS Young Minds Award for the best poster presentation at the V International Symposium on Biotechnology and Molecular Breeding in Horticultural Species in China in June 2024.

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Understanding calcium nutrition in peach crop through ^{44}Ca isotope labeling

› Francisca Carrasco-Cuello

Francisca Carrasco-Cuello is a PhD student at the IRTA Institute of Agrifood Research and Technology in Lleida, Spain. Francisca's work is currently focused on gaining a greater understanding of calcium uptake by peach and nectarine roots and its subsequent distribution to the aerial parts of the tree. She is also studying the role of calcium applications in improving fruit quality and postharvest storability. In tracing calcium uptake and absorption, she has utilized the stable isotope calcium-44. This technique has provided a precise understanding of calcium uptake by different rootstocks (Garnem, G×F, and Rootpac) and its subsequent absorption by both peaches and nectarines. Calcium is involved in numerous biochemical and morphological processes in plants and is implicated in many disorders of considerable economic importance. Despite the important role of calcium in maintaining fruit quality and prolonging shelf life, there is a lack of information on the mechanisms that determine its concentration in fruit. The results of her research have indicated that there is a difference in calcium uptake between peach rootstocks, with Garnem showing significantly better uptake efficiency. It has also been shown that the external absorption of calcium by peaches and nectarines is influenced by the timing of application during fruit development and the fruit surface, with peaches being more efficient than nectarines in calcium absorption through foliar applications. As a result, peach and nectarine producers have an opportunity to evaluate their calcium application strategies to enhance fruit quality, storability and more effectively utilize resources.

Francisca Carrasco-Cuello won the ISHS Young Minds Award for the best poster presentation at the X International Symposium on Plant Nutrition of Fruit Crops in USA June 2024.

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Nitrogen storage and biennial bearing in apple

› Thiago Campbell

Biennial bearing is not a novel concept for perennial fruit trees. Biennial bearing, or alternate bearing, is characterized by a heavy crop one year (the "on" year), accompanied by little to no crop the following year (the "off" year). While environmental factors such as spring frosts and drought can initiate a biennial bearing cycle in fruit trees, genetics play an important role, with certain cultivars having a greater likelihood of bearing biennially. In apples, 'Honeycrisp' is prone to biennial bearing, even when environmental factors remain constant and in good supply. Regenerative buds can make up more than 90% of buds in an "on" year, while in an "off" year, less than 20% of the buds are regenerative. Nonstructural carbohydrates fulfill distinct roles within plants, influencing flower bud initiation and fruit bud formation. Moreover, nitrogen reserves play a key role in fueling spring growth and flowering. In this study, we sought to quantify nonstructural carbohydrate and nitrogen levels of various plant tissues in both "on" and "off" trees of 'Honeycrisp' and 'Gala'. The crop load from each tree was used to distinguish between "on" and "off" trees. Nonstructural carbohydrate levels were higher in trees with a higher crop load in 'Honeycrisp', while nitrogen levels were lower in high cropping trees. For 'Gala', carbohydrate levels did not vary significantly, but nitrogen levels followed a similar pattern. In 2023, results showed less separation in 'Honeycrisp'. We theorize that abnormal events in 2022, when leaf senescence did not occur going into winter, could have disrupted carbohydrate and nitrogen translocation patterns in the trees, causing data to become more significant. Crop load was more significant in affecting carbohydrate and nitrogen levels in 'Honeycrisp' than 'Gala'. Carbohydrate and nitrogen levels within trees impact biennial bearing, but the strength and influence of these relationships are currently unclear.

Thiago Campbell won the ISHS Young Minds Award for the best poster presentation at the X International Symposium on Plant Nutrition of Fruit Crops in USA in June 2024.

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The world of Horticulture

› AgroEco innovation in action: CH Biotech's journey from agricultural waste to quality products

Guided by the principle of 'Think Local, Act Global', CH Biotech is on a mission to put Taiwan on the global map as a leader in agricultural biotechnology and a prominent research hub for the re-carbonization of soils. Today, the global agricultural landscape is grappling with some serious challenges brought on by climate change, the increasing demand for food, and a heightened emphasis on food quality and environmental conservation. These challenges have unlocked the potential for ground-breaking solutions in agricultural technologies, allowing farming practices to evolve with the changing times. With its high-quality and eco-friendly biotech agricultural products, CH Biotech is actively engaged in the production of more healthy and sustainable crops.

Since CH Biotech's establishment in 2013 with an initial investment of NT$1 million, the company has experienced substantial growth. Today, the company employs over 150 dedicated professionals and has a net worth exceeding NT$2 billion.

The success story of CH Biotech began with the dream of their chairman, Mr. Wu, to place acclaimed products from a Taiwanese company onto the global agricultural chemical market. Intent upon promoting sustainable agriculture, he built his organization by acquiring the best available talent from many different fields of agriculture, as well as constructing world-class R&D facilities. With his brilliant mind and guidance, CH Biotech has prospered through its unique and holistic approach of 'R&D in Taiwan, Made in the U.S.A. and Global Marketing'.

› Mr. Chen-Pang Wu, Chairman of CH Biotech.

Cultivating towards sustainability: greener future through CH Biotech innovation

Amidst the multifaceted challenges exacerbated by climate change, CH Biotech stands courageously on its commitment to promote low-carbon agriculture. Fundamental to CH Biotech's mission to champion sustainable agriculture is the utilization of precision agriculture strategies. These strategies leverage sophisticated technologies such as remote sensing, satellite imagery and data analytics to refine farm management practices. This enables farmers to achieve higher crop production, minimize waste and lessen environmental impact through the appropriate application of water, fertilizers and pesticides to meet the unique requirements of each crop.

What makes CH Biotech stand out from other companies is their unique approach to product research and development, which involves consultation with farmers to identify primary, specific issues. This approach enables them to conceptualize and design precision-oriented products.

Over the past decade, CH Biotech has pursued three core strategies: to reduce plant stress, enhance nutrient efficiency, and to utilize plant growth promotion technology. With these in mind, CH Biotech has success-

› CH Biotech headquarters and state-of-the-art R&D center in Chung Hsing Park, Central Taiwan Science Park, Nantou, Taiwan.

› CH Biotech R&D Labs houses multiple laboratories responsible for identifying and resolving crop production challenges while studying complex biological mechanisms.

› CH Biotech Greenhouse Facility equipped with an advanced Smart Control System.

fully developed a series of plant growth regulators and high-efficiency fertilizers that are highly effective, precise and low-carbon, satisfying the demands of modern agriculture.

These innovative products have been basically derived from agricultural waste or residues. This approach not only provides natural materials for the formulation of specific products, but it also helps to reduce global warming caused by improper disposal or combustion. To date, CH Biotech has launched 20 types of low-carbon plant growth regulator (PGR) products. In many regions of the world, these products have become an indispensable input for the cultivation of corn, soybeans, wheat, canola, cotton, fruit trees and other high-value vegetables.

However, CH Biotech is not merely engaged in the development of highly effective agricultural products, but is actively sculpting the future landscape of global food production. Their R&D is focused on three critical areas: the reduction of greenhouse gas emissions from crop cultivation, the mitigation of crop losses attributable to extreme weather events, and the minimization of environmental pollution arising from the excessive application of fertilizers and pesticides. Their pioneering work in climate adaptation technology is instrumental in safeguarding agriculture from the detrimental effects of extreme weather.

From Taiwan to the world: CH Biotech's integrated business strategy

The company's corporate headquarters and state-of-the-art R&D center is nestled in Chung Hsing Park, Central Taiwan Science Park, Nantou, Taiwan. This allows the company to tap into the diverse research talent and abundant resources available in the country. CH Biotech recognized very early that R&D had the largest yield in terms of profit distribution for new technology products. For this reason, recruiting and nurturing a top-tier team of research scientists has created a globally competitive R&D unit.

In addition, CH Biotech's subsidiary, situated in California, USA, serves as the company's production base, facilitating global outreach and market accessibility. The United States' systematic and efficient registration system for agrochemical products assures customers that the company's products are not only fit for purpose but that CH Biotech also adheres to the highest quality standards.

CH Biotech has obtained certification of good laboratory practices (GLP) and operates under its strict regulations and standards. Its GLP-compliant laboratory ensures quality throughout product development and produces internationally accredited test data reports, streamlining product registration in target markets.

CH Biotech's high-quality products and long-standing market presence have put the company on the global stage. Efficient and effective global distribution has enabled the company to navigate the risks posed by seasonal sales in local markets. CH Biotech's adoption of an "Asymmetrical Vertical Strategic Alliance", paired with an exclusive sales model, allows the company to maximize profits in collaboration with distributors. Through these alliances, CH Biotech has successfully established a market presence in the United States, Canada, South Korea, Australia, Brazil, Argentina, Chile and Uruguay.

Corporate social responsibility (beyond R&D and business strategy)

CH Biotech's commitment to positively impact Taiwan's agricultural biotechnology sector extends beyond R&D. Through various collaborative efforts with different academic institutions, academic partnerships and doctoral initiatives, the company is nurturing agricultural research talent and supporting student doctoral programs through scholarships. To further promote technical innovation in agriculture and biotechnology, the CH Biotech Innovation Awards provide the gold award winner with a scholarship amounting to NT$200,000.

In alignment with Taiwan's bold "2050 Net Zero Emissions" target, CH Biotech has released a technical guidebook that was adopted from the published "Recarbonizing global soils – a technical manual of recommended management practices" by the Food and Agriculture Organization of the United Nations (FAO). This guide provides best practice recommendations for soil re-carbonization on a global scale. The manual was carefully and precisely translated by selected R&D personnel and printed in both Chinese and English. A total of 10,000 copies of this guidebook have been distributed for free to individuals, institutions and groups. CH Biotech also provides free access to this via e-books (Chinese e-books).

"With the contributions of CH Biotech, a sustainable future is not merely a possibility but an attainable reality".

Editorial note: CH Biotech, a corporate member of ISHS, is entitled to submit one article per year for publication within *Chronica Horticulturae*. The publication of this article does not infer nor does it provide any endorsement by ISHS of the products produced and marketed by CH Biotech.

› About the author

CH Biotech R&D is a dynamic team of agricultural scientists, harmoniously working together to create high-quality, effective and environmentally friendly products. Since 2013, their unwavering commitment to excellence ensures that their solutions contribute to a sustainable and prosperous agribusiness sector worldwide. E-mail: info@chbio.com.tw; website: https://www.chbio.com.tw/

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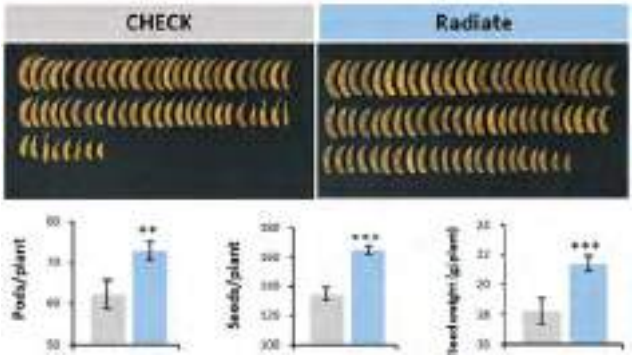
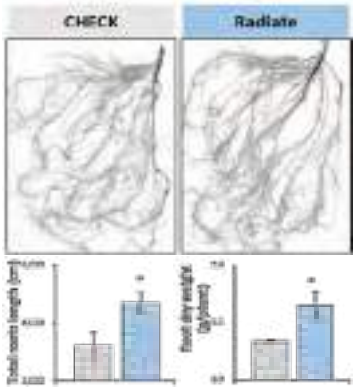
+20% yield increased in soybean

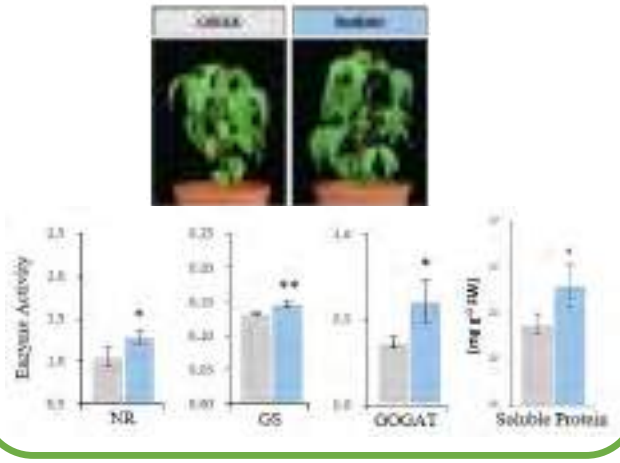


Better nutrient uptake and increased root growth



Radiate **reduced ROS damages and yield loss caused by drought stress**

Enhanced nitrogen assimilation and plant vitality

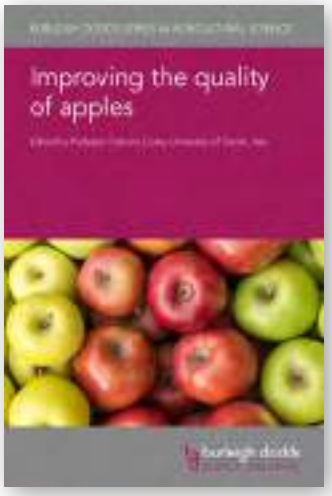


For more information, please contact us: info@chbio.com.tw

› New books, websites

Book reviews

The books listed below are non-ISHS-publications. For ISHS publications covering these or other subjects, visit the ISHS website www.ishs.org or the *Acta Horticulturae* website www.actahort.org



Costa, F., ed. (2024). Improving the Quality of Apples. Burleigh Dodds Series in Agricultural Science (Cambridge, UK: Burleigh Dodds Science Publishing). pp.256. ISBN 9781801463218 (hardback). £130 / $170 / €155.

A 25% discount will be received by entering the code "ISHS25" when ordering through https://shop.bdspublishing.com/store/bds/detail/workgroup/3-190-133370

Quality is paramount for every fruit crop and especially for apple, one of most widely grown and consumed fruit worldwide. This book, edited by Fabrizio Costa from the University of Trento, and formerly from Fondazione Edmund Mach, San Michele all'Adige, Italy, provides a very comprehensive, albeit somewhat cursory, overview of the results of relevant, old and ongoing research on quality worldwide. Nevertheless, the book is a "must have", for it considers many complex and intertwined aspects from the consumer to genetics, to pre- and postharvest management, that impact and determine eating quality.

The book is composed of eight chapters, each written by well-known and respected scientists, with years of experience. The four initial chapters deal with quality attributes, while the other four chapters deal with those breeding and management practices that either maintain quality or cause quality to deteriorate along the chain. The first chapter is dedicated to the consumer perception of quality. Alongside its classical determinants, such as appearance, texture and flavor, convenience, packaging and branding are also discussed, along with a number of other psychological, physiological, biological and economic determinants. Chapter 2 addresses the current understanding of texture development. The discussion overlaps in several places with the content of Chapter 6, and in more than one instance, the two chapters present contrasting views on some elements. However, in both cases, a solid bibliography is provided, which highlights the complexity of quality issues in fruit production. The next two chapters deal with nutritional and nutraceutical properties of apples, an area that has been and should be in the spotlight for the potential role apples could play in mitigating chronic diseases, blood pressure, etc.

Part 2 starts with a chapter on breeding and crop management to optimize quality, a monumental task to carry out in a single chapter. However, the authors do a very good job in dedicating at least a few lines to most of the facets this encompasses. While the discussion is limited, a very comprehensive reference list is provided for anyone interested in delving further into the topic. Chapter 6 deals with a detailed discussion of fruit development. Various models have been developed to describe and to predict fruit development during the growing season under precision orchard management approaches. The discussion considers the environmental and agronomic factors affecting fruit quality, and preharvest quality traits that can be used as predictors of postharvest quality. The preharvest management factors are the focus of the next chapter, another monumental task. Again, some overlap with the previous chapter appears, and the two chapters often present contrasting views, but this only reflects the difficulty and complexity of the task. The final chapter is dedicated to postharvest control of quality, and its preservation along the chain. All the important aspects are discussed, including the use of ozone, UV, ultrasound, catalytic oxidation, the use of cold plasma to protect from various diseases, airborne pollutants, and the control of ethylene.

All the chapters read very well, the rhythm is tight, as there is limited space (the book is just 230 pages). However, ample references are provided. One could consider each chapter as the starting point of a project dealing with a specific aspect of apple fruit quality. The conciseness of the book requires a good foundation in all the disciplines. This positions the book well for those young researchers starting a career on these topics. All the relevant scientists active in this broad field over the past 80 years are quoted in this book, indicating that the authors know their stuff well.

Reviewed by Luca Corelli Grappadelli, Chair ISHS Division Temperate Tree Fruits

› Courses and meetings

The following are non-ISHS events. Be sure to check out the Calendar of ISHS Events for an extensive listing of all ISHS meetings. For updated information, log on to www.ishs.org/calendar

AGENTIAL AI AgBio 2025 International Conference and Exhibition, 6-8 May 2025, Bangkok, Thailand. Info: AGENTIAL AI, e-mail: info@agentialai.com, web: https://agentialai.com/

V All Africa Horticultural Congress (AAHC2024)

The V All Africa Horticultural Congress (AAHC2024) took place in Marrakech, Morocco, from February 26 to March 1, 2024. It was hosted at Mohammed VI Polytechnic University (UM6P) in Ben Guerir, under the aegis of the International Society for Horticultural Sciences (ISHS). With the theme "Unlocking the potential of resilient horticulture," the congress aimed to explore and promote the potential of horticulture in Africa. Professionals in the field, researchers, young scientists, and entrepreneurs from 46 countries had the chance to meet and to share their research results, experiences, and latest innovations.

The event brought together over 150 participants from 19 African countries. Seven scientific thematic sessions were completed, with three workshops that offered a space for discussion and debate. FAO experts and sponsored participants contributed to these debates on: "Digital innovation for small scale farming in horticulture", "New technologies for urban vegetable production", and "Food sovereignty through seed and planting material".

Held over four days, the AAHC2024 congress provided a rich and varied program covering all areas of horticulture: "Innovative technologies and production strategies for sustainable controlled environments"; "Horticulture for food and nutrition security in Africa"; "Best agricultural practices for smart horticulture"; "Efficient use of water and nutrients in horticulture"; "Adapted horticulture to marginal environments"; "Integrated pest management for safe horticultural practices"; and "Harvest and postharvest technologies in horticulture". As an introduction, four eminent keynote speakers, all distinguished ladies, reviewed the horticultural sector in Africa, its contribution to food and nutrition security, as well as its opportunities and challenges: Dr. Ismahane Elouafi, recently appointed Executive Director of CGIAR; Boitshepo Bibi Giyose, nutrition expert at the Africa Union Development Agency; Dr. Yvonne Pinto, Director General of IRRI; and Prof. Erin J. McGuire, Director of Feed the Future Innovation Lab for Horticulture, UC Davis.

The final session was devoted to ISHS business, with an awards ceremony and the election of the next host for AAHC2028. ISHS President François Laurens and ISHS Board

› SHS President with the Organizing Committee and some members of the Scientific Committee. Left to right: Dr. Zora Singh, Dr. Moctar Fall, Dr. Redouane Choukrallah, Dr. François Laurent, Dr. Abdelhaq Hanafi, Dr. Melinda Knuth and Dr. Karin Hannweg.

› Plenary session.

› ISHS Medal Award ceremony for the congress organizers Prof. Abdelhaq Hanafi, Prof. Redouane Choukrallah and Dr. Rémi Kahane (from right to left) presented by ISHS President François Laurens (second from right).

› Participants of AAHC2024 at UM6P Ben Guerir.

› Uganda Christian University and Makerere University delegates for organizing AAHC2028 in Uganda.

member for Africa, Moctar Fall, presented the ISHS Young Minds Awards to PhD-student Kawtar Ziane from Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco, for the best oral presentation entitled "Testing the interaction of strawberry cultivars with organic and conventional cropping systems in Morocco" and to PhD-student Edouard Drabo, Laboratoire Central d'Entomologie Agricole, INERA, Ouagadougou, Burkina Faso, for the best poster presentation entitled "Evaluation of the varietal resistance and biopesticides against *Amrasca biguttula* (Ishida) (Hemiptera: Cicadellidae) in okra production in Burkina Faso". Prof. Abdelhaq Hanafi as President, Prof. Redouane Choukrallah as Vice-President, and Dr. Rémi Kahane as scientific editor, were each awarded the ISHS medal.

The congress ended with the successful bid from Uganda to host the next AAHC in 2028, with Prof. Elisabeth Kizito, from Uganda Christian University, being the first female president of an AAHC. The theme will be "A new chapter in the advancement of horticultural knowledge and innovation".

A full day field visit was organized to horticultural farms in the region of Marrakech. Participants viewed honey melon as a protected field crop, table grapes, pomegranates and clementine mandarins under netting. Following this experience, participants visited Agadir city and made a stop at Duroc, to visit a leading Moroccan producer and exporter of tomatoes.

Abdelhaq Hanafi, Redouane Choukrallah and Rémi Kahane

› Citrus orchard field visit.

› Winners of the ISHS Young Minds Awards: A) Kawtar Ziane (best oral presentation), B) Edouard Drabo (best poster presentation).

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› XIV International Symposium on Flower Bulbs and Herbaceous Perennials

Division Ornamental Plants **#ishs_dorn**

Division Protected Cultivation and Soilless Culture **#ishs_dpro**

› Group photo of guests, keynote speakers and participants of the symposium in front of Crystall Hall at Warsaw University of Life Sciences, venue of the symposium.

The XIV International Symposium on Flower Bulbs and Herbaceous Perennials was held at the Warsaw University of Life Sciences (SGGW), Warsaw, Poland, from 14-17 April 2024, with a post-symposium professional tour from 18-19 April 2024. The symposium was hosted by the Polish Society for Horticultural Science under the aegis of the International Society for Horticultural Science. The event was organized by the SGGW and the National Institute of Horticultural Research (NIHR) in Skierniewice, under honorary patronage of the Rector of the SGGW, in cooperation with the Embassy of the Netherlands in Poland and the Museum of King Jan III's Palace at Wilanów. The symposium was co-financed from state budget funds granted by the Polish Minister of Education and Science under the framework of the "Excellent Science II' program. The symposium brought together nearly 80 participants from 15 countries in Asia, Europe and North America. Their contributions to the symposium included 27 keynote lectures and oral presentations, as well as 39 posters.

The symposium began with an informal welcome meeting in the Crystal Hall of the SGGW on the afternoon of 14 April. This provided an opportunity for veterans and new participants to meet, mingle and converse. A general session was held on the second day of the symposium, with thematic sessions on five different subjects on the second and fourth day. The symposium included a poster session, although the poster boards were located in the same area as the coffee breaks, providing an excellent opportunity for delegates to read the posters and discuss the findings with authors throughout the symposium. The third day of the symposium was devoted to technical tours to Polish farms and companies around Warsaw, and to several historical gardens.

The symposium participants were warmly welcomed by the symposium convener – Dr. Dariusz Sochacki from SGGW, Warsaw, Poland, who noted that this was the second symposium of this series to be organized in Poland: the 6th Symposium took place in Skierniewice in 1992.

The general session, which included four lectures, opened with an overview of the intertwining science and geophyte production under changing climate conditions, presented by Dr. Rina Kamenetsky-Goldstein from the Volcani Center, Israel. The following lectures spoke about the application of biotechnology in the breeding of ornamental

› New Campus of Warsaw University of Life Sciences with blooming flower bulbs.

› Mr. Tomasz Michalik speaking about Polish market of herbaceous perennials.

› Post-symposium tour visiting Vitroflora Producer Group LTD.

› Production of tulip bulbs in Królik farm close to Poznań.

geophytes (Dr. Ki-Byung Lim from Kyungpook National University, Korea) and the research-practical aspects of intensive planting of flower bulbs in urban green spaces (Dr. William B. Miller from Cornell University, USA). The plenary session also included a presentation on the "Production and breeding of bulbous plants and herbaceous perennials in Poland" by Dr. Dariusz Sochacki (SGGW, Poland) and Mr. Tomasz Michalik (Vitroflora, Poland), with the cooperation of Dr. Jadwiga Treder (NIHR, Skierniewice).

The second day of the meeting was organized around two sessions: 1) propagation, cultivation and forcing, and 2) biodiversity, genetics, biotechnology and breeding. The keynote lecture for session 1 was given by Dr. Margherita Beruto (Chair of ISHS Division Ornamental Plants, Italy) on the micro-propagation of ornamental geotypes. Other papers delivered in this session included in vitro techniques for tulips, systems for the production of high-quality tubers of *Zantedeschia* and virus-free lilies, trials with herbaceous perennials, and using LED lighting during tulip forcing.

For session 2, the keynote lecture entitled "Developments in breeding of bulbous crops from a genetics and genomics perspective" was presented by Dr. Paul Arens (Wageningen University and Research, The Netherlands). This session was filled with oral presentations on breeding work with *Lycoris* and *Hemerocallis* hybridized with *Eremurus* and *Lycoris,* as well as resistance breeding of *Impatiens*. The report on the distant hybridization of daylily with *Eremurus* and *Lycoris,* presented by PhD student Yi Lv from the School of Landscape Architecture, Beijing Forestry University, China, was awarded the ISHS Young Minds Award for the best oral

› Dariusz Sochacki, Convener (left), and Margherita Beruto, Chair of ISHS Division Ornamental Plants (right), presenting the ISHS Young Minds Awards to A) Yi Lv for the best oral presentation, B) Sara Benchaa for the best poster presentation.

presentation. The winner of the ISHS Young Minds Award for the best poster was Sara Benchaa, a PhD student at Laval University in Quebec City, Canada. Her poster was entitled "Do recently released cultivars of *Ranunculus* and *Anemone* still need vernalization?"
The technical tour on the third day of the symposium featured three excursions. The tours included two modern farms forcing tulips hydroponically (BOTANIA and Morawski Flowers), a nursery producing herbaceous perennials (Panek), a company producing young perennial plants and bedding crops (Volmary), a tissue culture laboratory producing herbaceous perennials (Norwa Plants), as well as historic gardens at the Royal Castle in Warsaw, the birthplace of Fryderyk Chopin and the Park in Żelazowa Wola near Warsaw. The tours provided an opportunity to observe modern ornamental horticulture production in Poland. The day ended with an evening visit to the summer residence of King Jan III at Wilanów and a gala dinner in a Villa Intrata belonging to the Museum.

On the final day of the symposium, three thematic sessions were conducted. A keynote address on the long-term storage of cut flowers was given by Dr. John M. Dole (North Carolina State University, USA). Session 4 was devoted to plant protection and commenced with a keynote lecture entitled "Integrated management of diseases on ornamental geophytes and herbaceous perennials" by Dr. Gary A. Chastagner (Washington State University, USA). Session 5 was devoted to the use of geophytes and perennials in landscape and for other purposes. The keynote address was presented by Dr. Bożena Szewczyk-Taranek on the selection of perennials and geophytes for therapeutic horticulture. Two other addresses from the University of Agriculture in Krakow, Poland, discussed the evaluation of ornamental grasses and other perennials, as well as perennial meadows in parks.
The post-symposium tours included a visit to the Vitroflora Producer Group Ltd near Bydgoszcz (young plants of perennials, including in vitro propagation), the Królik Company near Poznań (bulbs and corms production, geophytes as cut flowers) and Polish Tulips – Orłowscy (Polskie Tulipany s.c.) near Kalisz (tulip forcing in hydroponics).
During the business meeting, Dr. Dariusz Sochacki (Poland) was elected as the new Chair of ISHS Working Group Flower Bulbs and Herbaceous Perennials. It was agreed that the next XV International Symposium on Flower Bulbs and Herbaceous Perennials will be in the USA in 2028.

Dariusz Sochacki and Julita Rabiza-Świder

Contact

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V International Symposium on Woody Ornamentals of the Temperate Zone

Division Ornamental Plants #ishs_dorn
Division Landscape and Urban Horticulture #ishs_durb
Division Plant Genetic Resources and Biotechnology #ishs_dbio
Division Protected Cultivation and Soilless Culture #ishs_dpro

The V International Symposium on Woody Ornamentals of the Temperate Zone (WOTZ2024) was held in Matsue City, Shimane Prefecture, Japan, from April 21-25, 2024. The symposium was organized by the WOTZ2024 committee under the aegis of the International Society for Horticultural Science (ISHS) and co-hosted by the Japanese Society for Horticultural Science (JSHS), the National Agriculture and Food Research Organization (NARO), the Expo '90 Foundation, and Shimane University. The symposium was supported by Matsue City, the Shimane Prefectural Government, the Japan Association of Botanical Gardens, and the Science Council of Japan. One platinum sponsor, eight silver sponsors, and five local sponsors also supported the symposium. In addition, an NPO for azaleas and a farmers' group for hydrangeas provided a flower exhibition at the venue.
Two conveners, Prof. Nobuo Kobayashi from Shimane University and Prof. Takashi Handa from Meiji University, and 16 local committee members, directed and managed the symposium program. One hundred and seventy two participants, including 62 international attendees from 12 countries, gathered and exchanged their ideas and research findings over the four days.
The symposium theme was "Expedition of the origin of miscellaneous woody ornamentals with traditional horticulture". Three plenary lectures demonstrated and reinforced the themes of the symposium. Eight sessions, consisting of 9 keynote presentations and 41 oral presentations, covered a wide range of topics related to the current status of ornamental plant use, genomics, genetics, interaction with biotic/abiotic environments, and breeding. In addition to the enchanting exhibitions by sponsors and supporters, 30 poster presentations provided cutting-edge scientific information on woody ornamental plants.
On April 21, at a special open seminar (a pre-symposium event), over 150 attendees, including the general public and students, listened to plenary lectures by Dr. Yuji Kurashige (Japan Association of Botanical Gardens), Dr. Valentina Scariot (University of

› Participants of the symposium.

Turin, Italy), and Mr. Akihito Uesada (Mayor of Matsue City), and appreciated a grand flower arrangement performance by acclaimed florist, Mr. Masahiko Nukaya, who received the Prime Minister's Award for flower arrangement. His grand works for WOTZ2024 decorated the stage and lobby of the venue.

The symposium officially started with an opening ceremony on April 22. Following opening remarks from convener Takashi Handa, congratulatory speeches were delivered by Dr. Johan Van Huylenbroeck (ISHS representative on behalf of the Chair of ISHS Division Ornamental Plants), Mr. Tatsuya Maruyama (Governor of Shimane Prefecture), Mr. Akihito Uesada (Mayor of Matsue City), Dr. Hiroki Otani (President of Shimane University), Dr. Masayoshi Nakayama (on behalf of the Chief of the Institute of Vegetable and Floriculture Science, NARO), and Dr. Munetaka Hosokawa (President of JSHS). Following the ceremony, Mr. Akihito Uesada gave a welcome plenary talk on "Peonies and camellias: flowers of Matsue bringing us together." Dr. Valentina Scariot (University of Turin, Italy) spoke about "Japanese flowers that embellish Italian gardens: the search for new shapes and colors," and Dr. Yuji Kurashige (Japan Association of Botanical Gardens) presented a plenary lecture entitled "Japanese woody ornamentals across the sea."

Oral presentations, including keynote speeches, were organized into eight sessions over three days. Keynote presentations were given by Dr. Marco Devecchi (University of Turin, Italy), Dr. Kenta Shirasawa (Kazusa DNA Research Institute, Japan), Dr. Valeria Bianciotto (IPSP, CNR, Italy), Dr. Lisa Alexander (USDA, USA), Dr. Johan Van Huylenbroeck (ILVO, Belgium), Dr. Thomas Debener (Leibniz University of Hannover, Germany), Dr. Yoshihiro Ueda (World Rose Convention Promotion Office in Fukuyama, Japan), Dr. Gabriela R. Facciuto (Instituto Nacional de Tecnología Agropecuaria, Argentina), and Dr. Stan C. Hokanson (University of Minnesota, USA).

Nine presentations were nominated for the ISHS Young Minds Awards (YMA) from the oral sessions. Poster sessions were displayed on April 22 and 24. Five posters by PhD students were nominated for the YMA, and each nominee gave a 3-minute presentation. YMA winners were Esther Geukens from ILVO-Plant, Belgium, for the best oral presentation entitled "Abiotic stress in *Ilex crenata*: solving problems of soil pH and black root rot" and Hikaru Ishikawa, Iwate University, Japan, for the best poster presentation entitled "Phylogenetic classification and functional prediction of DFR genes in grapevines."

› ISHS representative Johan Van Huylenbroeck (center) presenting the ISHS Convener Medal award to Prof. Takashi Handa (left) and Prof. Nobuo Kobayashi (right).

On April 23, registered participants visited the Shimane University Campus (azalea research, Plant Breeding Lab) and Daikon-jima Island (tree peony production, Matsumoto's farm). On Daikon-jima Island, the participants also visited Yushien Garden (a Japanese garden famous for tree peonies) and Yushien Agrifarm. Participants enjoyed seeing the many tree peony cultivars in a Japanese garden and within a controlled greenhouse facility to control their flowering time. A gala dinner was held in a Japanese restaurant in the Yushien Garden that evening. Mr. Akihito Uesada (Mayor of Matsue City) gave a toast. All enjoyed their dinner, folk songs, and the pantomime dance performances. At the conclusion of the evening, participants sang together "Viva Japon" (Trio Los Panchos, 1962), which the convener chose as the theme song for the symposium.

On April 25, the technical tour was divided into two parts and provided information on the production and utilization of technologies of woody ornamental plants, as well as experiences of traditions and cultures in Japan. Twenty-two participants visited the Adachi Museum of Art, Tottori Flower Gallery

› Plenary lecture by A) Dr. Yuji Kurashige, B) Dr. Valentina Scariot, and C) Mr. Akihito Uesada.

"*Hanakairou*", and Kotobuki Castle (Japanese confectionery factory). The Adachi Museum of Art is best known for its award-winning Japanese garden. The participants received special guidance and explanations from professional gardeners and managers at each site. In parallel, 25 participants visited the production site of potted *Hydrangea*, Takuwa's farm in Izumo. Then, they separated into two groups. One group visited the Izumo-style Japanese garden equipped with "*Tsuiji Matsu*" (big pine tree fences) at the Izumo Cultural Heritage Museum (Izumo Cultural Tradition Hall) and the Izumo Taisha Grand Shrine. Another group visited the Shimane Prefectural Agricultural Technology Center and participated in a workshop on *Hydrangea* breeding.

At the ISHS business meeting, it was decided that the JC Raulston Arboretum, at the University of North Carolina (USA), will host the next WOTZ in 2028. The next convener, Dr. Mark Weathington, introduced the venue. A video message from Dr. François Laurens (ISHS President) was projected onto the main screen and Dr. Hisayo Yamane (IHC2026 Committee) announced the XXXII International Horticultural Congress in 2026 in Kyoto, Japan. The conveners each received the ISHS medal. Closing remarks were delivered by the convener Nobuo Kobayashi.

On April 26, an optional post-symposium tour to the region of Okuizumo was conducted. Okuizumo lies 40 kilometers south of Matsue. The region has a historical background

› ISHS representative Johan Van Huylenbroeck (center) presenting the ISHS Young Minds Awards to Esther Geukens for the best oral presentation (right) and Hikaru Ishikawa for the best poster presentation (left).

of iron making and a stunning landscape of rice field terraces. It is typical of rural Japan where strong communities and people live harmoniously with nature. Participants visited "Oni-no-Shitaburui", a large gorge that is a nationally recognised sightseeing spot where native azaleas (*Rhododendron ripense*) and many plant species align the river in the V-shaped valley. Dr. Tetsuya Kako (plant breeder, Shimane Prefectural Agricultural Technology Center) and Dr. Nobuo Kobayashi (convener) guided the participants on a hike. Participants then visited an old folk house, "Ichi-mi-dou-shin-juku", where Mr. Tamotsu Itohara (Mayor of Okuizumo town) delivered a welcome address. Participants were invited to pound *mochi* (rice cakes) in the traditional way, to dress in a kimono, and enjoyed a country cooked lunch of freshly made *mochi*, simmered mountain vegetables, and wild boar soup.

We trust the symposium provided a memorable experience for all participants and express our gratitude to all those who supported the symposium and contributed to its success.

Tomoya Esumi, Takashi Handa and Nobuo Kobayashi

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Dr. Takashi Handa, Department of Agriculture, Meiji University, Japan, e-mail: thanda@meiji.ac.jp

› Technical visit and excursion to A) experimental field in the campus of Shimane University, B) potted *Hydrangea* farmer, C) "Oni-no-Shitaburui" with *Rhododendron ripense*.

X International Symposium on Plant Nutrition of Fruit Crops

Division Physiology and Plant-Environment Interactions of Horticultural Crops in Field Systems #ishs_dphy

› Participants of the symposium.

The X International Symposium on Plant Nutrition of Fruit Crops was held at Wenatchee in Washington State (United States) from June 24-27, 2024, under the aegis of the International Society for Horticultural Science. The event attracted some 75 researchers, industry representatives, technicians, growers and students. Fifty-six scientists from 14 different countries and six continents presented their research work in five main areas: soil-plant interaction, plant nutrient management, plant nutrition and physiology, foliar fertilizer management, and micronutrients. Each session was chaired by a renowned scientist whose specialty was related to the session's theme. Session chairs were as follows: Dr. Mehdi Sharifi, Dr. Ashley Thompson, Dr. Gennaro Fazio, Dr. Patrick Brown, Bernardita Sallato and Dr. Kim Hummer.

The diversity of crops covered in this symposium highlighted the important plant nutrition work taking place around the world in temperate, sub-tropical, and tropical fruit and nut crops. There were 18 different crops represented during the symposium. A diverse group of keynote speakers presented emerging and historical research on important areas of plant nutrition in fruit crops. Dr. Deirdre Griffin-Lahue (Assistant Professor, Washington State University, USA) presented a thought-provoking presentation entitled "What we do and don't know about soil health and the drivers of soil-plant interactions", introducing the associations between soil health and plant function. Dr. David Bryla (Research Scientist, USDA-ARS Corvallis, USA) gave a wonderful overview of nutrient management in small fruit crops entitled "Fertilization and nutrient physiology in small fruit crops". Dr. Lailiang Cheng (Professor, Cornell University, USA) and Dr. Massimo Tagliavini (Professor, Free University of Bolzano, Italy)

› Keynote speaker, Dr. Victoria Fernandez from the University of Madrid presenting her research on nutrient movement across cuticles on June 26, 2024.

› Session chair Dr. Patrick Brown from the University of California, Davis, presenting an award of recognition to keynote speaker, Dr. Massimo Tagliavini from Free University of Bolzano, Italy.

provided extensive overviews on the underlying physiology driving nutrient uptake, distribution, and its link with fruit quality with talks entitled “Macronutrient requirements of apple trees: contrasting ‘Honeycrisp’ with ‘Gala’” and “Understanding nitrogen cycling in orchards to optimize fertilization”, respectively. On the last day of presentations, Dr. Victoria Fernandez (Professor, University of Madrid, Spain) provided a detailed look at the movement of nutrients across plant cuticles and its association with efficacy of foliar fertilizer management with a talk entitled: “Main environmental factors affecting foliar absorption: effects on leaves”. Lastly, Dr. Patrick Brown (Distinguished Professor, University of California Davis, USA) gave a historical overview of boron research entitled “100 years of boron research – insights into boron management” and identified key gaps in knowledge that still need addressing despite more than a century of applied research in this area of study.

Dr. Kim Hummer, as ISHS representative, together with the Convener, established an ISHS Young Minds Award committee. There were seven oral presentations and seven poster presentations presented by junior scientists. The ISHS Young Minds Award for the best oral presentation was given to Dan Ostrowski from the University of California Davis, USA, for his talk “Exploring the potential for improved stress tolerance and enhanced fruit set with the addition of iodine in almond, pistachio, and avocado”. There were two winners of the ISHS Young Minds Award for the best poster presentation. This award was given to Thiago Campbell from Washington State University, USA, for his presentation entitled “Nitrogen storage and biennial bearing in apple” and to Francisca Carrasco-Cuello from IRTA, Spain, for her presentation entitled “Differential Ca absorption in peaches and nectarines”.

› Technical tour attendees learning about the process of composting, worm farming, and biochar production at the Soi Center at Royal Dairy in Royal City, WA, USA.

The technical tour, on the last day of the symposium, provided attendees with an opportunity to see the complex Columbia Basin Irrigation Project starting from the Grand Coulee Dam, the second largest concrete structure in the world and extending to the network of canals and irrigated fields spanning more than 200,000 ha. In the afternoon, attendees stopped at the Soil Center at Royal Dairy where they learned about compost, worm casting and biochar production with source material from a combination of dairy and fruit tree production systems. Lastly, the group stopped at the Washington State University Sunrise Research Orchard to learn about the Washington State Soil Health Initiative and the Tree Fruit Long Term Soil Health research project that was planted in 2023. This project will document soil health changes from different soil-based management treatments applied during the entire orchard lifespan of 15-20 years.

The main conclusion of the X International Symposium on Plant Nutrition in Fruit Crops was the emerging importance of biology in plant nutrient management. These factors include soil and plant-based biological processes that can make important contributions to temporal and special supply and demand for macro- and micro-nutrients during fruit production.

In the business meeting, Australia was chosen to hold the XI International Symposium on Plant Nutrition of Fruit Crops in 2027. Dr. Mehdi Sharifi from Summerland, Canada, will take over the duties as Working Group Chair from Dr. Lee Kalcsits who served as Chair from 2021 to 2024.

Lee Kalcsits

› Contact

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› Convener Lee Kalcsits and ISHS representative Kim Hummer presenting the ISHS Young Minds Awards to A) Dan Ostrowski (best oral presentation), B) Thiago Campbell (best poster presentation) and C) Francisca Carrasco-Cuello (best poster presentation).

X International Symposium on Light in Horticulture

Division Precision Horticulture and Engineering #ishs_deng
Division Landscape and Urban Horticulture #ishs_durb
Division Protected Cultivation and Soilless Culture #ishs_dpro
Commission Agroecology and Organic Farming Systems #ishs_cmor

The X International Symposium on Light in Horticulture (LightSym2024) was held in Seoul, Republic of Korea, from May 19-22, 2024. Under the theme 'Light for Plants and Future', the symposium attracted 316 participants from 26 countries and featured six keynote speeches from world-renowned experts: Bruce Bugbee (Utah State University, USA), Tracy Lawson (University of Essex, United Kingdom), Qichang Yang (Chinese Academy of Agricultural Sciences, China), Leo Marcelis (Wageningen University, The Netherlands), Eiji Goto (Chiba University, Japan) and Jung Eek Son (Seoul National University, Republic of Korea).

Recent research and industry trends have underscored the growing importance of controlled environment horticulture (CEH), driven by developments in state-of-the-art greenhouses. Moreover, vertical farming – which utilizes artificial lighting – has emerged as a promising system for future plant production and is a major focus within the agricultural sector.

This symposium discussed many aspects of current research, from the basic concept of plant photosynthesis to advanced technologies. These technologies include LED-based artificial light sources, the application of artificial intelligence, and the use of 3D modeling in vertical farms. Major research trends included improving light use efficiency; enhancing productivity and nutritional quality of horticultural crops using far-red, UV, and blue lights; utilizing LEDs for cultivating horticultural crops in vertical farms; attempts to apply 3D modeling and artificial intelligence to the light environment; and using artificial light sources to accelerate plant breeding. The symposium provided a significant opportunity for researchers and practitioners to present and promote their achievements to the global community.

ISHS Young Minds Awards were presented to Maria Mastoraki (Wageningen University, The Netherlands) for the best oral presenta-

› Participants of the symposium.

› Prof. In-Bok Lee (left), Chair of ISHS Division Precision Horticulture and Engineering, presenting the ISHS Convener Medal award to the symposium conveners (from left to right) Prof. Jung-Eek Son, Prof. Myung-Min Oh, Prof. Seung Jae Hwang and Prof. Wook Oh.

› Oral presentation.

tion entitled “Unveiling the impact of far-red light on carbohydrate allocation and yield in dwarf tomato cultivars” and to Jihye Lee (Chungbuk National University, Republic of Korea) for the best poster presentation entitled “Changes in growth and mineral absorption ratios of lettuce seedlings cultivated under artificial light spectrum in vertical farms”.

The technical tour was divided into two parts: in the morning, 30 participants visited N.THING (a vertical farm company) while 40 participants visited PLANTFARM (the biggest vertical farm company in Korea). In the afternoon, all participants visited the Hwaseong Fortress in Suwon and the National Agricultural Museum.

At the ISHS business meeting, it was decided that the XI International Symposium on Light in Horticulture will be held in October 2028 in Niagara Falls, Ontario, Canada.

Myung-Min Oh

› Prof. Wook Oh presenting the ISHS Young Minds Awards to A) Maria Mastoraki for the best oral presentation, and B) Jihye Lee for the best poster presentation.

› Contact

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› Technial tour to A) N.THING, B) PLANTFARM.

First International Symposium on Apricot and Plum

Division Temperate Tree Fruits #ishs_dfru
Division Physiology and Plant-Environment Interactions of Horticultural Crops in Field Systems #ishs_dphy

Under the aegis of the ISHS, the INRAE PACA Center organized the first ISHS symposium on the genetics, improvement and cultivation of apricot and plum trees from April 22-26, 2024, at the Palais des Papes in Avignon, France. Around 130 researchers, technicians and plant breeders from 23 countries met to share their work.

The symposium opened with a key message from Christian Huyghe (DS Agriculture INRAE, France) that there is an urgent need for orchardists to adopt agroecological farming practices. The take home message was: "Not changing and seeking the status quo is no longer an option".

The symposium was constructed around 6 thematic sessions introduced by guest speakers, followed by 50 oral presentations and 54 posters. Davide Neri from the University of Marche (Italy) introduced the 'Cropping systems and cultivation practices' session and insisted on how to walk "Towards a systemic approach respectful of diversity". The challenge is to preserve cultivated land and soil fertility, combining different levers by better understanding i) the plant and its root system, ii) physical protection of the orchard, iii) management of a living mulch, and iv) a participatory approach.

› Participants of the symposium.

The session on 'Biology and adaptation to climate risk' was presented by Iñaki Garcia de Cortazar Atauri from INRAE (France) who reminded participants that "climate change is a proven fact" with a known trajectory until 2050. He highlighted the insufficient incremental adjustment of practices and the need to work on systemic adjustments.

Cindy Morris from INRAE (France) introduced the 'Control of pests and diseases' session and explained the necessity of "Moving from a targeted (pathogen-centered) approach to a systemic approach", by using epidemiological surveillance as a method of agroecological management of orchard health.

The 'Postharvest and quality of fresh and processed fruits' session, introduced by Jill Stanley from Plant & Food Research (New Zealand), provided an opportunity to "Place the consumer at the heart of orchard and

› Ted DeJong (right), ISHS Vice-President in charge of Scientific Programs, presenting the ISHS Medal Award to the symposium conveners, Jean-Marc Audergon (left) and Bénédicte Quilot (center).

› Round Table with researchers and stakeholders and professionals from the sector around the themes of climate change and fruit quality.

› Jean-Marc Audergon (left), Bénédicte Quilot (second from left) and Ted DeJong (right) presenting the ISHS Young Minds Awards to A) Marie Serrie (best oral presentation) and B) Alessandro Tagliabue (best poster presentation).

postharvest management". Finally, the two sessions on 'Genetic resources, genetics and genomics' and 'Varietal creation and evaluation of varieties and rootstocks', were introduced by Andrea Patocchi from Agroscope (Switzerland) and David Ruiz from CSIC-CEBAS (Spain), respectively. They both insisted that "Improvement and breeding is an integration challenge", which requires i) the management of genetic diversity, ii) the deployment of new technologies, iii) the integration of multi characters, and iv) the adaptation of varieties to the constraints of tomorrow, i.e. climate change and reduction of pesticide use.

The winners of the ISHS Young Minds Awards were Marie Serrie from INRAE (France) for the best oral presentation on the topic of "Investigating the multi-disease challenge in apricot through single and multi-environment genome wide association studies", and Alessandro Tagliabue from the University of Milano (Italy) for the best poster entitled "Breezing: a new dedicated Italian plum breeding program".

Two field visits were undertaken to illustrate the work in progress and to highlight different systems and activities. The first at the CTIFL Balandran presented activities linked to the evaluation of plant material (agronomic behavior and fruit quality) and the national fruit certification program, which seeks to provide producers with plant material that is authentic and high health. At the INRAE A2M site in Amarine, genetic resources and their use in i) scientific studies (core-collection and approaches to seek genetic determinants), ii) prebreeding with the creation of parents carrying traits of interest, iii) varietal creation in partnership with CEP Innovation, and iv) varietal characterization in relation with GEVES were demonstrated.

The second field visit organized with the AOP Pêches et Apricots de France and Fruits Plus visited the Rhône Valley to see the national Ecophyto program and the work carried out for the industry by SEFRA in Etoile sur Rhône and UERI in Gotheron around the design of orchards and combinations of agrotechnical levers.

Participants shared a moment of valuable research/profession exchange in a round table moderated by Jean Harzig around the themes of climate change and fruit quality.

At the ISHS business meeting, it was decided that the II International Symposium on Apricot and Plum will be held in 2028 in Spain.

Jean-Marc Audergon and Bénédicte Quilot

› Field visit at the INRAE A2M site of Amarine.

› Contact

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› XVII International Symposium on Processing Tomato

Division Vegetables, Roots and Tubers #ishs_dveg

› From left to right: Zoltán Pék (Convener), Luca Sandei (Convener), Sophie Colvine (Symposium Secretary), Lajos Helyes (Convener), Carlos Campillo Torres (recipient of the Bernard Bièche Memorial Award) and Oussama M'hamdi (recipient of the ISHS Young Minds Awards for the best poster presentation).

The XVII International Symposium on Processing Tomato was held in conjunction with the XV World Processing Tomato Congress in Budapest (Hungary) from 9-12 June 2024.

The symposia brought academics, researchers and students together with growers, processors and business professionals working in the processing tomato industry. This series of symposia has been very successful since the first World Processing Tomato Congress in Avignon (France) in 1989 and the creation of the World Processing Tomato Council (WPTC) in 1998 in Pamplona (Spain).

The event was organized by the WPTC with the Hungarian company UNIVER acting as the local coordinator in conjunction with the Hungarian University of Agriculture and Life Sciences (MATE) and ISHS. Three scientists worked together to convene the event: Luca Sandei from the Experimental Station for the Food Preserving Industry (SSICA) in Italy, who is the current Chair of ISHS Working Group Production of Vegetables for Processing, and Lajos Helyes and Zoltán Pék from MATE. Sophie Colvine (WPTC, France) acted once again as Symposium Secretary, in parallel with the main congress organizer Gábor Palotás from UNIVER.

As this was the first opportunity for everyone to meet in person after the proposed event in 2020 was cancelled due to the COVID-19 pandemic and then moved online to March 2022, there was a lot of enthusiasm to attend the event. In total, 345 participants met in Budapest. Moreover, sponsorship from The Morning Star Company funded the participation of six scientists who may not have joined otherwise.

The call for papers was focused on three main topics: crop production, processing and markets, and attracted 69 submissions from 14 different countries. Altogether, 33 oral presentations were presented during sessions organized around the following topics: irrigation management; automation, precision farming and resilient crop management; pests, plant diseases and resistance breeding; analysis and products; and functional tomato products (FunTomP project).

In addition, several sessions were held concurrently with the congress including the opening session on "The future of food" featuring keynote presentations by Ryan Avery from Bayer Vegetable Seeds on "Emerging trends in agriculture" and by Magdalena Psuja from TetraPak on "Reimagining our food systems: accelerating transformation to better sustain our planet and its people". A workshop on *Alternaria* featured invited speaker Thierry Gauthier from INRAe (France) on the "Toxicity of *Alternaria* mycotoxins: an overview of current knowledge". In the poster session, some 36 posters were presented.

During the symposium, the Scientific Committee selected two junior scientists for the ISHS Young Minds Awards. The award for the best oral presentation was given to Léna Dole, a PhD candidate at the University of Montpellier, France, for her oral presentation on "*Alternaria* toxins: risk prevention and

› Léna Dole, winner of the ISHS Young Minds Award for the best oral presentation.

› Luca Sandei, Chair of ISHS Working Group Production of Vegetables for Processing, presenting the ISHS Young Minds Award for the best poster presentation to Oussama M'hamdi.

control for tomato food chain". The award for the best poster was given to Oussama M'hamdi, a PhD candidate from MATE, Hungary, for his work entitled "Prediction of tomato quality traits utilizing machine learning models".

The sixth Bernard Bièche Memorial Award, in memory of the man who was instrumental in the creation of AMITOM and WPTC and its cooperation with ISHS, was presented to Carlos Campillo Torres from the Centre for Scientific and Technological Research of Extremadura (CICYTEX) for his long involvement in tomato research and his excellent contributions to previous ISHS International Symposia on Processing Tomato.

Ample opportunities were offered during the four days for all attendees to interact, both during the sessions and in more informal settings during recesses, meals, but also during the outstanding gala dinner cruise on the Danube and the half day post-congress tours, which enabled some participants to visit the tomato processing facilities of UNIVER, as well as their model farm.

The unique format of this symposia continues to provide an excellent opportunity for exchange between leading scientists as well as tomato industry representatives from around the world. The WPTC is already working towards the next event, which is scheduled to take place in Monterey (California) in June 2026.

Sophie Colvine and Gábor Palotás

› Post-congress visit to UNIVER factory.

› Poster session.

› Contact

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Gábor Palotás, Symposium Secretary, UNIVER, Hungary, e-mail: gabor.palotas@univer.hu
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› UrbanFarm2024 – International Student Challenge

Division Landscape and Urban Horticulture #ishs_durb

The sixth International Student Challenge UrbanFarm2024 concluded on April 30, 2024. The competition was organized by the University of Bologna (UNIBO), under the aegis of the International Society for Horticultural Science (ISHS), supported by the Swedish University of Agricultural Science (SLU).

This year, teams were asked to design the external areas of a new prison that is to be built in Trelleborg (Skåne) by the Swedish Prison and Probation Service Kriminalvården. These spaces were to be utilized in the education and rehabilitation of inmates, facilitating their reintegration into society.

All projects were evaluated by an international jury composed of Prof. Francesco Orsini (UNIBO), Dr. Giuseppina Pennisi (UNIBO), Dr. Michele D'Ostuni (UNIBO), Prof. Anna Maria Palsdöttir (SLU), Prof. Marie Larsson (SLU), Andreas Wallin (head of the Kriminalvården), and the architects Karolina Halldin, Jennie Edfast and Elvira Grandin (from Krook & Tjäder).

Ten groups of students from 25 different countries took part in the challenge, which officially started on March 22. Groups were formed targeting diversified geographical provenance and interdisciplinary skills. After the kick-off meeting, the participants took part in two other meetings where they had the chance to access inspirational talks given by international experts. This helped stu-

› Logo realized by the group Lingonträdgard.

dents to get familiar with the context of the challenge, get acquainted with state-of-the-art practices related to urban agriculture, and collect ideas and start working on their projects.

The first round of the competition ended on April 10, when students submitted their abstracts and a 2-minute video. On the same day, students presented their work to the jury, with a 3-minute pitch presentation, followed by seven minutes of questions from jury members. A thorough evaluation by the jury took place over the next few days, providing a first ranking of the participating teams. Each jury member assigned a maximum of 10 points for the abstract and 10 points for the video. Another 5 points were then assigned to the team that received the highest number of public votes for their video on the online platform.

The second round ended on April 22, when students submitted their project proposals. Each jury member evaluated the final proposals assigning 10 points to each of the following criteria: i) overall project concept; ii) agricultural innovation and credibility; iii) environmental sustainability; iv) economic sustainability; v) social and educational sustainability. Accordingly, a maximum of 50 points was assigned to the teams.

The Grand Finale was held on April 30, hosted by SLU on their campus in Alnarp (Malmo). During this event, the students finally met in person and made a 5-minute pitch presentation, followed by five minutes of questions by the jury. During the presentation, the jury assessed the students' performance in terms of clarity, presentation and creativity.

› Winning team with Andreas Wallin (head of Kriminalvården). From left to right: Hasara Kumaragama, Goutham Nidhi, Emily Kroll, Shannon Cronin, Samuel Martintoni and Allison Sermarini.

After the last presentation, the jury started the consultation process that would eventually select the winner. The winning team was Lingonträdgard (Team 8), composed of Samuel Martintoni, Shubham Bam, Shannon Cronin, Hasara Kumaragama, Allison Sermarini, Emily Kroll and Goutham Nidhi. Their proposal focused on the indoor production of vegetables using an aeroponic system, and the outdoor production of various types of fruit. These would then be used to make jams which could be consumed by the inmates. They also created a website to disseminate their project proposal (https://krollems.wixsite.com/hjortronh-ng). Team members were presented with the ISHS Young Minds Award together with a one-year complimentary membership to ISHS.

Andrea D'Aprile, Michele D'Ostuni, Virginia Cioncoloni and Giuseppina Pennisi

› Contact

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From the Secretariat

› New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Armenia: Dr. Mahsa Daryadar; **Australia:** Michael Paul Daly, Mr. John Darby Taguiam; **Belgium:** Ms. Ma. Cecilia Cardinez; **Brazil:** Dr. Gisele da Silva Arduim, Dr. Valdir Lourenco Jr., Eiko Mori Andrade, Prof. Dr. Daiana Petry Rufato, Ms. Cíntia Sabino de Oliveira, Mr. Felipe Terra, Prof. Francisco Zerbini; **Canada:** Cathy Knoblauch, Stephanie Vickers; **Chile:** Mr. Carlos Flores, Roberto Jara Maureira; **China:** Dr. Jiajing Chen, Dr. Wenxing Chen, Prof. Dr. Feng Cheng, Prof. Dr. Qiaohong Duan, Yan Jie Fan, Xiang Gao, Dr. Zhihua Guo, Mr. Chenxing Hao, Prof. Bo Li, Prof. Dr. Chunmei Li, Prof. Dr. Dazhi Li, Prof. Dr. Hongye Li, Prof. Dr. Jing Li, Qionghou Li, Dr. Wen Li, Shengjun Liu, Dr. Wei Liu, Assoc. Prof. Xiaofen Liu, Prof. Yongzhong Liu, Yang Lu, Dr. Zhihao Lu, Xuzhao Luo, Mr. Ryosuke Nakai, Assoc. Prof. Xin Qiao, Assoc. Prof. Shaofei Rao, Dr. Bobo Song, Prof. Dr. Chuankui Song, Weiyuan Song, Daifa Su, Dr. Peng Wang, Dr. Shusheng Wang, Tengfei Wang, Prof. Dr. Juyou Wu, Prof. Xiaojian Xia, Dr. Xiaoe Xiao, Ms. Guo Xu, Prof. Tao Xu, Prof. Xiuling Yang, Prof. Fang Yuan, Ms. Jiaying Yuan, Mr. Yingzhe Yuan, Prof. Dr. Li Yuan-Yuan, Prof. Dr. Fei Zhang, Lingkui Zhang, Prof. Dr. Youjun

Zhang, Zhongyan Zhang, Zheng Zheng, Assoc. Prof. Qinggang Zhu; **Chinese Taipei:** Mr. Chih-hung Lin, Ms. Yu-Chen Lu; **Denmark:** Dr. Nicolai Meyling, Dr. Kai Nielsen; **Finland:** Mr. Nedeljko Basic; **France:** Claire Amar, Dr. Pierre-François Bert, Dr. Delphine Giraud, Dr. Deirdre Holcroft, Mr. Sanjar Katchaganov, Mr. Bernard Le Moine, Marc Voline; **Germany:** Ms. Andrea Baron, Holger Braun, Ms. Katja Burow, Michael Muser, Sophie Wenz; **Greece:** Dr. Konstantina Argyropoulou, Ioanna Baira, Ms. Aikaterini Gaitanaki, Prof. Eleni Goumenaki, Dr. Ioannis Karavidas; **Guadeloupe:** Saturnin Bruyere; **Hungary:** Mr. Oussama M'hamdi; **India:** Mr. Rushikesh Bharsakale, Dr. Puran Chandra, Dr. Nisha M Nisha, Mr. Sahilkumar Patel, Ms. Varshini R A, Mr. Kamal Deep Singh, Dr. Praveen Kumar Singh, Dr. Celia Chalam Vasimalla; **Iran:** Prof. Dr. Masoud Ahmadzadeh; **Ireland:** Ms. Gabrielle Young; **Israel:** Ben Avni, Dr. Gilor Kelly, Dr. Lena Plesser; **Italy:** Ms. Gaia Besate, Loredana Canfora, Assist. Prof. Chiara Catalano, Dr. Angelo Ciacciulli, Dr. Silvia Di Silvestro, Dr. Giulia Franzoni, Mr. Federico La Spada, Ms. Federica Mecozzi, Dr. Simone Pasqualin; **Japan:** Mr. Ryotaro Asakusa, Mr. Takumi Fujiki, Mr. Tetsuo Funabashi, Assoc. Prof. Yoshinori Kawagoe, Haruto Kikuchi, Mr. Manabu Kitagawa, Ms. Mya Le, Ms. Elizabeth Manneh, Mr. Ryusuke Matsuzaki; **Korea (Republic of):** Prof. Dr. Wan Jin Jahng, Mr. Young Ho Jo, Jae-Ho Joa, Kyong Hee Joung, Mr. Taeyeup Kim, Dr. Byulhana Lee, Dr. Kyung Hae Lee, Ms. Hyegyoung Yoo; **Lithuania:** Mr. Vilius Rinkunas; **Malawi:** Assoc. Prof. Jarret Mhango; **Mexico:** Alma Viridiana Marcial Rolon; **Morocco:** Dr. Nadia Houmy, Mr. Ilias Oussif; **Netherlands:** Jielyu Han, Dr. Peter Spoor; **New Zealand:** Dr. Charles Ampomah-Dwamena, Mr. James Bristow, Dr. Ivy Gan, Ms. Rebecca Gough, Mr. Nate Hulston, Ms. Lisa Jamieson, Mr. Yi-Chun Lai, Dharini Marinkovich, Dr. Guinevere Ortiz, Ms. I.P. Shamini Pushparajah, Yeimi Katherine Rodriguez Perez, Hassan Saeiahagh, Mr. Zian Wang, Dr. Xiumei Yang; **Peru:** Adan Orlando Castope Rodriguez, Ms. Ximena Gonzales Huaman, Maria Velarde; **Poland:** Dr. Katarzyna Góralska, Prof. Dr. Jolanta Kowalska, Assoc. Prof. Danuta Solecka, Dr. Pawel Trzcinski, Dr. Diana Wieczorek; **Portugal:** Dr. Alexandra Machado, Dr. Enrique Pino-Hernández; **Romania:** Mr. Leonard Nistor, Dr. Marius Petrache; **Samoa:** Dr. Seeseei Molimau-Samasoni; **Saudi Arabia:** Mr. Mohammad Aslam Parweez; **Slovenia:** Mr. Luka Batistic; **South Africa:** John Conroy, Dr. Heino Papenfus; **Spain:** Mr. Manuel Agusti, Dr. Pau Bretó Monfort, Emilio Fuertes, Dr. Bartosz Tylkowski; **Switzerland:** Camille Voegeli; **Turkey:** Basak Selin Dincer, Islam Ege; **United Arab Emirates:** Dr. Azad Omrani Sabbaghi; **United Kingdom:** Dr. Maria Carcamo de la Concepcion, Dr. Barend H.J. de Graaf, Ms. Evette Hammond, Prof. Robert Howlett, Mr. Philipp Nedomlel, Avery Rowe; **United States of America:** Dr. Elizabeth Alger, Dr. Jerry Benzl, Dr. Narayan Bhusal, Neil Checketts, Samuel Dotson des Bordes, Lee Dongyun, Dr. Yongping Duan, Dr. Amy Enfield, Dr. Alejandro Estrada, Markus Flury, Prof. Dr. Susheng Gan, Brad Gleason, Mr. Ben Goolsby, Chayce Griffith, Mr. Matthew Gullickson, Dr. Thomas Karl, Dr. Amita Kaundal, Fatemeh Khodadadi, Shanthanu Krishna Kumar, James Larson, Dr. Francielle Lima, Dr. Yiyun Lin, Prof. Dr. Zhongchi Liu, Dr. Brian Makeredza, Matthew Mattia, Matt Naumann, Daniel Olivier, Peter Petracek, Robert Polomski, Richard Porter, Ms. Maricielo Postillos Flores, Mr. Rai Ramnarace, Ja Re, Prof. Guo-qing Song, Dr. Youping Sun, Assist. Prof. Mary Sutton, Dr. Steven Van Nocker, Georgios Vidalakis, Kaitlyn Vondracek, Dr. Antt Htet Wai, Yu Wang, Penelope Woodhouse, Mr. Kunyu Zhang.

› Calendar of ISHS events

For updates and more information, go to **www.ishs.org** › calendar of events. For a comprehensive list of meetings in each Division or Working Group use the "science" option from the website navigation menu.
To claim reduced registration for ISHS members, your personal membership number is required when registering - ensure your ISHS membership is current **before** registering. When in doubt, sign in to your membership account and check/renew your membership status first: **www.actahort.org** or **www.ishs.org**

Year 2024

- October 1-4, 2024, Brasília, DF (Brazil): **VII International Symposium on Tomato Diseases.** Info: Prof. Eduardo Mizubuti, Departamento de Fitopatologia, Universidade Federal de Viçosa, 36570-900 Viçosa-MG, Brazil. Phone: (55) 31 3899 1090, E-mail: mizubuti@ufv.br or Dr. Alice Kazuko Inoue-Nagata, Embrapa Vegetables Km 09,BR060, 70275970 Brasilia-DF, Brazil. Phone: (55)6133859053, E-mail: alice.nagata@embrapa.br or Prof. Dr. Nadson Pontes, BR 153, km 633. CP 92, Zona Rural, 75650-000 Morrinhos-GO, Brazil. Phone: (55)64-34137900, E-mail: nadson.pontes@ifgoiano.edu.br E-mail symposium: 7istd@7istd.com Web: https://7istd.com/
- October 20-25, 2024, Yangling (China): **VIII International Symposium on Persimmon.** Info: Prof. Yong Yang, Northwest A&F University, Yangling, Shaanxi 712100, China. Phone: (86)29-87082613, E-mail: yang.yong521@163.com or Prof. Dr. Zhengrong Luo, National Key Lab for Germplasm Innovation &, Utilization of Horticultural Crops, Huazhong Agricultural University, Shizishan, Wuhan, Hubei 430070, China. Phone: (86)27-8728-2677, Fax: (86)27-8728-2010, E-mail: luozhr@mail.hzau.edu.cn or Dr. Qinglin Zhang, National Key Lab for Germplasm Innovation &, Utilization of Horticultural Crops, Huazhong Agricultural University, Wuhan, Hubei, 430070, China. Phone: (86)27-8728 -2677, E-mail: qlzhang2000@webmail.hzau.edu.cn E-mail symposium: persimmon@mail.hzau.edu.cn Web: https://persimmon2024.hzau.edu.cn/
- October 28-30, 2024, Coimbra (Portugal): **International Symposium on *Arbutus unedo* (Strawberry Tree) and Related Species: from Biology to Biotechnology.** Info: Prof. Dr. Jorge Canhoto, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)917859860, E-mail: jorgecan@ci.uc.pt or Dr. João Martins, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)239240700, E-mail: joao.martins@uc.pt E-mail symposium: arbutus2024ishs@uc.pt
- November 10-15, 2024, Jeju (Korea (Republic of)): **XV International Citrus Congress**. Info: Prof. Dr. Kwan Jeong Song, Dept. of Horticultural Sceince, College of Applied & Life Sciences, Cheju National Unversity, 1 Ara 1-Dong, Jeju City, Jeju-Do 690-756, Korea (Republic of). Phone: (82)647543328, Fax: (82)647254905, E-mail: kwansong@jejunu.ac.kr E-mail symposium: info.icc2024@gmail.com Web: https://www.icc2024.kr/

- November 11-15, 2024, Rotorua (New Zealand): **IX International Postharvest Symposium**. Info: Dr. Allan Woolf, Plant and Food Research, Mt Albert Research Centre, 120 Mt Albert Road, Sandringham, 1025, Auck, Private Bag 92169, Auckland, New Zealand. Phone: (64)99257267, Fax: (64)99258628, E-mail: allan.woolf@plantandfood.co.nz or Prof. Andrew East, Massey University, Private Bag 11222, Palmerston North, New Zealand. E-mail: a.r.east@massey.ac.nz Web: https://www.scienceevents.co.nz/postharvest2024
- November 11-15, 2024, Rotorua (New Zealand): **X International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2024**. Info: Dr. Carolyn Lister, New Zealand Institute for Plant and Food Research Limited, Lincoln, New Zealand. Phone: (64)3-3259453, E-mail: carolyn.lister@plantandfood.co.nz Web: https://www.scienceevents.co.nz/postharvest2024
- November 11-15, 2024, Rotorua (New Zealand): **VII International Symposium on Postharvest Pathology: Next Frontiers for Improved Knowledge and Management of Postharvest Disease.** Info: Dr. Kerry Everett, PB 92169, Mt Albert, 1142 Auckland, New Zealand. Phone: (64)9-9257133, E-mail: kerry.everett@plantandfood.co.nz Web: https://www.scienceevents.co.nz/postharvest2024
- November 19-21, 2024, New Delhi (India): **X International Scientific and Practical Conference on Biotechnology as an Instrument for Plant Biodiversity Conservation (physiological, biochemical, embryological, genetic and legal aspects**). Info: Dr. Sandhya Gupta, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, Delhi, 110 012, India. Phone: (91)9958499781, Fax: (91)11-25842495, E-mail: sandhya_gupta87@yahoo.com or Dr. Surendra Kumar Malik, NBPGR, Pusa Campus, New Delhi 110 012, Delhi, India. Phone: (91)1125848955, Fax: (91)1125848955, E-mail: skm1909@gmail.com E-mail symposium: info@biotech2024.in Web: https://biotech2024.in/

Year 2025

- January 19-24, 2025, Napier (New Zealand): **XIII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems.** Info: Dr. Adam Friend, 55 Old Mill Road, RD 3, Motueka 7198, Tasman, New Zealand. Phone: (64)3-9073622, Fax: (64)3-9073596, E-mail: adam.friend@plantandfood.co.nz or Dr. Ben van Hooijdonk, Plant and Food Research, Hawkes Bay, Private Bag 1401, Havelock North, 4130, New Zealand. E-mail: ben.vanhooijdonk@plantandfood.co.nz Web: https://www.scienceevents.co.nz/orchard-systems
- March 16-21, 2025, Yancheng city, Jiangsu Province (China): **X International Strawberry Symposium.** Info: Dr. Jian Sun, Institute of Forestry and Pomology, Beijing Academy of Agriculture and Forestry, NO.12, Ruiwangfen Jia, Xiangshan, Haidian, Beijing, 100093, China. Phone: (86)10-82598882, E-mail: sjroad@126.com or Dr. Yuntao Zhang, BJ Academy Forestry & Pomology Sciences, Rui Wang Fen, Xiang-Shan, Hai Dian District, Beijing 100093, China. Phone: (86)1082598882, Fax: (86)1062598882, E-mail: zhytao1963@126.com or Prof. Mizhen Zhao, 50 Zhongling Street,Nanjing, Nanjing, 210014, China. Phone: (86)25-84390219, Fax: (86)25-84390218, E-mail: njzhaomz@163.com or Prof. Jiajun Lei, Shenyang Agricultural University, Shenyang, China. E-mail: jiajunleisy@163.com Web: https://www.iss2025.org.cn
- March 30 - April 4, 2025, Temecula, CA (United States of America): **XV International Protea Research Symposium.** Info: Kenneth W. Leonhardt, Dept of Horticulture, University of Hawaii, 3190 Maile Way, Rm 102, Honolulu, HI 96822-2232, United States of America. Phone: (1)8089568909, Fax: (1)8089563894, E-mail: leonhard@hawaii.edu E-mail symposium: protea2025@gmail.com Web: https://www.proteaconference2025.org
- May 5-9, 2025, Rimini (Italy): **International Symposium on Biotechnological Tools in Horticulture.** Info: Dr. Silvia Sabbadini, Via Brecce Bianche 10, Ancona, Italy. E-mail: s.sabbadini@staff.univpm.it or Dr. Luca Capriotti, Dept Agric., Food & Environmental Sciences, Università Politecnica delle Marche, Via Brecce Bianche 10, Ancona, Italy. Phone: (39)3662844234, E-mail: l.capriotti@staff.univpm.it or Dr. Angela Ricci, Dept Agric., Food & Environmental Sciences, Università Politecnica delle Marche, Via Brecce Bianche 10, Ancona, Italy. E-mail: angela.ricci@pm.univpm.it E-mail symposium: info@symposiumbiotechinhort.com Web: https://symposiumbiotechinhort.com/
- May 6-9, 2025, Adeje, Tenerife (Spain - Canary Islands): **XI International Congress on Cacti as Food, Fodder and Other Uses.** Info: Prof. Dr. M. Pilar Cano, Nicolás Cabrera, 9, 28049 Madrid Madrid, Spain. Phone: (32)910017937, Fax: (34)910017905, E-mail: mpilar.cano@csic.es or Dr. M. Gloria Lobo, Carretera del Boquerón s/n, 38270 Valle de Guerra, Spain - Canary Islands. Phone: (34) 922923316, E-mail: globo@icia.es Web: https://www.cactuscongress2025.com/
- May 10-15, 2025, Beijing (China): **IX International Symposium on Rose Research and Cultivation.** Info: Prof. Junping Gao, China Agricultural University, Beijing, 100193, China. E-mail: gaojp@cau.edu.cn E-mail symposium: Roses2025@163.com Web: http://www.rose2025.cn/
- May 18-22, 2025, Wenatchee, WA (United States of America): **XIV International Controlled and Modified Atmosphere Research Conference - CAMA2025.** Info: Dr. Carolina A. Torres, Washington State Univ, 1100 N. Western Ave, Wenatchee, WA 98801, United States of America. Phone: (1)206 331 4780, Fax: (1)509 848 2231, E-mail: ctorres@wsu.edu E-mail symposium: info@cama2025.com Web: https://cama2025.com
- May 28-31, 2025, Mazatlán, Sinaloa (Mexico): **XIV International Mango Symposium.** Info: Prof. Dr. Sergio Marquez-Berber, 4ta Cda Huautla 3A, San Luis Huexotla, 4ta Cda Huautla 3A, San Luis Huexotla, Texcoco, Mexico, 56220, Mexico. Phone: 5215951070500, Fax: 5959521642, E-mail: sermarber@gmail.com E-mail symposium: info@mango2025.com
- June 1-5, 2025, Richland, WA (United States of America): **X International Cherry Symposium.** Info: Dr. Matthew Whiting, Washington State University, IAREC, 24106 N. Bunn Road, Prosser, WA 99350, United States of America. E-mail: mdwhiting@wsu.edu Web: https://www.xishscherrysymposium.com/
- June 2-6, 2025, Thessaloniki (Greece): **IX International Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops and III International Symposium on Vegetable Grafting.** Info: Athanasios Koukounaras, Aristotle University of Thessaloniki, Alamanas 33, 55 132 Kalamaria, Thessaloniki, Greece. E-mail: thankou@agro.auth.gr Web: https://sest-vg2025.com/
- June 22-27, 2025, Almeria (Spain): **GreenSys2025 - International Symposium on Advanced Technologies and Management for Sustainable Greenhouse Systems.** Info: Prof. Dr. Diego L. Valera, Dpto. Ingeniería, Universidad de Almería, Ctra Sacramento sn, 04120 Almería, Spain. Phone: (34)950015546, E-mail: dvalera@ual.es or Prof. Dr. Francisco Domingo Molina Aiz, Universidad de Almería, CITE II-A, Despacho 1.07, Carretera Sacramento s/n, 04120 Almería, Spain. Phone: (34)950015449, Fax: (34)950015491, E-mail: fmolina@ual.es E-mail symposium: greensys2025@ual.es Web: http://www2.ual.es/greensys2025/
- June 23-26, 2025, Chicago, IL (United States of America): **XV International Symposium on Plant Bioregulators in Fruit Production.** Info: Todd Einhorn, Michigan State University, Horticulture, 1066 Bogue Street, Plant & Soil Sciences Building

A338, East Lansing, MI 48824, United States of America. Phone: (517) 353-0430, Fax: (517) 353-0890, E-mail: einhornt@msu.edu or Prof. Dr. Randolph M. Beaudry, Michigan State University, Department of Horticulture, A22 Plant& Soil Sci. Building, East Lansing, MI 48824-1325, United States of America. Phone: (1)517355-5191ext303, Fax: (1)517353-0890, E-mail: beaudry@msu.edu or Dr. Steven McArtney, 1910 Innovation Way Suite 100, 870 Technology Way, Libertyville IL 60048, United States of America. Phone: (1) 847-968-4722, E-mail: steve.mcartney@valentbiosciences.com or Peter Petracek, 2045 East 8th Street, Grayslake MN 60030, United States of America. E-mail: bppetr@gmail.com Web: https://www.canr.msu.edu/hrt/2025FruitBioReg/

- July 10-11, 2025, Melaka (Malaysia): **III International Symposium on Tropical and Subtropical Ornamentals.** Info: Prof. Dr. Asmah Binti Awal, Faculty of Plantation and Agrotechnology, UiTM Cawangan Melaka, Kampus Jasin, 77300 Melaka Merlimau, Malaysia. E-mail: asmah138@uitm.edu.my E-mail symposium: secretariat.tso@gmail.com

NEW
- August 3-7, 2025, Fort Collins, CO (United States of America): **IV International Symposium on Germplasm of Ornamentals.** Info: Mengmeng Gu, Dept. Horticulture & Landscape Architecture, Colorado State University, 1173 Campus Delivery, Fort Collins CO 80523, United States of America. Phone: (1)9792299683, E-mail: mengmeng.gu@colostate.edu or Dr. Youping Sun, Department of Plants, Soils & Climate, Utah State University, 4820 Old Main Hill, Logan Utah 84335, United States of America. Phone: (1)4357972972, E-mail: youping.sun@usu.edu Web: https://agsci.colostate.edu/hortla/isgo/

NEW
- August 4-8, 2025, Beijing (China): **XI International Congress on Hazelnut.** Info: Prof. Jianguo Zhang, Research Institute of Forestry, Chinese Academy of Forestry, Dongxiaofu 1, Haidian District, Beijing, China. E-mail: chinahazelnut2025@163.com E-mail symposium: chinahazelnut2025@163.com

NEW
- August 25-31, 2025, Naples and Alba (Italy): **International Symposium on Temperate Tree Nuts: from Agroecologically Sustainable to Organic Production.** Info: Prof. Dr. Chiara Cirillo, Dept. Agricultural Sciences, University of Napoli Federico II, Via Università, 100, 80055 Portici NA, Italy. Phone: (39)081-2539381, Fax: (39)081-7755114, E-mail: chiciril@unina.it or Prof. Roberto Botta, DISAFA - University of Torino, Largo Paolo Braccini 2, 10095 Grugliasco (TO), Italy. Phone: (39)0116708800, Fax: (39)0116708658, E-mail: roberto.botta@unito.it or Prof. Dr. Tiziano Caruso, Department of Agricultural & Forest Science, University of Palermo, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39) 09123861207, E-mail: tiziano.caruso@unipa.it Web: https://ttn2025.it/
- September 7-12, 2025, Freising (Germany): **II International Symposium on Growing Media, Compost Utilization and Substrate Analysis for Soilless Cultivation.** Info: Dr. Dieter Lohr, Weihenstephan-Triesdorf University, Institute of Horticulture, Am Staudengarten 14, 85354 Freising, Germany. E-mail: dieter.lohr@hswt.de or Dr. Elke Meinken, Am Staudengarten 14, 85354 Freising, Germany. E-mail: elke.meinken@hswt.de or Prof. Dr. Nazim Gruda, University of Bonn, INRES Horticultural Sciences, Auf dem Hügel 6, 53121 Bonn, Germany. E-mail: ngruda@uni-bonn.de Web: https://www.growingmedia2025.com/
- September 16-19, 2025, Bogor (Indonesia): **IX International Symposium on Edible Alliums.** Info: Dr. Awang Maharijaya, Pakuan Regency, cluster Lingga Buana, Blok E6 no 24, 16680 West Java Bogor, Indonesia. E-mail: awangmaharijaya@apps.ipb.ac.id E-mail symposium: allium2025@apps.ipb.ac.id

NEW
- September 22-26, 2025, Yunnan (China): **II International Symposium on Botanical Gardens and Landscapes.** Info: Prof. Yongping Yang, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun, Mengla, Yunnan, 666303, China. Phone: (86)6918716681, Fax: (86)6918715070, E-mail: yangyp@xtbg.ac.cn or Prof. Fuchuan Wu, Xishuangbanna Tropical Botanical Garden, Yunnan, China. E-mail: wfc@xtbg.org.cn or Prof. Dr. Kanchit Thammasiri, Department of Gardening and Horticulture, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Science, Menglun, Mengla, Yunnan 666303, China. E-mail: kanchitthammasiri@gmail.com E-mail symposium: bgl2025.china@gmail.com Web: https://bgl2025.casconf.cn/

NEW
- September 22-26, 2025, Davis, CA (United States of America): **VI International Cannabaceae Symposium.** Info: Dr. Angel Vicente Fernandez Marti, 1451 River Park Dr, Suite 130, Sacramento CA 95815, United States of America. Phone: (1)530-564-2049, E-mail: afernandez@myfloradna.com or Dr. Ajith Anand, 1451 River Park Dr, Sacramento California 95815, United States of America. E-mail: ajith.anand@myfloradna.com or Ms. Emily Rigby, PO Box 418, Mapleton, Queensland 4560, Australia. E-mail: rigby.research@gmail.com or Prof. Dr. Ted M. DeJong, Department of Plant Sciences, Mail Stop II, UC Davis, One Shields Ave, Davis, CA 95616-8683, United States of America. Phone: (1)530-752-1843, Fax: (1)530-752-8502, E-mail: tmdejong@ucdavis.edu

NEW
- September 22-24, 2025, Bari (Italy): **VI International Symposium on Pomegranate and Minor Mediterranean Fruits.** Info: Assoc. Prof. Giuseppe Ferrara, Università di Bari, Dpt. Scienze Suolo, Pianta e Alimenti, Via Amendola 165/a, 70126 Bari, Italy. Phone: (39)805442979, Fax: (39)805442979, E-mail: giuseppe.ferrara@uniba.it or Prof. Dr. Stefano La Malfa, Di3A, Catania University, Via Valdisavoia 5, 95123 Catania, Italy. Phone: (39)095-354641, Fax: (39)095-234406, E-mail: stefano.lamalfa@unict.it Web: https://www.pomsym2025.com/

NEW
- October 13-16, 2025, Kalamata (Greece): **X International Symposium on New Ornamental Crops.** Info: Assoc. Prof. Anastasios Darras, University of the Peloponnese, Antikalamos, Kalamata, 24100 None Kalamata, Greece. Phone: +306974396588, E-mail: a.darras@uop.gr Web: https://newornamentals2025.uop.gr/
- November 5-7, 2025, Bogota (Colombia): **VI International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions.** Info: Dr. Maria Soledad Hernandez, Amazonic Research Institute- Sinchi, Calle 20. No 5-44, Bogota, D.C, Colombia. Phone: (57)1 4442060, Fax: (57)12862418, E-mail: shernandez@sinchi.org.co or Ms. Luz Mantilla, Calle 20 No 5-44, Bogota 111211, Colombia. Phone: 576012442060, E-mail: luzmarmantilla@sinchi.org.co
- November 11-13, 2025, Shizuoka (Japan): **VI Asia Symposium on Quality Management in Postharvest Systems.** Info: Prof. Dr. Masaya Kato, Faculty of Agriculture, Shizuoka University, Ohya, Suruga, Shizuoka 422-8529, Japan. Phone: (81)54-238-4830, Fax: (81)54-237-3028, E-mail: kato.masaya@shizuoka.ac.jp E-mail symposium: asqp2025@gmail.com Web: https://asqp2025.org/

Year 2026

- January 18-23, 2026, Tatura, Victoria (Australia): **XI International Symposium on Irrigation of Horticultural Crops.** Info: Dr. Alessio Scalisi, Tatura SmartFarm, Agriculture Victoria Research, Dept Energy, Environment and Climate Action, 255 Ferguson Rd, Tatura, Victoria 3616, Australia. E-mail: alessio.scalisi@agriculture.vic.gov.au or Dr. Ian Goodwin, Tatura SmartFarm, Agriculture Victoria Research, Dept Energy, Environment and Climate Action, 255 Ferguson Rd, Tatura, Victoria 3616, Australia. Phone: (61)354831101, Fax: (61)358335299, E-mail: ian.goodwin@agriculture.vic.gov.au or Prof. Pablo J. Zarco-Tejada, SAFES, Faculty of Science, and, Department of Infrastructure Engineering, Faculty Engineering & Information Technol., Univ. Melbourne, Parkville, Victoria 3052, Australia. E-mail: pablo.zarco@unimelb.edu.au

NEW

- January 26-31, 2026, Kaohsiung City (Chinese Taipei): **VII International Jujube Symposium.** Info: Dr. Wen-Li Lee, Taiwan Agricultural Research Institute, No.530, Wenlong E.Rd., Fengshan Dist., 83052 Kaohsiung City, Chinese Taipei. Phone: (886)7310191, E-mail: wenlly@tari.gov.tw
- March 16-20, 2026, Skukuza (South Africa): **IV International Symposium on Beverage Crops.** Info: Prof. Dr. Olaniyi Fawole, Postharvest and Agroprocessing Research Lab, Department of Botany & Plant Biotechnology, University of Johannesburg, APK Campus, South Africa. E-mail: olaniyif@uj.ac.za
- May 4-8, 2026, Lleida (Spain): **IX International Symposium on Almonds and Pistachios.** Info: Dr. Xavier Miarnau, IRTA-Fruitcentre, Parc Agrobiotech, Parc de Gardeny, 25003 Lleida, Spain. Phone: (34)675788825, E-mail: xavier.miarnau@irta.cat or Dr. Joaquim Bellvert Rios, Parc de Gardeny, IRTA Fruitcentre, 25003 Lleida Lleida, Spain. Phone: +34669012747, E-mail: joaquim.bellvert@irta.es

NEW

- May 17-22, 2026, Athens (Greece): **X Southeastern and Eastern Europe Symposium on Vegetables and Potatoes.** Info: Dr. Dimitrios Savvas, Agricultural University of Athens, Laboratory of Vegetable Production, Iera Odos 75, 11855 Athens, Greece. Phone: (30)2105294510, Fax: (30)2105294504, E-mail: dsavvas@aua.gr or Assist. Prof. Georgia Ntatsi, Agricultural University of Athens, Laboratory of Vegetable Crops, Iera Odos 75, 11855 Athens, Greece. Phone: (30)2015294532, E-mail: ntatsi@aua.gr or Prof. Dr. Nazim Gruda, University of Bonn, INRES Horticultural Sciences, Auf dem Hügel 6, 53121 Bonn, Germany. E-mail: ngruda@uni-bonn.de

NEW

- June 22-24, 2026, Jejudo (Korea (Republic of)): **XVI International Asparagus Symposium.** Info: Prof. Dr. Yang Gyu Ku, Department of Horticulture Industry, College of Agriculture and Food Sciences, Wonkwang University, Iksan-city, Korea (Republic of). Phone: (82)638506672, Fax: (82)638507308, E-mail: ygku35@wku.ac.kr or Prof. Dr. Young Yeol Cho, Collage of Applied Life Sciences, Department of Horticultural Science, Jeju National University, Jeju, Korea (Republic of). Phone: (82)647543325, Fax: (82)647254905, E-mail: yycho@jejunu.ac.kr or Prof. Dr. Jong Hyang Bae, Department of Horticulture Industry, College of Agriculture and Food Sciences, Wonkwang University, Iksan-city, Korea (Republic of). Phone: (82)638506671, Fax: (82)638507308, E-mail: bae@wku.ac.kr or Prof. Dr. Young Rog Yeoung, Department of Plant Science, College of Life Science, GangneungWoju National University, Gangwon-Do, Korea (Republic of). Phone: (82)336402356, Fax: (82)336402909, E-mail: yryeoung@gwnu.ac.kr

NEW

- August 23-28, 2026, Kyoto (Japan): **XXXII International Horticultural Congress: IHC2026.** Info: Prof. Dr. Ryutaro Tao, Lab. Pomology, Fac. Agric., Kyoto University, Kitashirakawa Oiwake-cho, Sakyo-ku Kyoto 606-8502, Japan. Phone: (81)757536053, Fax: (81)757536497, E-mail: tao.ryutaro.8c@kyoto-u.ac.jp E-mail symposium: ihc2026@convention.co.jp Web: https://www.ihc2026.org/

NEW

- November 18-20, 2026, Bastia, Corsica (France): **V International Symposium on Citrus Biotechnology.** Info: Dr. Francois Luro, AGAP Corse Equipe SEAPAG, station INRAE, 20230 San Giuliano, France. Phone: (33)495595946, E-mail: francois.luro@inrae.fr

Year 2027

NEW

- June 6-10, 2027, Wageningen (Netherlands): **GreenSys2027.** Info: Dr. Silke Hemming, Wageningen University & Research, Business Unit Greenhouse Horticulture, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands. Phone: (31)317 4 86921, E-mail: silke.hemming@wur.nl or Prof. Dr. Leo F. M. Marcelis, Wageningen University, Horticulture & Product Physiology, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands. Phone: (31)317485675, E-mail: leo.marcelis@wur.nl or Dr. Ep Heuvelink, Greenhouse Crop Physiology and Modelling, Wageningen University, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands. Phone: (31)317483679, Fax: (31)317484709, E-mail: ep.heuvelink@wur.nl
- June 7-10, 2027, Coimbra (Portugal): **XXVIII International EUCARPIA Symposium Section Ornamentals - From Biology to Bioeconomy.** Info: Prof. Dr. Jorge Canhoto, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)917859860, E-mail: jorgecan@ci.uc.pt

NEW

- June 14-18, 2027, Alnarp (Sweden): **XVII EUCARPIA Symposium on Fruit Breeding and Genetics.** Info: Assoc. Prof. Larisa Gustavsson, Swedish University of Agricultural Sciences, Department of Plant Breeding, Alnarp, Box 190, 234 22 Lomma, Sweden, Sweden. Phone: (46)402858114, E-mail: larisa.gustavsson@slu.se or Prof. Dr. Henryk Flachowsky, Pillnitzer Platz 3a, 01326 Dresden, Germany. E-mail: henryk.flachowsky@julius-kuehn.de

NEW

- June 16-18, 2027, Torino (Italy): **VIII International Chestnut Symposium.** Info: Prof. Dr. Gabriele Loris Beccaro, Università degli Studi di Torino, Dept. Agric., Forestry & Food Sci., Largo Paolo Braccini 2, 10095 Grugliasco, Torino, Italy. Phone: (39)0116708802, Fax: (39)116708658, E-mail: gabriele.beccaro@unito.it or Prof. Roberto Botta, DISAFA - University of Torino, Largo Paolo Braccini 2, 10095 Grugliasco (TO), Italy. Phone: (39)0116708800, Fax: (39)0116708658, E-mail: roberto.botta@unito.it

NEW

- July 11-16, 2027, Pergine Valsugana (Italy): **XIV International Rubus and Ribes Symposium.** Info: Gianluca Savini, Sant'Orsola Sca., Via dell'aeroporto 14, 38057 Località Cirè di Pergine Valsugana TN, Italy. E-mail: gianluca.savini@santorsola.com or Lara Giongo, Fondazione Edmund Mach via E. Mach,1, San Michele aA, Italy. E-mail: lara.giongo@fmach.it E-mail symposium: ruri@santorsola.com Web: https://ruri.santorsola.com/

NEW

- August 31 - September 3, 2027, Banja Luka (Bosnia and Herzegovina): **VI Balkan Symposium on Fruit Production Systems.** Info: Prof. Dr. Miljan Cvetkovic, Vojislava Djede Kecmanovica 1A, 78000 Banja Luka, Bosnia and Herzegovina. Phone: (387) 51 330 938, E-mail: miljan.cvetkovic@agro.unibl.org or Prof. Dr. Boris Pasalic, Kosovke djevojke 2, 78000 Banjaluka, Bosnia and Herzegovina. E-mail: boris.pasalic@agro.unibl.org

NEW

- September 6-9, 2027, Matera (Italy): **XII International Symposium on Kiwifruit.** Info: Prof. Dr. Bartolomeo Dichio, Università degli Studi della Basilicata, DICEM, Via S.Rocco, 75100 Matera, Italy. Phone: (39)08351971422, E-mail: bartolomeo.dichio@unibas.it or Prof. Cristos Xiloyannis, vico san leonardo,35, DICEM, Via S.Rocco, 75100 Matera, Italy. Phone: (39)0835314347, E-mail: cristosxiloyannis15@gmail.com or Dr. Alba Mininni, Università degli studi della Basilicata, DICEM, via passarelli 113, 75100 Matera (MT), Italy. E-mail: alba.mininni@unibas.it

NEW

- September 13-17, 2027, Beijing (China): **XI International Symposium on Soil and Substrate Disinfestation.** Info: Qiuxia Wang, Institute of Plant Protection, Chinese Academy of Agricultural Sciences, 2 West Yuanmingyuan Road, Haidian District, Beijing, China. E-mail: wqxcasy@163.com E-mail symposium: sd2027@vip.163.com

NEW

- September 27-30, 2027, Athens (Greece): **III International Symposium on Growing Media, Compost Utilization and Substrate Analysis for Soilless Cultivation.** Info: Dr. Dimitrios Savvas, Agricultural University of Athens, Laboratory of Vegetable Production, Iera Odos 75, 11855 Athens, Greece. Phone: (30)2105294510, Fax: (30)2105294504, E-mail: dsavvas@aua.gr or Assist. Prof. Georgia Ntatsi, Agricultural University of Athens, Laboratory of Vegetable Crops, Iera Odos 75, 11855 Athens, Greece. Phone: (30)2015294532, E-mail: ntatsi@aua.gr

For updates logon to www.ishs.org/symposia

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International Society for Horticultural Science

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ISHS Individual Membership for Professionals

Committed to a Better World Through Horticulture

Horticulture is essential to our lives, influencing food, nutrition, health, and well-being. ISHS is a non-profit independent and scientific society that promotes the exchange of horticultural knowledge, research and applied solutions to a world wide audience.

Our Method:
ISHS brings together people, ideas, research and experimental results, to enhance the positive impact of sustainable, science-based innovation in horticulture.

Our Objective:
ISHS aims to collaboratively develop solutions that empower horticulturists to address sustainability, climate change, health and well-being and the adoption of technology.

Our Commitment:
Since its inception, ISHS has upheld an international vision, supporting horticultural research and facilitating the adoption of new technologies world wide. We connect horticultural scientists and practitioners and promote sustainable lives and livelihoods. We connect horticultural scientists and practitioners and the industry, and we promote sustainable livelihoods.

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Our Network:
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An **ISHS individual membership** for professionals unlocks a world of opportunities in horticultural innovation. Whether you are an existing member, or looking to join us for the first time, our expert international community facilitates multidisciplinary collaborations leading to innovative solutions for your strategic challenges.

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-10% MULTI-YEAR*

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Lukas Bertschinger
CEO klb innovation
ISHS Board Member for Finance, Membership, Outreach and Europe

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As a student or early-career professional, by joining the largest global horticultural network, you'll enjoy numerous membership benefits:

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› Global alliances

Working together! Connect and collaborate globally with partners across diverse disciplines. Enhance your career opportunities and make targeted contacts drawing on the ISHS membership directory and partnering opportunities at symposia and online exchanges.

› Specialised content

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As an early-career professional who is heavily involved in ISHS, I have benefited greatly from expanding my network of scientists much faster than if I did so independently of the organization. I've developed connections with NGO's and international organizations that will be career-long. This has set me up for success in the tenure process of my position and in my standing as a researcher.

Melinda Knuth
Assistant Professor at North Carolina State University Horticultural Science

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› Mentoring for a better tomorrow

Lead by example! Advise and accompany the next generation of horticultural scientists thanks to your professional experience, enabling younger members to gain access to invaluable expertise. An enriching experience for all concerned, your contributions will inspire our 'Young Minds', help accelerate their professional development and strengthen the ISHS community.

› Global alliances, and cultivate your international contacts

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› Continuous learning

Exclusive content! Whether you wish to explore new horticultural techniques or discover the latest innovative solutions to global challenges, our cutting-edge publications and insightful webinars will keep you up to date.

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ISHS membership RETIRED

NEW! Membership discounts now available

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-10% MULTI-YEAR*

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Although I'm retired, I continue to undertake research at my university. This provides me with a reason to keep attending and presenting papers at ISHS symposia, and to keep my knowledge base up to date. In this respect, reviewing research papers for Acta Horticulturae and eJHS has been invaluable. Through my participation in ISHS symposia and congresses, I am able to maintain contact with my international friends and development partners, and to engage with new and emerging researchers and doctoral candidates.

Mike Nichols
Retired Senior Lecturer in Horticulture, Massey University, New Zealand

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- ***Scripta Horticulturae*** – specific horticultural issues series
- ***PubHort*** - Crossroads of horticultural publications (publication platform)
- ***HortForum*** and ***HortDialogues*** **webinar** series
- Peer-reviewed **open access ISHS journal: eJHS** - 25% article processing charge discount
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- **Membership directory**

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- **Chair** ISHS **Divisions** and **Commissions**
- **Become a thought leader** of ISHS **Working Groups**

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- **Discounted registration fee** to attend 30+ symposia per year, the International Horticultural Congress and regional congresses in Europe, Asia and Africa
- **Waived abstract submission charge** for ISHS symposia and congresses

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- **Fellow award** for an outstanding contribution to global horticultural science
- **Honorary membership** for exceptional service to the Society
- **Horticulture Innovation Award** for exceptional contribution to horticulture innovation
- **ISHS Medal** for meritorious service to the Society
- For **Young Minds recognition** see the award opportunities under career support

Young Minds career support

ISHS membership YOUNG MINDS JOIN NOW!

- Full range of **benefits for PRO members**
- **Financially attractive on-boarding** for students and early-career professionals
- **Young Minds award program** at symposia and congresses
- **Miklos Faust International Travel Award for Young Pomologists** for early-career fruit scientists to attend the ISHS International Horticultural Congress
- Global **Young Minds Committee** and support program NEW
- Personalised **mentoring support program***
- Academic **exchange and internship** opportunities*
- **Collaboration** and **job platform***
- **Corporate sector** exchange opportunity online and at congresses*

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NEW

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- Opportunity to participate in the **Young Minds Mentoring Program**
- Opportunity to join the **ISHS Ambassadors Club***
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*in preparation

For annual fee information, please check our website: ishs.org

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