

A publication of the International Society for Horticultural Science

Chronica Horticulturae



Horticultural highlights

Challenges and opportunities of the French apple chain • Rose selection in France: a long and beautiful history

Symposia and workshops

People Plant • Horticultural Therapies • Landscape and Urban Horticulture
• Postharvest and Quality Management of Horticultural Products of Interest
for Tropical Regions • Quality Management in Postharvest Systems in Asia
• Kiwifruit • Organic Fruit • Organic Vegetables

Volume 62

•
Number 1
2022



IHC 2022

ANGERS — FRANCE

Chronica Horticulturae



Chronica Horticulturae® Volume 62 – Number 1; March 2022;
ISSN: 0578-039X (print), 2506-9772 (electronic).

Published quarterly by the International Society for Horticultural Science, Leuven, Belgium. Lay-out and printing by Drukkerij Graphius, Gent, Belgium. ISHS® 2022. All rights reserved. No part of this magazine may be reproduced and/or published in any form, photocopy, microfilm or any other means without written permission from the publisher. All previous issues are also available online at www.ishs.org. Contact the ISHS Secretariat for details on full colour advertisements (1/1, 1/2, 1/4 page) and/or mailing list options.

Editorial office and contact address:

ISHS Secretariat, PO Box 500, B-3001 Leuven 1, Belgium. Phone: (+32)16229427, Fax: (+32)16229450, E-mail: info@ishs.org, Web: www.ishs.org or www.actahort.org.

Editorial staff

Kim Hummer, Editor, hummerk@oregonstate.edu
Kelly Van Dijk, Associate Editor, kelly.vandijk@ishs.org
Peter Vanderborght, Executive Director

Editorial Advisory Board

Sisir Kumar Mitra, Former Dean, Faculty of Horticulture, BCKV, Kalyani, West Bengal, India, *Chair of the Editorial Advisory Board*
Peter J. Batt, Peter J Batt and Associates, Perth, WA, Australia
Margherita Beruto, Regional Institute for Floriculture, San Remo, Italy
Jorge Canhoto, Department of Life Sciences, University of Coimbra, Coimbra, Portugal
Tiziano Caruso, Department of Agricultural & Forest Science, University of Palermo, Palermo, Italy
Evelyn Costes, INRA UMR AGAP, Montpellier Cedex 1, France
Janet Cubey, Science and Collections, Royal Horticultural Society (UK), New Zealand
Stefania De Pascale, Department of Agricultural Engineering & Agronomy, University of Naples, Portici, Italy
Ted M. DeJong, Department of Plant Sciences, UC Davis, Davis, CA, USA
Martine Dorais, Centre de recherche & d'innovation-végétaux, Laval University, Quebec, Canada
Karin Hannweg, ARC+TSC, Nelspruit Mpumalanga, South Africa
Murat Kacira, Department of Biosystems Engineering, Tucson, AZ, USA
Daniel Leskovar, Texas A&M AgriLife Research, Texas A&M University, Uvalde, TX, USA
Francesco Orsini, University of Bologna, Bologna, Italy
Bhimanagouda Patil, VFIC, Department of Horticulture, Texas A&M University, College Station, TX, USA
Jorge Benjamín Retamales, Universidad de Talca, Escuela de Agronomía, Talca, Chile
Anne Vezina, Bioversity International, Montpellier Cedex 5, France
Christopher B. Watkins, Department of Horticulture, Cornell University, Ithaca, NY, USA

Membership and orders of Chronica Horticulturae

Chronica Horticulturae is provided to members free of charge: Individual Membership is 95 EUR (including VAT) per year (or two years for members in developing countries). Student Membership: 50 EUR per year (including VAT). For details on ISHS membership categories and membership advantages, or to apply for ISHS membership go to www.ishs.org/members.

Payments

All major Credit Cards accepted. Always quote your name and invoice or membership number. Make checks payable to ISHS Secretariat. Money transfers: ISHS main bank account number is 230-0019444-64. Bank details: BNP Paribas Fortis Bank, Branch "Heverlee Arenberg", Naamsesteenweg 173/175, B-3001 Leuven 1, Belgium. BIC (SWIFT) code: GEBABEBB08A, IBAN: BE29230001944464. Please arrange for all bank costs to be taken from your account assuring that ISHS receives the net amount. Prices listed are in euro (EUR) but ISHS accepts payments in USD as well.

Acta Horticulturae

Acta Horticulturae is the series of proceedings of ISHS Scientific Meetings, Symposia or Congresses (ISSN: 0567-7572). ISHS Members are entitled to a substantial discount on the price of *Acta Horticulturae*. A complete and accurate record of the entire *Acta Horticulturae* collection, including all abstracts and full text articles, is available online at www.actahort.org. ISHS Individual Membership includes credits to download 15 full text *Acta Horticulturae* articles. All *Acta Horticulturae* titles - including those no longer available in print format - are available on USB-drive or in the e-Acta format.

eJHS

The *European Journal of Horticultural Science* (eJHS) accepts original research articles and reviews on significant plant science discoveries and new or modified methodologies and technologies with a broad international and cross-disciplinary interest in the scope of global horticulture. The Journal focuses on applied and fundamental aspects of the entire food value chain, ranging from breeding, production, processing, trading to retailing of horticultural crops and commodities in temperate and Mediterranean regions. ISHS members benefit from a discounted publishing charge. eJHS is available in print + online Open Access. Additional information can be viewed on www.ishs.org/ejhs.

Fruits – International Journal of Tropical and Subtropical Horticulture

Fruits – International Journal of Tropical and Subtropical Horticulture accepts original research articles and reviews on tropical and subtropical horticultural crops. The Journal is available in print + online. Additional information can be viewed on www.ishs.org/fruits.

Scripta Horticulturae

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.

PubHort – crossroads of horticultural publications

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. The PubHort platform aims to provide opportunities not only to ISHS publications but also to other important series of related societies and organizations. The ISHS and its partners welcome their members to use this valuable tool and invite others to share their commitment to our profession. The PubHort eLibrary portal contains over 78,000 downloadable full text scientific articles in pdf format, and includes The Horticulture Journal, Journal of the American Pomological Society, Journal of the International Society for Mushroom Science, Proceedings of the International Plant Propagators' Society, Journal of the Interamerican Society for Tropical Horticulture, etc.

Additional information can be viewed on the PubHort website www.pubhort.org.



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.

> Contents

● News & Views from the Board

- 3 After the pandemic will horticulture be the same?, *S. Nicola*
- 5 Science New Zealand 2021 Awards Recognise Dr. Jill Stanley
- 6 ISHS governance meetings at IHC2022: important announcements and information

● Spotlight on Honoured ISHS Members

- 7 Ryutaro Tao

● Horticultural Science News

- 10 ISHS Young Minds Award winner summaries
- The World of Horticulture
- 17 Challenges and opportunities of the French apple chain, *J.-L. Regnard, C. Coureau, V. Mathieu, B. Gandubert, J. Lussan, F. Aubert, X. Le Clanche, S. Gaborieau, V. Guérin and F. Laurens*
- 28 Rose selection in France: a long and beautiful history, *J. Clotault, F. Foucher, A. Grapin, L. Hibrand-Saint Oyant, V. Malécot, S. Paillard, A. Pernet, V. Soufflet-Freslon and C. Oghina-Pavie*
- 37 New books, websites
- 38 Courses and meetings

● Symposia and Workshops

- 39 XV International People Plant Symposium and II International Symposium on Horticultural Therapies
- 40 VIII International Conference on Landscape and Urban Horticulture
- 42 V International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions
- 44 V Asia Symposium on Quality Management in Postharvest Systems
- 45 X International Symposium on Kiwifruit
- 47 III International Organic Fruit Symposium and I International Organic Vegetable Symposium

● News from the ISHS Secretariat

- 49 New ISHS members
- 51 Calendar of ISHS events
- 55 Available issues of *Acta Horticulturae*
- 56 *Chronica Horticulturae* author information

Cover photograph: Field of roses in Doué-en-Anjou (45 km southeast of Angers). This region is the main French garden rosebush production area. See article p.28.



➤ After the pandemic will horticulture be the same?

Silvana Nicola, Secretary of the ISHS Board



➤ Silvana Nicola

The COVID-19 pandemic has caused many victims worldwide and has generated a serious economic crisis. Substantial changes have occurred in the food and ornamental production chains (Bulgari et al., 2021, and citations therein). The pandemic has affected agriculture to a great extent, causing significant economic losses and notable changes that are likely to persist over time. The vulnerability of food production chains under sanitary emergencies has clearly been palpable. COVID-19 has prevented and modified the normal food supply chain. Infections, quarantine measures and restrictions have led to the delayed delivery of agricultural inputs, the lack of arrivals of seasonal laborers, the non-harvesting of crops, the accumulation of products, and the disruption of the distribution grid, thereby sometimes causing shortages of products in grocery stores. The closure of the Horeca (hotel-restaurant-catering/café) also contributed to the disruption of supply chains. The closing measures introduced by the government for restaurants, hotels, catering, and bars further depressed the sales and the price of fresh products. The exceptional pandemic conditions that were created weakened high-value food products in particular due to their short duration in terms of shelf-life. Problems can emerge at different stages in the food supply chain and can interfere with the regular flow of food and services, from primary production to final consumption (Gray, 2020; Van der Ploeg, 2020). Starting from the availability of agricultural inputs, farmers are facing a shortage of seeds, fertilizers, and pesticides. Import and export exchange has become slower or has stopped. The effects are starting to be visible and the impact on the availability of goods is evident. One of the areas getting the most attention is major delays in shipping and logistics. The ships that move goods across the globe are anchored offshore at major ports waiting to unload or load. Ports in China are backed up at record levels (Giles, 2021). This involves all sort of goods, including new equipment and spare parts. The trucking shortage is limiting agricultural product delivery. Horticulture is the primary agriculture sector involved in supplying fresh products to the

market and to shelves. The agri-food sector has been closely connected internationally, but the COVID-19 crisis highlighted critical issues in the system related to the flow of goods, thus encouraging some countries to adopt a more domestic ‘food sovereignty’ approach, towards greater local food production (Lal; 2020; Shahidi, 2020), and inevitably changing the logistics of the entire food system (Galanakis, 2020). Possibly the COVID-19 crisis will result in a new and lasting attention to the infrastructures and the workforce at the base of food supply chains, to where food comes from, to produce seasonally and to the expansion of alternative food chains. Potentially, this focus may drive change, for example a reduction in intermediaries from the producer to the consumer and, possibly, a significant reduction in wasted food. The continuing labor crisis in agriculture is driving innovation and automation, leading to implementing more mechanical harvest systems (Giles, 2021).

As with the food sector, the pandemic restrictions had seriously impacted the ornamental sector. A large reduction in the demand of cut flowers, ornamental plants, trees, and bulbs occurred during the COVID-19 pandemic (Van der Ploeg, 2020). The restrictions on international flights and cargo transport affected the logistics of the supply chains to a great extent. The ornamental sector has a strong socio-economic value worldwide. Ornamental products positively affect the quality of life and have considerable benefits on mental health and on socialization activities. In some cases, the sales of houseplants increased, most probably because these goods are thought to help overcome the stress derived from being confined at home during the lockdown.

In this context, it has been appropriate to work toward increasing the resilience of a system during the pandemic but also in all those circumstances that change or influence the equilibrium of such a system. Research activities into food production in the urban context, e.g., to speed up its availability, are key elements in the attempt to prevent the multiple inconveniences that COVID-19 has caused. Food production, shortness of the supply chain, and speed of reaching the con-

sumers are summed up in the concept of urban farming and indoor farming. These production approaches represent one of the fastest growing sectors in the social context and contribute significantly to increasing the resilience of the system and food security, even in the pandemic context. From an academic point of view, experimentation in this area is constantly growing, as can be seen in all the major scientific databases.

The virtuous combination of logistics and new technologies can transform the pre-COVID-19 context, defined as “static service operations”, into an active and functional model for the consumer at the COVID-19 time defined as “bring-service-near your home mobile service operation”. There has been a notable development of home delivery as a first resilience reaction, to replace direct purchasing in person. This is a consequence of the development of new applications for smartphones. This technology can manage and order the desired products quickly, thereby allowing the consumers to remain at home and maintain social distancing (Hobbs, 2020; Zhao and Bacao, 2020). These dynamics have also developed in the urban farming context, thus not only bypassing conventional transport, but at the same time also replacing transportation, since food can be produced directly in the environment where it is consumed (e.g., houses or condominiums), thereby ensuring a timely supply and reduced user movement.

Farmers have implemented innovative sales and market opportunities to sell as much of their highly perishable produce as they can. The main solutions adopted involve direct sales, such as in farmer’s markets and farm stands, thus exploring a market other than that of large-scale distribution (Richards and Rickard, 2020). The pandemic crisis has also offered a chance for community-supported agricultural organizations, and urban farming, to seize a market opportunity by expanding local delivery services. In this context, there has been an evolution in the sales channel using social media and home delivery, or even online sales via a website or apps offering home deliveries. Urban farming will obviously not be able to completely replace agricultural production, which

is derived from a more peripheral or even international production context, from the quantity, economy, and crop choice points of view. However, it should be noted that this new concept of production significantly reduces the inconveniences and difficulties of acquiring food during critical periods that society must face over time.

The adoption of resilient food systems has in turn led to the growth of domestic horticulture and urban agriculture, thereby improving family and community production. Several strategies can be introduced to increase local food production within cities, including indoor growing modules, rooftop gardens, local community gardens, and vertical farming. Home gardens, which provide various ecosystem services, such as plant biodiversity, microclimate, water runoff, water quality and human health, have played an important role in food procurement during the pandemic. With the expansion of home gardens, some observers believe that this trend could help resolve food insecurity issues and open new prospects for the food system (Chandran, 2020). In the cities, growing crops on rooftops and inside tall buildings makes it possible to achieve an efficient use of the restricted space available. In some cases, initiatives have sprouted from local communities, while in other cases, prestigious architectural firms have designed innovative projects that make use of technology to incentivize local self-sufficiency from a nutritional standpoint, as well as to reduce the impact of urban demands on rural areas. Self-safe production in urban gardening may be important, due to the opportunity of controlling the whole plant productive cycle. Vertical farming can ensure crop production all-year round in an air-conditioned facility, thereby reducing transportation costs, with a greater control of food safety and biosecurity, and substantially reduced inputs. The most critical aspects are related to the production costs and, among such costs, that of energy is the major issue. Thus far, only leafy greens and herbs are grown commercially in vertical farms, and this needs to expand to other crops such as fruits and other vegetables if it is to contribute to greater food

security in cities (O'Sullivan et al., 2020). The challenge is that these crops are less adapted to be grown successfully and economically in such systems, and may need to be bred for specific traits, e.g. different architecture, shorter life cycles.

The pandemic has affected the fresh horticultural product supply to a great extent. New logistic and production systems need to be designed to counter the difficulties we have recently observed. More local production will be required for flexibility to ensure that enough food is produced for the population. A pandemic horticultural production plan should be drawn up by each nation to ensure the food security of their citizens. The delocalization of production is a strategy that can lower production costs, but long-distance logistics becomes vulnerable in the case of a sanitary emergence, as has been experienced in the present pandemic situation.

The seriousness of the COVID-19 pandemic, its continuation over time, and its impact on people's lives, will inevitably lead to short- and long-term changes. Moreover, the horticultural sector throughout the world will also be affected. Some substantial problems have already been highlighted: the fragility of a market that is, at present, too interconnected and dependent on imports and exports and which, in times of crisis, can cause serious shortages and/or surpluses and wastage; the collapse of the labor supply, especially of migrant and seasonal workers; and the reduction in demand for some food products and flowers. To face such problems, and any future crises, governments will need to develop emergency response plans and strengthen their economic support. The crisis has highlighted areas of inequalities of the food system and business cannot continue as usual. As reported by FAO, the Committee on Food Security is currently working on guidelines to re-orient and transform the food system to be more resilient and sustainable (FAO, 2020). The latest State of Food and Agriculture (SOFA) report by FAO (2021), "Making agrifood systems more resilient to shocks and stresses," provides an assessment of the ability of national agri-food systems to respond to or recover readily from

shocks and stressors. It also offers guidance to governments on how they can improve resilience.

The winning strategy could be to promote the diversity of agri-food production and to encourage the reconnection of farmers and consumers, through community marketing schemes, to facilitate the distribution of products during periods of crisis, while co-existing with the mainstream distribution channels. The above-mentioned solutions are very suitable for the horticultural sector, certainly less so for staple foods (rice, maize, and exotic fruits). Vegetable production is best suited to become more local, allowing the shortening of food chains (FAO, 2020). Peasant markets, traditional 'wet' markets, and new forms of e-commerce are circuits that favor trade directly between producers and consumers, and make the latter more aware of, and demanding about, the quality of produce. Moreover, these informal marketplaces are more sustainable, as they reduce transport and limit waste and the amount of packaging. Nevertheless, in each form of food product trade, hygienic practices must guarantee cleanliness and be implemented to ensure food safety and public health. There are also more and more examples of food production in the urban context that are contributing to shortening the food supply chain.

This crisis not only has an economic dimension, but also has a significant impact on human life. The COVID-19 crisis has exemplified the importance of contact with nature, and of the presence of green spaces in cities and houses (Pérez-Urrestarazu et al., 2021; Theodorou et al., 2021). These aspects can certainly help to revitalize the ornamental sector, and such activities as urban gardening, social horticulture, and therapeutic horticulture.

For as unexpected as this pandemic was, horticulture is a living example of flexibility and change. Our sectors right now are being redesigned and adjusted to rise, face, and meet the needs of feeding and satisfying humanity. ●

References

Bulgari, R., Petrini, A., Cocetta, G., Nicoletto, C., Ertani, A., Sambo, P., Ferrante, A., and Nicola, S. (2021). The impact of COVID-19 on horticulture: critical issues and opportunities derived from an unexpected occurrence. *Horticulturae* 7, 124. <https://doi.org/10.3390/horticulturae7060124>

Chandran, R. (2020). Grow your own: urban farming is flourishing during the coronavirus lockdowns. *World Economic Forum*. <https://www.weforum.org/agenda/2020/04/grow-your-own-urban-farm->

[ing-flourishes-in-coronavirus-lockdowns/](https://www.weforum.org/agenda/2020/04/grow-your-own-urban-farm-) (accessed 16 February 2022).

FAO. (2020). COVID-19 and the risk to food supply chains: how to respond? <http://www.fao.org/documents/card/fr/c/ca8388en/> (accessed 1 February 2022).

- FAO. (2021). The State of Food and Agriculture 2021. Making Agrifood Systems More Resilient to Shocks and Stresses (Rome: FAO), pp.182.
- Giles, F. (2021). Will COVID-19 change how and where our food is grown? Growing Produce. <https://www.growingproduce.com/farm-management/will-covid-19-change-how-and-where-our-food-is-grown/> (accessed 1 February 2022).
- Galanakis, C.M. (2020). The food systems in the era of the coronavirus (COVID-19) pandemic crisis. *Foods* 9, 523.
- Gray, R.S. (2020). Agriculture, transportation, and the COVID-19 crisis. *Can. J. Agric. Econ. Can. Agroekon.* 68, 239–243.
- Hobbs, J.E. (2020). Food supply chains during the COVID-19 pandemic. *Can. J. Agric. Econ. Can. Agroekon.* 68, 171–176.
- Lal, R. (2020). Home gardening and urban agriculture for advancing food and nutritional security in response to the COVID-19 pandemic. *Food Secur.* 12, 871–876. <https://doi.org/10.1007/s12571-020-01058-3>
- O'Sullivan, C.A., McIntyre, C.L., Dry, I.B., Hani, S.M., Hochman, Z., and Bonnett, G.D. (2020). Vertical farms bear fruit. *Nat Biotechnol* 38, 160–162. <https://doi.org/10.1038/s41587-019-0400-z>
- Pérez-Urrestarazu, L., Kaltsidi, M.P., Nektarios, P.A., Markakis, G., Loges, V., Perini, K., and Fernández-Cañero, R. (2021). Particularities of having plants at home during the confinement due to the COVID-19 pandemic. *Urban For. Urban Green.* 59, 126919.
- Richards, T.J., and Rickard, B. (2020). COVID-19 impact on fruit and vegetable markets. *Can. J. Agric. Econ. Can. Agroekon.* 68, 189–194.
- Shahidi, F. (2020). Does COVID-19 affect food safety and security? *J. Food Bioact.* 9, 1–3. <https://doi.org/10.31665/JFB.2020.9212>
- Theodorou, A., Panno, A., Carrus, G., Carbone, G.A., Massullo, C., and Imperatori, C. (2021). Stay home, stay safe, stay green: the role of gardening activities on mental health during the Covid-19 home confinement. *Urban For. Urban Green.* 61, 127091.
- Van der Ploeg, J.D. (2020). From biomedical to politico-economic crisis: the food system in times of Covid-19. *J. Peasant Stud.* 47, 944–972.
- Zhao, Y., and Bacao, F. (2020). What factors determining customer continuingly using food delivery apps during 2019 novel coronavirus pandemic period? *Int. J. Hosp. Manag.* 91, 102683.

➤ Science New Zealand 2021 Awards Recognise Dr. Jill Stanley

The Science New Zealand 2021 Awards recognised Dr. Jill Stanley as an accomplished fruit crop scientist for her outstanding tree fruit research.

Dr. Jill Stanley received a Lifetime Achievement Award for her contribution to plant physiology and crop science over four decades. During her career, Dr. Stanley worked on a range of crops in varied locations, including the UK and Spain. She has collaborated with numerous international researchers and growers, and now leads a team of 40 people. Her stonefruit research has focused on improving practical outcomes for growers by enhancing productivity and fruit quality. Stanley's work has helped growers use resources more efficiently to increase returns and deliver quality fruit to consumers. Her research has been instrumental in the development and release of three exciting new apricot cultivars. She was the team lead of the stonefruit aspects of the Future Orchard Planting Systems (FOPS) programme, developing new planar (two-dimensional) growing systems. Dr. Stanley is dedicated to supporting career development in Aotearoa's next generation of scientists. The ISHS congratulates Dr. Stanley on this great recognition. 🟢



➤ Did you renew your ISHS membership?

Loton to www.ishs.org/members and renew online!

> ISHS governance meetings at IHC2022: important announcements and information

Dear member of the International Society for Horticultural Science,

2022 is a Congress year. As usual there will be a General Assembly where members receive formal reports from the Board, consider amendments to the ISHS Statutes, recognize worthy colleagues and confirm important future events. The following information includes announcements and invitations required by the ISHS Statutes.

A. ISHS General Assembly – invitation to the membership

The outgoing Board is looking forward to reporting on the developments of the Society during the last four years. This meeting also provides an opportunity for members to accept or reject important Council decisions or recommendations and to voice their comments, concerns and suggestions for Board considerations.

The 2022 ISHS General Assembly will take place at the Congress Center in Angers, France (where IHC2022 is taking place) on Thursday, 18 August 2022, 2 pm-3 pm.

The provisional Agenda for this meeting is as follows:

1. Opening by the President of ISHS
2. Board reports for the years 2018-2021 time period
3. Proposed amendment to the ISHS Statutes
4. XXXII International Horticultural Congress – Japan
 - 4.1. Inauguration of the President of the XXXII IHC
 - 4.2. Information about the XXXII IHC
5. Announcement of the date and place of the XXXIII IHC
6. ISHS Fellows, Honorary Members and other awards

7. Confirmation and inauguration of the new ISHS President and the Members of the Board
8. Other business
9. Adjournment

B. ISHS management meetings (*) at the time of the Congress

- a) Meeting of the Board
Monday, 8 August and Tuesday, 9 August 2022
- b) Meeting of the Executive Committee
Wednesday, 10 August and Thursday, 11 August 2022, Congress Venue
- c) Joint Meeting of the Council and Executive Committee
Friday, 12 August and Saturday, 13 August 2022, Congress Venue
Friday, 19 August 2022, Congress Venue

(*) Exact details, time schedule and agenda to be distributed in due course.

C. Bids welcomed for future ISHS Congress hosts

The Council, meeting in Angers this coming August, will evaluate proposals for the Congress to be held in 2030. Representatives of ISHS Country/Region Members interested in bidding for that Congress are invited to send or email a letter of intent to the ISHS Secretariat for the attention of the Executive Director. If interested, contact the Secretariat for more detailed information and instructions. ●



Canopy
SS1 SunScan
LAI and PAR Mapping

- Direct display of Leaf Area Index (LAI)
- Useable in changeable sky conditions
- Wireless-linked reference sensor

View **new** SunScan explainer video at www.delta-t.co.uk

AT
Delta-T Devices

> Ryutaro Tao

Position or previous position

Professor of the Graduate School of
Agriculture Kyoto University
IHC2026 President
JSHS President

ISHS honour

ISHS Fellow

1. Tell us a bit about yourself (hometown, present location, family, hobbies, community involvement).

I grew up in a southern suburb of Osaka, Japan. That area is famous for seedless table grape production. I had several chances to go to U-pick grapevine orchards with my family and friends. This likely affected my career choice for pursuing fruit tree science. I like traveling to places where I have never been. I like to travel because I can see new things I've never seen before. My job has allowed me to experience things I've never experienced before.

2. What got you started in a career in horticultural science?

Ever since I was a child, I have enjoyed growing plants and raising animals. I also liked to play with machines. I couldn't decide whether to go to the Faculty of Engineering or the Faculty of Agriculture at first. But in the end, I decided to go for the Faculty of Agriculture. I thought I would be able to spend more time in nature in that department. Then I decided to pursue fruit tree science because it struck

me that fruit is pretty and delicious – not like the staple agronomic crops.

3. Give a brief overview of your career/achievements.

I have been a Professor of Kyoto University since 1988. My present professional responsibilities include not only research activities but also educational activities in teaching classes in horticulture, pomology, cell biology, general genetics and so on at the Faculty and the Graduate School of Agriculture, Kyoto University. Currently I am serving as the Vice-Dean of the Graduate School of Agriculture.

My research career started when I began my thesis study on the development of tissue and cell culture systems for persimmon (*Diospyros kaki*) in 1983 at Kyoto University. Since then I have been working on research projects to utilize tissue and cell culture and transgenic techniques to improve fruit tree species. Since 1990, I also worked on the reproductive biology of fruit tree species. I worked specifically on the S-RNase-based self-incompatibility system in *Prunus* and floral induction in *Diospyros* and *Rosaceae*. I have also been extensively working on the sexual system in *Diospyros* and *Actinidia* for the last 10 years.

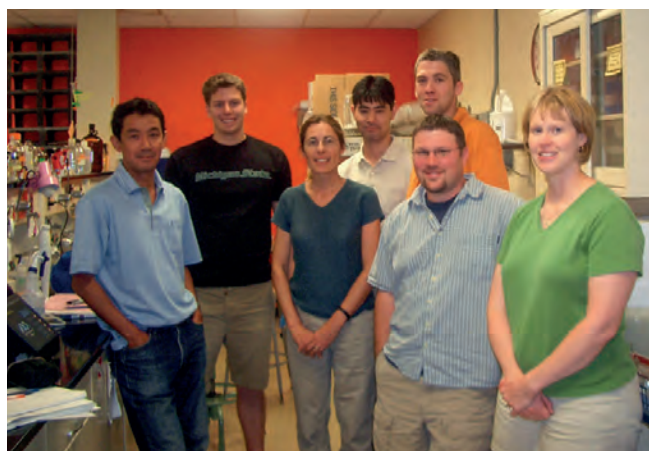
One of my major achievements was the development of a wide variety of efficient tissue culture systems for *D. kaki*. The systems included microporopagation, organogenesis, embryogenesis, plant regeneration from protoplasts, somatic hybridization, and *Agrobacterium*-mediated transformation. I also made

the first field trial of a transgenic persimmon with the BT gene for insect resistance. This work was performed in a University of California at Davis experimental orchard in collaboration with Prof. A.M. Dandekar. With our collaborative efforts, a wide range of biotechnological techniques can now be utilized for persimmon breeding and propagation. These achievements were highly recognized worldwide. I was awarded the Cross-commodity Publication Award of American Society for Horticultural Science (ASHS) in 1997, and the Japanese Society for Horticultural Science (JSHS) Promising Researcher Award in 1997.

My most important achievement was the identification of the specificity determinant genes of the S-RNase-based gametophytic self-incompatibility (GSI) system in *Prunus* fruit tree species. It was known that GSI in *Prunus* is controlled by at least two genes for the pistil and the pollen S determinants. The identity of these determinants was unknown. I conducted 2D-PAGE gel electrophoresis to identify the pistil determinant S-RNase and cloned the gene for *Prunus* S-RNase for the first time in the world. The S-RNase DNA sequence information was utilized to develop the PCR-based methods for S genotyping. This technique is now used worldwide to type S genotypes of cultivars of SI *Prunus* species such as almonds, cherries, plums, and apricots. After the identification of the pistil S, I identified the pollen S of *Prunus*. This work had a very great impact not only in horticulture but also in plant science. This finding was the first identification of pollen S in the S-RNase-based GSI system.



> Farewell party at Prof. Abhaya M. Dandekar's house with the lab members after the two years of Japan Society for the Promotion of Science postdoc program for research abroad at Prof. Dandekar's lab at the Department of Pomology, U.C. Davis (1995).



> Collaboration study on self-incompatibility of cherries was conducted during late 1990s and early 2000s with Prof. Amy Iezzoni's lab at the Michigan State University (MSU). Photo was taken when Prof. Tao visited MSU in 2005.



► Celebration party for the JSHS Outstanding Horticulturist Award with Prof. Tao's former students and some of immediate seniors and juniors (2014).

It has now been found in diverse plant species in the *Rosaceae*, *Rutaceae*, *Solanaceae*, and *Plantaginaceae*. Based on the pollen S identification, marker-assisted selection of self-compatible (SC) individuals has been developed and utilized for SC breeding. With these achievements on *Prunus* GSI, I was awarded the Japanese Society for Horticultural Science (JSHS) Outstanding Horticulturist Award, the most important award of JSHS, in 2014. I was also awarded in 2019 the Japan Prize of Agricultural Science on the *Prunus* GSI study "The discovery of *Prunus*-specific self-incompatibility recognition system and its horticultural applications" from the Association of Japanese Agricultural Scientific Societies (AJASS), which includes over fifty Japanese scientific societies from diverse agricultural disciplines. The Japan Prize of Agricultural Science was established in 1926, and is highly regarded as the premier award for agricultural research in Japan.

My next achievements were in the reproduction biology of fruit tree species. Recently, I clarified the sex determination system in *Diospyros* together with my collaborators. Our results were the first identification of sex determination mechanism in plant dioecism. Our results were published in *Science* and in *Plant Cell and Plant Journal*. Notably, the first report of this series was published in the *Japanese Journal for Horticultural Science*, "The Horticulture Journal". Very recently, we also clarified the sex determination system in dioecious *Actinidia*. These findings were published in *Plant Cell* and *Nature Plants*. The basic information is now utilized to develop artificial methods for sex control in persimmon and kiwifruit.

I have also finished several important research projects that had practical applications in fruit tree species. I studied flowering controls in apples, pears, plums, and apricots, ploidy manipulations through unreduced gamete manipulations and others. These results have been published in more than 150 papers in refereed scientific journals, in

25 review papers and book chapters. Several publication awards were awarded to some of my papers.

My contribution to horticulture is not limited to my scientific activities, but also through educational activities to mentor students and young researchers in horticulture. I served as an advisor of more than 50 graduate Japanese and international students. Many of them are now working in horticultural professions including horticulture researchers.

I have a high level of professional conduct, and have always cared about the mentorship of my students. I have a humble approach to life. That is what has enabled me to have such an impact, not only in the world of fruit tree science, but the world in general.

4. What do you consider to be your greatest achievements?

The development of tissue and cell culture systems for persimmon (*Diospyros kaki*) and my studies on gametophytic self-incompa-

tibility system in *Prunus* species were my greatest achievements.

5. Did you encounter difficulties along your career path and how did you deal with them or how did you turn them into opportunities?

When I was a doctoral student, I developed a system for plant regeneration from protoplasts and fused protoplasts. This did not go well initially. I was worried that I would not be able to obtain a doctoral degree if my results did not go well, without any guarantee of success. However, by continuing to experiment while consulting with other researchers, I eventually succeeded. I found a way to regenerate plants from protoplasts and fused protoplasts. Through this experience, I learned the importance of continuing to work hard and not giving up on anything.

6. Tell us about one funny/exciting/interesting experience that happened to you during your career.

Since I was a young student, I had a desire to do research abroad. The most exciting thing in my research life was that I was able to do fruit tree transformation research under the supervision of Prof. Abhaya Dandekar at the University of California Davis, in the US, for two years immediately after receiving my PhD.

7. What made you become a member of ISHS and why did you keep the membership? What contribution or role has ISHS played in your career?

I became a member of ISHS when I attended the International Horticultural Congress in Florence, Italy. Soon after, I started my job as an assistant professor at Kyoto University.



► Dinner after ISHS Board meeting in Leuven (2015).



➤ Prof. Tao made a presentation for the IHC2026 bid at the ISHS Council meeting in Istanbul (2018). IHC2026 has been successfully invited to Kyoto, Japan, and Prof. Tao became the IHC2026 President.

I have been a Society member ever since. As a member of ISHS, I have participated in many international symposia and have made many international friends. I was elected as the Treasurer for the ISHS Board from 2014 to 2018.

8. What advice would you give to young people interested in a career in horticulture/horticultural science?

Horticulture is a very attractive discipline because it is a field of study that can contribute to basic science as well as to practical development.

9. What are the most interesting new roles or opportunities you see emerging in the future within horticultural science?

As humans become wealthier on a global scale, the field of horticulture, which includes crops to enrich our lives, will become more attractive than the research that has focused on agronomic crops as staple food. It will be necessary to develop horticultural production systems and varieties that can cope with an aging population, as well as production styles and varieties that can be automated by robotics. 🌱

The image shows two journal covers: 'eJHS' (European Journal of Horticultural Science) and 'FRUITS' (International Journal of Tropical and Subtropical Horticulture). The 'eJHS' cover features a green plant, and the 'FRUITS' cover features a hand holding purple grapes. The ISHS logo is in the top right corner of the graphic.

eJHS

European Journal of Horticultural Science

FRUITS

International Journal of Tropical and Subtropical Horticulture

eJHS and Fruits provide a new and fresh alternative to ISHS members and all others wishing to publish their research in a high profile international horticultural journal with rising impact. We warmly invite your article submissions.

Check out www.ishs.org/ejhs and www.ishs.org/fruits for more details.

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.

Evaluation of ethylene scavengers for potential application in fresh produce packaging



➤ Namrata Pathak

Fresh fruit and vegetables are sensitive products with a short shelf-life. Often these are packaged to maintain their quality for a longer time. Active substances can be added in packaging to provide additional benefits such as moisture absorption, antimicrobial effect or removal of foul odours. Among such active substances, some materials scavenge or remove ethylene. Ethylene is a colorless gas, often referred to as “ripening hormone,” produced by fruit and vegetables. Accumulation of ethylene in packages causes the unde-

sireable fast ripening in fruit and vegetables. Commercial sachets containing scavengers are put in fruit and vegetable packaging to remove ethylene. This research is part of a “FreshInPac” project funded by CORNET that aims to develop bio-based multifunctional packages with ethylene absorbing and antimicrobial effects for extending shelf-life of produce. The objective of this study was to comparatively analyze various materials developed in-house as well as commercial scavengers for ethylene removal under similar conditions (temperature 20°C; humidity ~50%; and initial ethylene concentration 10 ppm in a 1-L glass jar). The materials investigated were categorized by their ethylene removing principle: 1) adsorbers (bentonite, sepiolite, halloysite, zeolite, diatomite): these can physically adsorb ethylene, thus, removing it from the environment; 2) adsorber-oxidizer (potassium permanganate (KMnO₄) based products, commercial as well as KMnO₄ deposited on zeolite in the lab): these chemically react with ethylene, thereby, converting it to other products and these materials are themselves used up in the process irreversibly; 3) catalysts (titanium dioxide, magnesium oxide, and diatomite with palladium): these are similar to oxidizers except these

remain unused at the end of the reaction. Natural clays and zeolite did not show any appreciable ethylene absorption. However, a pre-heat treatment of the materials removed attached moisture from the particles resulting in increased ethylene absorption capacity. KMnO₄ based materials were the fastest and best at removing ethylene. Titanium dioxide-palladium absorbed ethylene slowly. These results will be helpful in improving ethylene scavenging materials to extend the life of packaged fruits and vegetables.

Namrata Pathak won the ISHS Young Minds Award for the best poster presentation at the XIII International Controlled and Modified Atmosphere Research Conference (CAMA2021), which was held virtually in Belgium in August 2021.

➤ Contact

Namrata Pathak, Leibniz-Institut für Agrartechnik und Bioökonomie e.V. (ATB), Max-Eyth-Allee 100, 14469 Potsdam, Germany, e-mail: namrata.naini@gmail.com

The effect of foliar sprays containing calcium on quality and storability of ‘Stanley’ plums



➤ Aleksandra Korićanac

Aleksandra Korićanac is a PhD student at the University of Belgrade, Faculty of Agriculture (module Fruit Science and Viticulture), Serbia. She is a Research Trainee at the Fruit Research Institute, Čačak, Serbia, where she has been employed since March 2019. Her research is focused on fruit quality changes during ripening, harvest, storage, and post-harvest management of temperate zone fruit species, particularly plums. She is interested in studying the effect of pre- and postharvest treatments, which preserve fruit quality in an effective, economic, and environmentally friendly way.

Consumers demand high quality plum fruits in the marketplace. Because high softening rate is one of the major limiting factors for

storability and transportability of plums, application of various pre- and postharvest treatments, which could improve or preserve fruit firmness, is of great importance. Calcium ions and pectic substances are the most essential determinants of fruit firmness. As the uptake of foliar applied calcium is the greatest in the early stage of fruit development, Aleksandra’s study, conducted in the Fruit Research Institute, Čačak, evaluated the effect of application of three commercial foliar sprays containing calcium on quality and storage potential of ‘Stanley’ plum. The preharvest treatments, regardless of commercial type, induced significantly higher fruit firmness, both at harvest and after 28 days of cold storage. Nevertheless, fruits

from the treated trees had higher content of calcium after storage and lower potassium/calcium ratio, which could be an indicator of good storage potential. The results indicated that four applications of calcium containing sprays after petal fall can promote fruit quality, and particularly fruit firmness, by primarily affecting the calcium content. In

this way, plum producers could enhance fruit quality and respond to market requirements in a relatively simple and economical way. Aleksandra Korićanac won the ISHS Young Minds Award for the best oral presentation at the XII International Symposium on Plum and Prune Genetics, Breeding and Pomology in Serbia in September 2021.

> Contact

Aleksandra Korićanac, Fruit Research Institute, Kralja Petra I br. 9, 32000 Čačak, Serbia, e-mail: akoricanac@institut-cacak.org

Bolting garlic quality and morphological traits are influenced by scape removal



> Iva Bažon

Iva Bažon is a PhD student at the Institute of Agriculture and Tourism (Poreč, Croatia), Department of Agriculture and Nutrition, and she has enrolled in a PhD study program at the University of Zagreb, Faculty of Agriculture (Croatia). Her work is financed through Young Researchers' Career Development Project (ESF DOK-2018-01) and the Centre of Excellence for Biodiversity and

Molecular Plant Breeding (CroP-BioDiv, KK.01.1.1.01.0005).

She is involved in the research of morphological and biochemical traits of Croatian garlic landraces maintained in a genebank collection of the Institute.

Garlic is propagated vegetatively with cloves, but bulbs still may vary in morphological traits and content of secondary metabolites. The identification and selection of clones with superior agronomic and biological value is gaining interest for their use in the breeding programs.

Garlic landraces can be bolting or non-bolting and many bolting old landraces are grown in the northern coast of Croatia. The aim of this research was to better understand the effect of growing technologies applied by local producers on garlic landraces' yield and quality. Scape removal is a common agricultural practice applied because garlic is usually sold in braids. This procedure may affect bulb size. The objective of this research was to determine the impact of garlic landrace and scape removal on morphological, physical and biochemical quality parameters.

'Istarski crveni' had higher dry matter (DM), firmness and antioxidant capacity (FRAP), while 'Brsečki' was found to be superior in bulb size, intensity of red coloration, total soluble solids (TSS) and glucose content.

When scapes were removed the bulbs were larger, but TSS, DM, glucose, volatile diallyl disulfide and the antioxidant capacity (DPPH) were lower. It was concluded that the practice of scape removal may be applied by producers if bulb size is preferred over content of physical (TSS, DM) and some biochemical parameters.

Iva Bažon won the ISHS Young Minds Award for the best oral presentation at the VIII South-Eastern Europe Symposium on Vegetables and Potatoes, which was held virtually in North Macedonia in September 2021.

> Contact

Iva Bažon, Institute of Agriculture and Tourism, Department of Agriculture and Nutrition, Karla Huguesa 8, 52440 Poreč, Croatia, e-mail: iva@iptpo.hr

Stomatal Conductance

AP4 Porometer

- Class leading accuracy
- Simple user interface
- Six-point field calibration
- 5 year warranty



View AP4 explainer video on our website: www.delta-t.co.uk

Influence of the nitrogen source on the tolerance of *Actinidia chinensis* to *Pseudomonas syringae* pv. *actinidiae*



► Marta Nunes da Silva

Marta Nunes da Silva is a biologist by training. She obtained her PhD in Agronomical Sciences in April 2021, from the University of Porto, Portugal. Her research interests include the study of plant-pathogens interactions, through physiological, genomic and metabolomic approaches, and plant nutrition, focusing on the effect of environmental contamination and distinct cultural practices on plant fitness and productivity. Marta's PhD study focused on unravelling the regulatory mechanisms underpinning kiwifruit

plant tolerance to the pandemic bacterium *Pseudomonas syringae* pv. *actinidiae* (Psa) through integrated approaches. Marta used micro- and mesocosm settings to evaluate plant genotypic variability to Psa and develop sustainable disease mitigation strategies. Her study showed that the green-fleshed kiwifruit (*Actinidia chinensis* var. *deliciosa*) consistently showed higher endophytic bacterial density than the kiwi berry (*A. arguta*), being accompanied by a greater extent of disease symptoms, decreased total chlorophylls, increased lipid peroxidation and an upregulation of the ammonia assimilation cycle. In contrast, in *A. arguta* bacterial colonization was lower, resulting in limited impairments in plant metabolism. Her results suggest that the abscisic acid pathway and the differential expression of specific defence-related genes play key roles in the distinct tolerance of *A. chinensis* and *A. arguta* to Psa. Moreover, NH_4^+ seems to be unfavourable to *A. chinensis* defence mechanisms by increasing N accumulation in plant tissues (which favours Psa growth), and by promoting the jasmonic acid and ethylene pathways (which negatively affect plant defences). An evaluation of the antimicrobial potential of six plant essential oils (PEOs)

(anise, basil, cardamom, cumin, fennel, and laurel) also revealed that cumin was effective in decreasing Psa endophytic population after foliar application. Overall, Marta's findings provided innovative knowledge on the regulatory pathways triggered by Psa infection in *Actinidia*. It demonstrated the relevance of N nutrition in kiwifruit plants' susceptibility to the pathogen, and highlighted the contribution of PEOs and elicitors to more successful and sustainable disease management. So far, her PhD work resulted in four publications in peer-reviewed international journals, including the eJHS (European Journal of Horticultural Science).

Marta Nunes da Silva won the ISHS Young Minds Award for the best oral presentation at the X International Symposium on Kiwifruit, which was held virtually in Turkey in September 2021.

► Contact

Marta Nunes da Silva, Escola Superior de Biotecnologia da Universidade Católica Portuguesa, Rua de Diogo Botelho 1327, 4169-005 Porto, Portugal, e-mail: martanunes04@gmail.com

Adhesion capacity and biofilm formation of *Escherichia coli* and *Salmonella* in tomato (*Solanum lycopersicum* L.) in postharvest stage



► Itzel Rojas Puebla

Itzel Rojas Puebla is a doctoral student in the Faculty of Agricultural Sciences at Autonomous University of the State of Mexico. Her research focused on evaluating bacterial strains from different pathotypes and origins to develop biofilm using the epidermis of tomato fruit (*Solanum lycopersicum* L.) as a substrate. The presence of bacteria like *E. coli* O157:H7 and *Salmonella* in food is a warning

of an outbreak of disease. *E. coli* O157:H7 can colonize edible plants by means of adhesion, survival, and internalization. This bacterium can potentially produce biofilm without causing virulence to humans. The objective of this research was to evaluate the capacity of adhesion and biofilm formation of *E. coli* and *Salmonella* on tomato fruits during the postharvest stage. We considered four bacterial serotypes and used the plate microdilution technique. We determined cfu mL^{-1} and physicochemical variables including weight, pH, titratable acidity, and total soluble solids. The results showed significant differences among the four serotypes and time (13 days). Average optical density (OP) for the treatment was: Control (0.78 nm), 49766 (1.51 nm), DL933 (1.47 nm), HB101 (1.42 nm). The best formation occurred about 4 to 5 days after inoculation (DAI). This is consistent with the highest counts of CFU 4 and 6 DAI, with an average of 3.65Log10. The results confirm that pathogens like *E. coli* can adhere to fruits, developing a biofilm, which could turn into a potential threat to food safety and could be a source of infectious disease. The

methods used to guarantee food safety are based on adopting good agricultural practices (GAP), good food handling practices (GFHP) and a hazard analysis and control of critical points (HACCP).

Itzel Rojas Puebla won the ISHS Young Minds Award for the best oral presentation at the V International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions, which was held virtually in Mexico in October 2021.

► Contact

Itzel Rojas Puebla, Facultad de Ciencias Agrícolas, Universidad Autónoma del Estado de México, El Cerrillo Piedras Blancas, C.P. 50295, Toluca de Lerdo, Estado de México, Mexico, e-mail: ang_04abril@hotmail.com

Chemical analysis and evolutionary relationship among four types of quelites



► Daniela Arrieta Flores

In Mexico, 'quelites' are consumed tender plants that grow adjacent to other crops. The consumption of quelites, as vegetables, in Mexico has occurred since pre-Hispanic times. Nowadays, among the most cultivated, studied, and consumed species are huazontle (*Chenopodium berlandieri* subsp. *nuttalliae*), quelite (*Chenopodium berlandieri*), verdolaga (*Portulaca oleracea*), and chaya (*Cnidoscolus acnitifolius*); however, many others with nutritional and functional potential have not been studied. The lack of information on their physiological characteristics,

cultivation, and nutritional properties makes the promotion of human consumption of 'quelites' difficult.

The aim of this study was to analyse botanical, functional, and phylogenetic parameters in four quelite selections, which are marketed in the state of Tlaxcala, Mexico. The selections studied were: quelite, verdolaga, pápalo, and pipicha. This work was presented as a bachelor's thesis to obtain a degree in Biotechnology Engineering and was carried out at the Autonomous Metropolitan University (UAM-I) and the Polytechnic University of Tlaxcala with the direction and co-direction of Drs. Lizette Liliana Rodríguez Verástegui and Candy Yuriria Ramírez Zavaleta, respectively.

To meet the goals of the project, the research was divided into three objectives: i) to determine the ash, moisture, and pH content, ii) to quantify the content of total soluble phenolic compounds (TPC) and the antioxidant capacity (AC) by ABTS ((2,2'-azino-bis-(3-ethyl-benzothiazoline-6-sulfonic acid)) and FRAP (ferric reducing antioxidant power) methods, and iii) to analyze the evolutionary relationship between them. CFTs were higher in leaves than stems, and were significantly lower in quelite than in purslane. CFT correlated ($r^2=0.3435-0.9985$) with CA by FRAP

method, in most quelite selections, except for pipicha. According to a phylogenetic analysis, and based on their evolutionary closeness between the conserved proteins MatK, RbcL and Rpl32, quelite and purslane tend to be closer to each other, and could share some nutritional properties.

More studies about the nutritional and medicinal properties of quelites are underway to promote cultivation, consumption, and classification of the quelites based on their qualities.

Daniela Arrieta Flores won the ISHS Young Minds Award for the best poster presentation at the V International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions, which was held virtually in Mexico in October 2021.

► Contact

Daniela Arrieta Flores, Calle cipreses 15, San Buenaventura Atempan, 90010 Tlaxcala, Mexico, e-mail: dan.arrieta.04@gmail.com; Last work address: A. Universidad Politécnica, No.1 San Pedro Xalcaltzinco, 90180 Tepeyanco, Tlaxcala, Mexico

Exploring the relationship between landscape features and brain activation using vision AI



► Yu Hsin Tung

Exposure to nature has been proven not only to restore our attention and increase positive emotion but also to lower stress and anxiety levels, bringing multiple health effects. Neurological research has found that a 90-minute walk in nature lowers the activation of emotion regulation areas in the brain, which is associated with a lower risk of mental illness. While the positive health benefits of human interaction with nature have been described,

our knowledge is limited on the key feature or elements in nature that are critical to our health. Although these features may be subtle and difficult to identify, new technologies can improve our understanding in this area. Computer learning can now identify features from big datasets and researchers have tried to connect them with neurological responses. Our study pursued three specific goals: to identify landscape features in various environments, to investigate the emotional health effects of neurological responses, and to explore correlations between the two. First, we reanalyzed the data from a previous functional magnetic resonance imaging (fMRI) experiment that dynamically captured the brain responses of 35 participants as they viewed different landscape photographs. A pre-trained machine learning algorithm was applied to identify the physical environmental features in each photograph. Lastly, we set the coordination in the brain area related to emotion, the amygdala, to investigate the relationship between activation of this brain area and physical features in the photographed environments. This research explores the possibility of connecting land-

scape features and emotional response. The results provide us with more opportunities to explore key factors and planting principles that may impact our brain and mental health. It also gives us an insight into the key elements of nature that help landscape designers to establish healthful landscape criteria.

Yu Hsin Tung won the ISHS Young Minds Award for the best oral presentation at the XV International People Plant Symposium and II International Symposium on Horticultural Therapies: The Role of Horticulture in Human Well-being and Social Development, which was held virtually in USA in October 2021.

► Contact

Yu Hsin Tung, Department of Horticulture and Landscape Architecture, National Taiwan University, 10673 Taipei City, Taiwan, e-mail: f06628303@g.ntu.edu.tw

The influence of therapeutic horticulture on the human-nature relationship



► Timea Buru. ©Ioan Pan

Dr. Timea Buru (Hitter) is a landscape engineer with a Ph.D. in Horticulture. She is an assistant professor at the Department of Horticulture and Landscaping, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania. Her major professors were Prof. Dr. Maria Cantor, Prof. Dr. Ionel Papuc and Prof. Dr. Erzsébet Buta. The objective of her study focused on the influence of therapeutic horticulture on the

human-nature relationship. Nature, plants, or gardening activities have a positive impact on people's well-being, mental and physical health. The objective of the study was to determine how therapeutic horticulture interventions can help to increase university student's well-being and reduce depression symptoms. At the beginning of the study, randomly selected students were assessed using a psychological survey, the Beck depression inventory (BDI), to determine the level of their depression. The BDI is a subjective method. In addition, biological fluid analysis, an objective method, was measured for each volunteer to identify the presence of depression related biomarkers. After the first phase of this trial, the selected participants with BDI index higher than 10, were divided into a control and an experimental group. For 10 days in the summer of 2019, volunteers from the experimental group attended therapeutic horticulture (TH) activities like potting, planting, cutting, and maintenance of ornamental plants in their university campus. The main observation of TH activities was that depression levels decreased from moderate to normal levels.

On the other hand, changes of the biomarker's contributions (kynurenine pathway of tryptophan) were not statistically different. Based on this preliminary result, therapeutic horticulture intervention may be a possible alternative therapy to increase people's well-being in case of moderate depression, measured by a non-invasive method. Further research is needed.

Timea Buru won the ISHS Young Minds Award for the best poster presentation at the XV International People Plant Symposium and II International Symposium on Horticultural Therapies: The Role of Horticulture in Human Well-being and Social Development, which was held virtually in USA in October 2021.

► Contact

Timea Buru, Faculty of Horticulture, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăştur Street, 400372, Cluj-Napoca, Romania, e-mail: timea.hitter@usamvcluj.ro

The combination of a novel pollen counting methodology and light microscopy reveal pollen abnormalities



► Michelle Stanton

I am Michelle Stanton. A short time ago, I completed the requirements to receive an MSc (Agric) in Horticultural Sciences in the Department of Plant and Soil Sciences at the University of Pretoria, South Africa, under the supervision of Professor Elsa S. du Toit. My dissertation explored pollination as it related to the low-yielding nature of avocado trees. Within the study, my team developed a novel pollen counting methodology. Light microscopy revealed pollen abnormalities in cold stressed avocado (*Persea americana* Mill.) flowers cultivated in subtropical climates. This under-researched facet of cold stress

affected pollen health and development in avocado trees cultivated in subtropical regions. I used the novel pollen counting method to counteract the problem of inconsistent cutting depths encountered with semithin sectioning preparations for light microscopy. Anthers were prepared for light microscopy using a series of ethanol dehydrations and subsequent resin embedding. Problems with the anthers were displayed as absent and/or empty compartments. While many pollen grains appeared to be healthy, some were malformed, and a few were observed as empty shells. *P. americana* 'Fuerte' anthers appeared to be more adept at maintaining pollen health during cold, while *P. americana* 'Hass' performed better during warm periods. The influence of a warm-front just prior to anther collection in one of the sampling years may have improved the overall pollen health. This suggested that pollen health depends on sufficiently warm temperatures late in the flower development process if the pollen is to mature properly. A slight difference in the amount of pollen was detected in the anthers of flowers sampled in the male and female phase. This suggests that the overnight closure of these dichogamous flowers is physiologically important and potentially sensitive to cold temperatures. Furthermore, analysis of the temperature trends for the sampling

area showed that the avocado trees were regularly exposed to sub -15°C temperatures during the period of meiosis, a critical level in tropical plants. These findings suggested that avocados grown in subtropical and temperate areas, which experience low temperatures during and after the period of meiosis, may result in less pollen and a higher degree of abnormalities being produced. This further compounded the problem of low pollination in commercial avocado orchards, and fruit yield was reduced.

Throughout the past three years, I have gained valuable knowledge and indispensable experience, for which I am very grateful. It is an honour and blessing to have this work acknowledged by the International Society for Horticultural Sciences. Thank you!

Michelle Stanton won the ISHS Young Minds Award for the best oral presentation at the I International Symposium on Reproductive Biology of Fruit Tree Species, which was held virtually in France in November 2021.

► Contact

Michelle Stanton, Department of Plant and Soil Sciences, University of Pretoria, Private Bag X20, Hatfield, Pretoria, 0028, South Africa, e-mail: u15126430@tuks.co.za

Occurrence and mechanistic basis of diplogamete formation in apple (*Malus x domestica* Borkh.)



► Han Palmers

Han Palmers is a PhD student in the laboratory for Plant Genetics and Crop Improvement (PGCI) at the Catholic University of Leuven (KU Leuven), Belgium. His research concerns the occurrence and genetic control of meiotic plasticity in apple, and its application to apple breeding. Meiosis, the reductional division, is a key process in plant reproduction that usually serves to halve the somatic chromosome number to generate

haploid gametes. In several plant species, meiotic aberrations can result in the formation of diploid (2n) gametes. These 2n gametes form a direct route to polyploid progeny, and are therefore thought to play an important role in plant genome evolution. Usually, 2n gamete formation is under genetic control, though it can be strongly influenced by environmental stimuli, such as temperature stress. In apple, the existence of triploid cultivars in the diversity collection suggests that diploid gametes were involved. However, little is known about the rate and mechanistic basis of 2n gamete formation in apple. This limits the use of meiotic plasticity as a tool in apple breeding.

To investigate the occurrence and genetic variation in 2n gamete production in apple, Han is surveying the apple reference collection (REFPOP), a genetically diverse collection of 269 accessions used for apple breeding replicated in six countries throughout Europe. Natural variation in diplogamete formation is quantified via the characterization of pollen size, male meiotic stability, and seed ploidy. Accessions showing a significant production of 2n gametes will be subjected

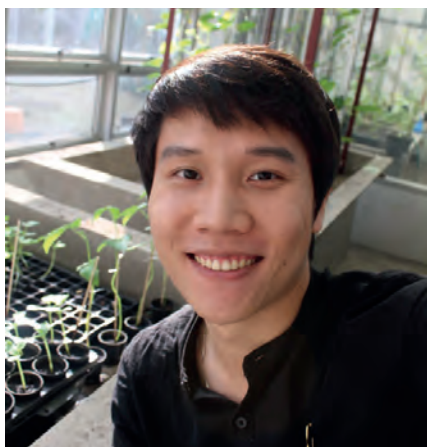
to extensive cytological analysis to elucidate the underlying cellular mechanism. Han will integrate the natural variation in diplogamete formation in genome-wide association studies (GWAS). His goals will be to identify and characterize genetic elements that contribute to diplogamete formation. The knowledge gained from this research will improve the understanding of meiotic plasticity in apple and will provide tools to increase the production of diploid gametes, thereby facilitating apple breeding.

Han Palmers won the ISHS Young Minds Award for the best poster presentation at the I International Symposium on Reproductive Biology of Fruit Tree Species, which was held virtually in France in November 2021.

► Contact

Han Palmers, Laboratory for Plant Genetics and Crop Improvement, KU Leuven, Willem de Croylaan 42, 3001 Leuven, Belgium, e-mail: han.palmers@kuleuven.be

Survey and detection of virus and viroid diseases from chrysanthemum in Thailand



► Salit Supakitthanakorn

I am Salit Supakitthanakorn, a Ph.D. candidate from the Division of Plant Pathology, Department of Entomology and Plant Pathology, Faculty of Agriculture, Chiang Mai University, Thailand, under the supervision of Asst. Prof. Dr. On-Uma Ruangwong. My current research is working on the diagnosis and development of molecular techniques for detection of virus and viroid diseases in chrysanthemum. In Thailand, chrysanthemum plants (*Chrysanthemum x morifolium*) have been cultivated for many decades. The main cultivation areas are in the northern region. However, notwithstanding that chrysanthemum plants are widely grown, data

on virus and viroid diseases are absent. In 2019, our laboratory surveyed chrysanthemum fields and found virus- and viroid-like symptoms on chrysanthemum leaves along with vector insects of plant viruses. Therefore, we decided to examine and identify disease-causing viruses and viroids in chrysanthemum. From the literature, we found approximately 10 viruses and 2 viroids that infect chrysanthemum including: *Chrysanthemum virus B* (CVB), *Cucumber mosaic virus* (CMV), *Chrysanthemum stem necrosis virus* (CSNV), *Impatiens necrotic spot virus* (INSV), *Tobacco mosaic virus* (TMV), *Tomato aspermy virus* (TAV), *Tomato spotted wilt virus* (TSWV), *Turnip mosaic virus* (TuMV), *Zucchini yellow mosaic virus* (ZYMV), *Chrysanthemum chlorotic mottle viroid* (CChMVd) and *Chrysanthemum stunt viroid* (CSVd). These viruses and viroids were detected using RT-PCR. Moreover, triple-antibody sandwich (TAS)-ELISA was used to detect the DNA virus, *Tomato yellow leaf curl New Delhi virus* (ToLCNDV), using the monoclonal antibody. The results of our virus and viroid detection from 223 chrysanthemum samples revealed three viruses (CVB, TMV and TuMV) and two viroids (CChMVd and CSVd). The nucleotide sequences of the detected viruses and viroids were analyzed. We confirmed the sequences with isolates deposited in GenBank. Among the detected pathogens, CVB had the highest

incidence. Furthermore, according to our results, the incidence of virus and viroid diseases in chrysanthemum of Thailand was lower by 10% compared to that reported in literature. Moreover, viral particles were observed under transmission electron microscope (TEM) and found that CVB had flexuous rod particles; TMV had rigid rod particles; and TuMV had filamentous particles. This study provides viral detection results along with associated symptoms observed on chrysanthemum cultivated in northern Thailand. To our knowledge, this is the first detection of virus and viroid diseases from chrysanthemum in Thailand.

Salit Supakitthanakorn won the ISHS Young Minds Award for the best oral presentation at the XV International Symposium on Virus Diseases of Ornamental Plants, which was held virtually in USA and Singapore in December 2021.

► Contact

Salit Supakitthanakorn, Division of Plant Pathology, Department of Entomology and Plant Pathology, Faculty of Agriculture, Chiang Mai University, Chiang Mai 50200, Thailand, e-mail: salit.supakitthanakorn@gmail.com, salit_su@cmu.ac.th

Effects of SNP and cPTIO on oxidative membrane damage and pericarp browning of harvested longan fruit



› Sitthisak Intarasit

Sitthisak Intarasit is a Ph.D. candidate in the Department of Biology at Chiang Mai University, Thailand. He completed his BSc in Biology in 2017, and his MSc in Plant Biology in 2019. These degrees were obtained from Chiang Mai University. His Ph.D. focused on browning disorder in longan (*Dimocarpus longan* Lour.), with emphasis on reactive nitrogen species (RNS) and nitrosative stress. Postharvest longan fruits are prone to senescence. Pericarp browning or dis-

ease development due to water loss, injury, pathogen infection, or damage caused by reactive oxygen species (ROS) severely degrades the commercial value of the fruit. Sitthisak's research evaluated the involvement of nitric oxide (NO), an important RNS, in ROS accumulation and oxidative damage to pericarp browning of 'Daw' longan fruit. This damage occurred during storage under ambient condition by using sodium nitroprusside (SNP, NO donor) and 2-(4-carboxyphenyl)-4,4,5,5-tetramethylimidazoline-1-oxyl-3-oxide (cPTIO, NO scavenger) application. Longan fruits were dipped in distilled water (control), SNP (50 and 100 mM) or cPTIO (100 and 500 μ M) for 10 min, then stored at $25\pm1^\circ\text{C}$ for 7 days. SNP-treated fruit exhibited higher ROS content (superoxide radical, hydrogen peroxide and hydroxyl radical), oxidative membrane damage (malondialdehyde, protein carbonyl and electrolyte leakage) as well as pericarp browning (browning index and polyphenol oxidase activity), compared with control fruits. In contrast, exposure to cPTIO attenuated ROS content, oxidative membrane damage and pericarp browning of longan pericarp during storage. The severity of pericarp browning, ROS production and

oxidative damage depended on SNP or cPTIO concentrations. These findings suggest that NO might be involved in oxidative stress, which contributes to pericarp browning in harvested longan by alteration of the balance between ROS generation and scavenging. The results of Sitthisak's research will improve the knowledge on RNS metabolism and cellular damage in response to pericarp browning of postharvest longan fruit. Moreover, his research will provide a scientific basis and reference to further investigation of postharvest quality maintenance of longan and other fruits by regulating RNS metabolism and RNS-induced oxido-nitrosative stress.

Sitthisak Intarasit won the ISHS Young Minds Award for the best oral presentation at the V Asia Symposium on Quality Management in Postharvest Systems in Thailand in December 2021.

› Contact

Sitthisak Intarasit, Department of Biology, Chiang Mai University, 50200 Chiang Mai, Thailand, e-mail: golfdoctor9@gmail.com

Changes in expression of carotenoid and chlorophyll metabolic genes during regreening process in citrus fruit



› Nichapat Keawmanee

Nichapat Keawmanee is a Ph.D. student in the Science of Biological Production, United Graduate School of Agricultural Science, Shizuoka University, Japan, under the supervision of Prof. Masaya Kato. Her recent research focused on the changes of pigment profiles in citrus during the fruit regreening process. Citrus fruit ripen from green to orange during the winter season. When the fruit remains on the tree late into the spring or summer season, the fruit skin color will

reverse from orange to green. This is particularly visible for Valencia oranges. The occurrence of the regreening process is related to the accumulation of pigments such as chlorophylls and carotenoids in the fruit skin. In a previous study, researchers found that temperature, light, nitrogen fertilizer, and plant hormones induced the regreening process. However, the mechanism of regreening remains unknown. The objective of this study was to determine the chlorophyll and carotenoid content and related gene expression in Valencia orange skin during fruit regreening. During the regreening process, the color of skin reversed from orange to green accompanied by a decrease of the carotenoids content and accumulation of chlorophyll. In addition, the occurrence of green color was more obvious in the stem end than in other areas. Changes of pigment profiles were regulated by the expression of chlorophyll and carotenoid metabolism genes. The up-regulation of chlorophyll biosynthetic genes and the down-regulation of chlorophyll degradation genes contributed to increased chlorophyll content. Meanwhile, the down-regulation of carotenoid biosynthetic genes led to the decrease of carotenoid content. These

results suggested that the regreening process of citrus fruit was regulated by promoting the chlorophyll biosynthetic genes, and repressing the chlorophyll degradation and carotenoid biosynthetic genes. Further work will study the effect of exogenous gibberellins on pigment profile during the regreening process. The expression of genes being associated with pigment accumulation is still unknown. We hope that this research might help gain a deeper insight into the role of phytohormones in regulating the pigment profiles during the regreening.

Nichapat Keawmanee won the ISHS Young Minds Award for the best poster presentation at the V Asia Symposium on Quality Management in Postharvest Systems in Thailand in December 2021.

› Contact

Nichapat Keawmanee, Department of Bioresource Sciences, Faculty of Agriculture, Shizuoka University, 836 Ohya, Suruga, Shizuoka 422-8529, Japan, e-mail: nicha.maanee@gmail.com

> Challenges and opportunities of the French apple chain

Jean-Luc Regnard, Claude Coureau, Vincent Mathieu, Benjamin Gandubert, Jennifer Lussan, Frédéric Aubert, Xavier Le Clanche, Sandrine Gaborieau, Vincent Guérin and François Laurens

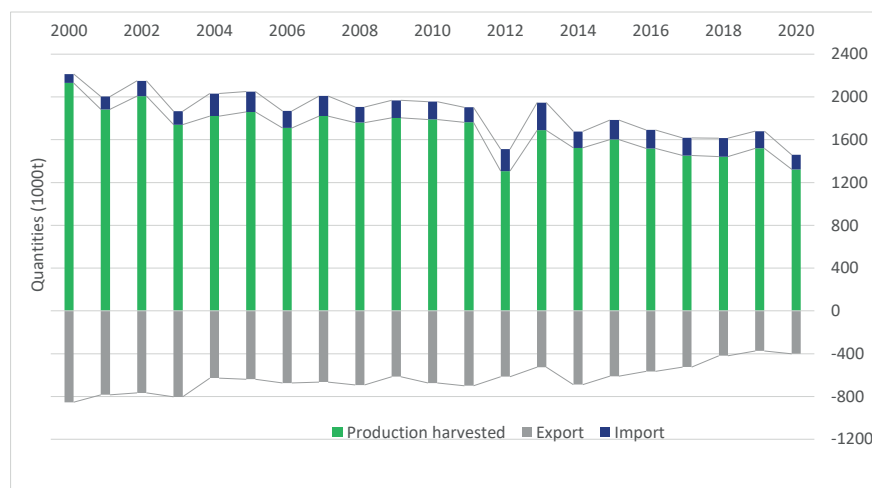
Apple production in France has been marked by a centuries-old tradition and numerous successes. Its recent evolution is underpinned by the diversity of the geographical and market contexts in which it takes place. The impact of globalization now represents a permanent challenge for the actors of the apple industry, in search of economic, social, and environmental sustainability, recently reinforced by sanitary constraints and climate change. The present overview, while not exhaustive, develops the main economic aspects of the apple sector, its territorial reality, some main lines of technical progress, and outlines some ways to face the major current challenges.

The apple industry in France: excellence in the face of international challenges

Key figures on production and trade

Apple production for the fresh market is one of the pillars of French fruit economy, which it tries to maintain in the current context of globalization. Between the years 2000 and 2015, the area of commercial apple orchards steadily decreased from 53,000 to 36,500 ha, before it stabilized around 37,500 ha. There are about 3,500 apple farms, with an average orchard area of about 11 ha. This average masks strong disparities: more than 88% of French apple orchards are located in specialized fruit farms, about 1,100, where the average orchard size exceeds 30 ha. In contrast, there are also multi-purpose production farms with smaller orchards, and small family farms producing apples for niche markets (e.g., in the suburban context). The size of apple orchards that are certified for organic production or in conversion, approached 9,000 ha in 2020, which is nearly 25% of the total production area.

The potential of the national apple production has globally decreased, from 2 million tons (Mt) in the 2000s to 1.75 Mt in the early 2010s. It has stabilized at a threshold of 1.5-1.65 Mt since 2014, making France the 3rd largest European apple producer behind



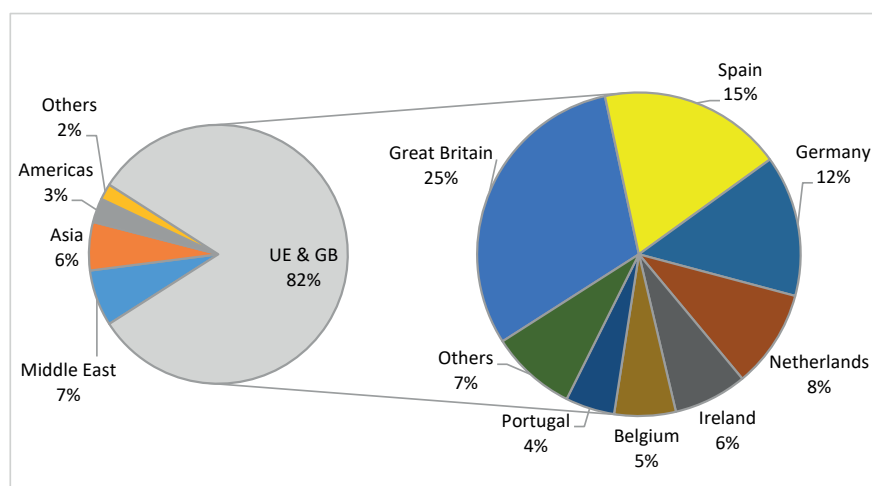
■ Figure 1. Apple production, imports and exports in France (fresh market). By convention, the quantities exported are indicated in negative values. Source: French Agreste statistics and customs.

Poland and Italy. However, this production potential can be adversely affected by climate. The frequency of climate events has increased over the last decade (particularly in 2012, 2020, and 2021) (Figure 1). Affected by spring frost, the 2021 harvest is estimated at 1.36 Mt. On this basis, an average yield of about 40 t ha⁻¹ can be calculated, for all apple orchards combined (extensive and intensive, young and mature, conventional and organic). This is a respectable performance, and very stable since the 2000s, masking much higher yields per ha in the most specialized farms.

In terms of trade, France was the world leader in apple exports for the fresh market until 2003, with an average volume shipped close to 0.80 Mt. Outclassed by other exporting countries (China, Chile, Italy) from 2004 onwards, and more recently by Poland, France is ranked 7th largest exporter, with annual exports of 0.40-0.50 Mt (Figure 1), close to amounts shipped by New Zealand and Iran. In France, apples remain the leading exported fruit in volume and value. The main client countries are Great Britain and some European Union countries (Spain, Germany, The Netherlands) for 4/5th of the French

apples shipped (Figure 2). The other destinations (1/5th: Middle East, Asia) are more irregular, or disputed by other suppliers, notably on price. The number of client countries nevertheless remains very high, at more than 100. For imports (0.15-0.20 Mt) (Figure 1), France is an open market, with 50% of its suppliers European (Italy, Belgium, Spain, Poland), and others located in the southern hemisphere (Chile, New Zealand). A significant part of apple imports counted as fresh, actually goes to processing.

In 2019, 21% of the French apple harvested production (0.38 Mt) was dedicated to processing, of which 80% was delivered to the compote industry (FranceAgriMer, 2020). For this product, France is the European leader and net exporter (about 30,000 t year⁻¹). Domestic consumption of compote is increasing, especially among children, with a high-end positioning and a growing share of no-sugar-added products (42% of manufacturing in 2019). Industrial processing is an important outlet for the use of sorting residues (small sizes, and damaged fruits). These fruits which are unsuitable for fresh market also contribute to the fight against food waste. For processed French apples,



■ Figure 2. Destinations of apple exports from France (2020-21 season, Agreste and customs data).

industrial supplies are the subject of contracts within AFIDEM (French Interprofessional Association for Multipurpose Fruits and Vegetables). The fruit for cider, calvados, and the cider brandy sector (0.20-0.25 Mt of apples for cider or juice year⁻¹; 950,000 hL of cider year⁻¹), based on a dedicated orchard of about 9,000 ha, is not covered by this report.

A steady consumption, with an attentive and demanding consumer

The evolution of apple consumption in France (fresh market) is based on data from Kantar Worldpanel, in particular via the indicator of the family purchases for home use. This indicator is representative of 65% of total consumption (source: Inter-professional Technical Center for Fruit and Vegetables, CTIFL), even if the share of fruit consumed outside the home is trending in increasing, except for the recent pandemic period. The analysis of the 2019 data (FranceAgriMer, 2021a) shows that apple remains the leading fruit purchased by households (16 kg year⁻¹),

i.e., a level equivalent to 13 kg per capita. There has been a downward trend in apple volume purchased, -1.6% per year since 2011, offset in terms of sum spent (+1.5% per year) thanks to higher sales prices. Apple has a good image (taste quality, health, and convenience) and shows a penetration rate of 88% and a satisfaction rate exceeding 90%. In terms of value, apple purchases represent 15-17% of the money spent in the fresh fruit shelf. The share of pre-packed fruit in this amount has increased to almost 40% (last two campaigns), while many consumers continue to prefer bulk (markets, direct sales). As a new French regulation (since January 1, 2022) prohibits the use of plastic bags for batches of less than 1.5 kg, one can expect a higher part of presentation in cardboard or wooden sales units for lots of 4-6 fruits (Figure 3), at least for mass distribution. French consumers can name between two and eight different varieties, while they consume an average of five (Cavard-Vibert, 2020). Their first criteria of choice in 2019 were

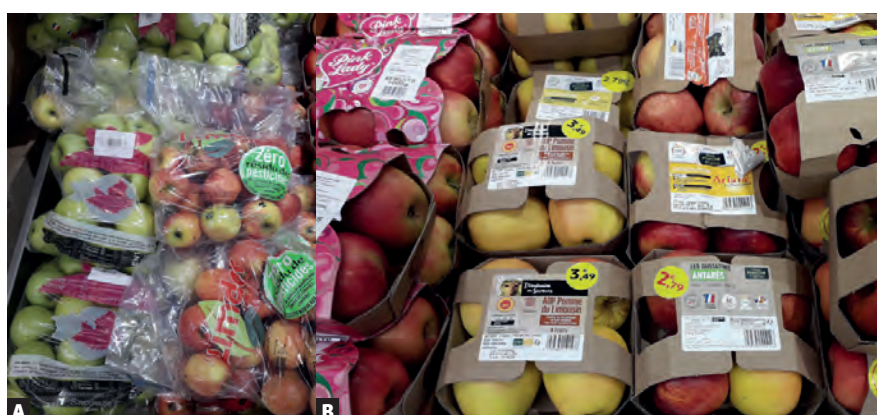
variety, price, origin, freshness, and production method. The French supply of organic apples is becoming surplus to the needs of the domestic market (20% of families are buyers, for 10-15% of volumes). This makes some organic produce return to the conventional market.

The analysis of apple sales by distribution channel indicates that hypermarkets, supermarkets, and hard discounters represent 60% of the quantity purchased. This marks a slight decrease, while an increase in sales is noted for the drive-through formats (2%). It has been encouraged by the Covid-19 pandemic, as well as supermarkets specialized in fresh produce (4%) and organic stores (2%). Premier stores and markets, and direct sales, have a market share close to 23%.

Collective approaches aiming at excellence and meeting societal expectations

The French apple sector is highly structured. Upstream, collective strategies, based on recognized producers' organizations, are connected within the French Apple and Pear Association (ANPP). This association brings nearly 1,400 apple producers together and represents about 70% of the surface area and tonnage for this product. It has set up a charter of good arboricultural practices, through the "Eco-friendly orchards" label (Figure 4A), recognized by the Ministry of Agriculture. It actively communicates on this approach specific to French production through various audiovisual channels and "open-orchard days". The Eco-friendly orchard label has made strong progress with French consumers both in terms of awareness (more than 50% of buyers in 2020) and confidence (77%), which is in line with societal expectations for respect of the environment. The ANPP also synthesizes the knowledge of the national and export markets to elaborate strategies of sector, develop products, and support and encourage consumption near the consumers.

About fifteen professional families of the fresh fruit and vegetable sector are grouped together within Interfel, a private law and initiative inter-professional organization recognized by the European Union. Among its actions, Interfel participates in the governance of CTIFL, particularly in its research and development orientations. Interfel also guides the actions of the Agency for Research and Information in Fruit and Vegetables (Aprifel), which gathers and disseminates knowledge on the links between fruit and vegetable consumption and health to promote their consumption. At the end of 2017, the French fresh and processed fruit and vegetables interprofessions submitted a sector plan to the public authorities. Its



■ Figure 3. Presentation of apples in pre-packed units at the retail stage. A) Plastic bags of 1.5-3.0 kg used for small sizes and 2nd choice (packaging discontinued for lots of less than 1.5 kg). B) Cardboard trays of 4 or 6 fruits, sometimes with an assortment of apples. These fruit shelves reflect the diversity of the French varietal offer, particularly present in the large-scale fresh produce specialists (©J.-L. Regnard).



A



B

■ Figure 4. A) The Eco-friendly orchards label applies to fruit from the French apple producers' quality charter. Officially approved, this label certifies that the production comes from orchards affiliated to the ANPP, committed to the production of healthy, tasty, and quality fruit, according to integrated fruit production methods that respect the environment and biodiversity, as well as the economic sustainability of the farms. The addition of the tricolor banner is a response to the French consumer's expectations of local products. B) The French high environmental value label is relative to farms strongly involved in environmental objectives. This high level of certification, not specific to fruit production, but complementary to the previous one, is awarded after external control of procedures and result indicators.

■ Table 1. Breakdown of apple production in France by variety (registered trademark [®], cultivar denomination and plant breeder right _{pbr}), for the average of the 2018-20 campaigns (in 1,000 t and %, source ANPP). For many varieties (*), mutants are available, with either a modified precocity, fewer cosmetic defects, or more intense skin color.

Varieties	2018-20 (1,000 t)	%
Golden Delicious*	403	27.1
Gala*	297	20.0
Granny Smith*	141	9.5
Fuji*	59	3.9
Braeburn*	59	4.0
Red Delicious*	52	3.5
Jonagold*	27	1.8
Elstar*	16	1.1
Sub-total international	1,054	70.8
Pink Lady [®] Cripps Pink _{pbr} *	163	11.0
Jazz [®] Scilate _{pbr}	24	1.6
Joya [®] Cripps Red _{pbr}	13	0.9
Honey Crunch [®] Honeycrisp _{pbr}	15	1.0
Juliet [®] Coop 43 _{pbr}	13	0.9
Les Naturianes [®] Ariane _{pbr}	15	1.0
Chouquette [®] Dalinette _{pbr}	5	0.3
Tentation [®] Delblush _{pbr}	6	0.4
Sub-total managed	254	17.1
Belchard [®] Chantecler _{pbr}	52	3.5
Canada	39	2.6
Boskoop*	8	0.6
Queen of the Pippin*	11	0.7
Goldrush [®] Coop 38 _{pbr}	5	0.4
RubINETTE [®] Rafzubin _{pbr}	5	0.3
Sub-total terroir	120	8.0
Idared	3	0.2
Others	58	3.9
TOTAL	1,488	100.0

main goal is aimed at strengthening competitiveness, supporting consumption, and reinforcing the place of products and companies internationally. These interprofessions have been privileged interlocutors of the French government for the elaboration of the national strategic plan (NSP) recently submitted to the European authorities. This is a prelude to the elaboration of the future Common Agricultural Policy (CAP 2023-2027), which will be ambitious in terms of environment and climate (European Green Deal).

Strengths and weaknesses of the French apple sector

France's place in the international apple industry is studied by a competitive intelligence published annually for the attention

of the sector's actors, comparing the main apple-producing countries, on the basis of different criteria from production to consumer. The latest edition of this watch (FranceAgriMer, 2021b) shows that France was ranked 7th for competitiveness in 2019, thanks to certain assets: the diversity of its varietal offer, the satisfactory renewal rate of its orchards (4.3% on average), the technical skills of its producers, the dynamics of the organic sector, and a set of favorable natural factors (climate, water availability). French apple production remains handicapped by high production costs, the loss of orchard surface area (although stabilized since 2015), which limits the potential in volumes, and a contraction of exported quantities.

A rich production potential for diverse and demanding markets

Apple production in France is characterized by great diversity. This is the result of the varied soil and climatic conditions found in the different basins, but also of the great diversity of the varieties grown, reinforced by the active breeding programs and the renewal rate of the orchards. French apple production areas are mainly located in irrigated plains, but also in hillsides or in piedmont (Figure 5), or in green belt.

According to recent official statistics of the Ministry of Agriculture, the share of French regions for a normal apple harvest (without spring frost) shows the major origins of the volumes of fruit harvested: Provence-Alpes-Côte d'Azur (23%), Occitanie (21%), New Aquit-



■ Figure 5. Apple orchards in Limousin. The medium elevation (350-500 m), the contrast of day/night temperatures, the soils on a crystalline base, in association with the local know-how, contribute to the reputation of the ‘Pomme du Limousin’ protected designation of origin (PDO; AOP in French). The PDO specifications are a refractive index of at least 12.5 °Brix, a firmness of at least 5 kg cm⁻² and an acidity of at least 3.7 g L⁻¹ of malic acid (°F. Besse).

aine (20%) and Pays de la Loire (17%), whereas significant volumes come from the regions Auvergne Rhône-Alpes (7%) and Centre Val de Loire (5%).

The distribution of the main apple varieties in ANPP orchards is displayed in Figure 6. It shows the importance of ‘Gala’ (often 25%) in the Provence, Languedoc, Tarn-et-Garonne and Loire Valley basins, a high share of ‘Granny Smith’ and ‘Pink Lady’ in Languedoc-Roussillon, and some particularities such as the dominance of ‘Golden Delicious’ in the Alps and Limousin, the share of ‘Belchard’® Chantecler_{pbr} in Charentes and Aquitaine, and the presence of regional apples in Brittany and ‘Boskoop’ in the north. The regional grow-

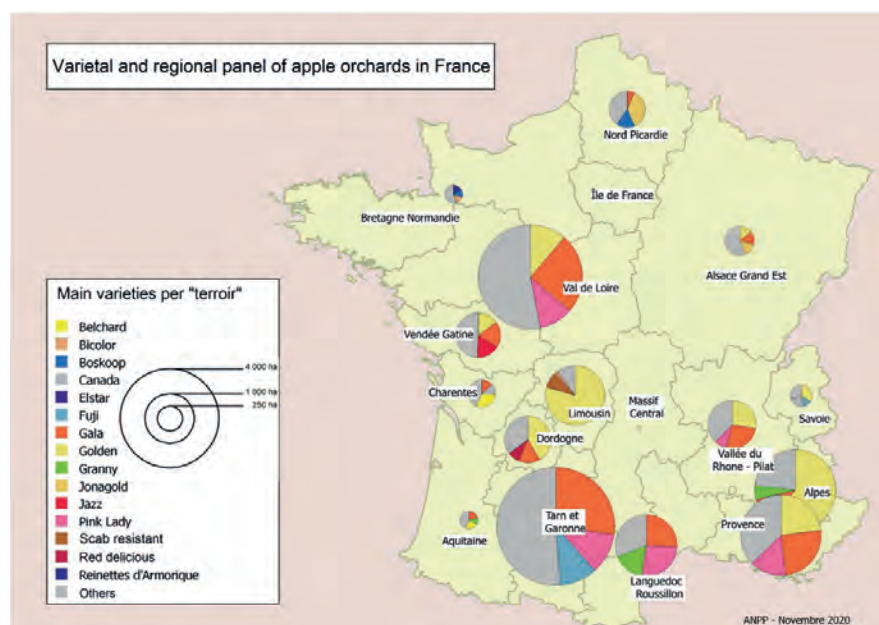
ing of diverse apples is based on the analysis of the market need (national or export), local opportunities, and characteristics of the physical environment. A wide range of varieties can thus be accessed through French fresh food retail specialists.

French orchard production can be segmented into three major groups of varieties (Table 1): international varieties, intended for both the domestic and export markets (71% of the 2018-2020 quantities, slightly down), “club” varieties, aiming for a higher value on one or two of these two markets (17% of the volumes produced, i.e., before application of the specifications, slightly up), and the so-called “terroir” varieties (8%) rather suit-

able for the national or even regional market. Some apple productions also benefit from official quality signs: protected geographical indications (PGIs) ‘Pommes et Poires de Savoie’ (since 1996) and ‘Pommes des Alpes de Haute-Durance’ (since 2010), and protected designation of origin (PDO) ‘Pomme du Limousin’ (since 2007). These terroirs have made it possible to distinguish certain favorable characteristics acquired at 350-450 m elevation (‘Golden Delicious’, in particular). A red label can be associated with part of this production, for ‘Golden Delicious’ and ‘Gala’, with a minimum of 13.5 °Brix, harvested at an optimal stage of ripeness.

Following the example of ‘Pink Lady’® apples (‘Cripps Pink’ and its mutants), some varietal innovations are launched and managed in “clubs” (Table 1), the varieties being more or less exclusive to a few marketers, who sell the fruit under an exclusive brand name, based on the typicity of the fruit (e.g., ‘Jazz’®, ‘Joya’®, ‘Honeycrunch’®, ‘Juliet’®, and ‘Les Natures Ariane’®). In this context, red-fleshed varieties have recently been released (‘Kissabel’® or ‘Red Moon’® brands), also intended for exclusive sale. By contrast, the recent scab resistant varieties bred within the INRAE/NOVADI partnership (‘Story’®Inored_{pbr}, ‘Garance’®Lespin_{pbr}, ‘Mandy’®Inolov_{pbr}, ‘Lory’®Inogo_{pbr} and ‘Galy’®Inobi_{pbr}, see below) are not intended for exclusive distribution, but benefit from branding strategies aimed at increasing their market value and their visibility among consumers. An increasing number of recent varieties with good hardiness, resulting from resistance or tolerance to scab, are being planted (Table 2). Some of them are suitable for production according to organic principles and are adapted for niche markets or short circuits. Given the potential for scab to overcome genetic resistance due to the *Vf(Rvi6)* gene, some treatments are still needed for these varieties, targeted at the pathogen’s peak infections. Active research is being conducted (INRAE and international partners, Laurens et al., 2018) to overcome this difficulty by the breeding for a durable resistance to this pathogen.

Since the 1980s, French producers have increasingly tended to plant apple varieties with sweeter and less acidic fruit that is medium size, with very firm flesh and good storage capacity (Collective, 2021). These decisions are supposed to meet the expectations of consumers, including the youngest, in terms of gustatory pleasure, or adaptation to nomadic consumption. But they must also answer the expectations of the supply chain distribution, in terms of tolerance to handling and transport. It is necessary for the apple sector to remain attentive to the great varietal diversity now available, without becoming counterproductive in terms



■ Figure 6. Varietal plantings in apple growing regions in France for orchards affiliated with ANPP. The pie chart surfaces are relative to the territorial importance, and indicate the share of the main varieties. Source: ANPP, November 2020.

A public-private partnership in apple breeding

For more than 25 years, NOVADI and INRAE have been running a breeding program, dedicated to the selection of apple varieties that naturally offer a high level of hardiness to bio-aggressors. The main objectives of the varietal selection include a set of favorable agronomic traits: resistance or tolerance to the common races of scab, to powdery mildew and fireblight, non-attractiveness to aphids, ease of tree management, regular yield of top-quality fruit (aroma, sugar/acid balance, juiciness, fine texture) reaching high pack-out percentages thanks to an attractive presentation, and having a long shelf-life. The different stages of the breeding process are carried out jointly, with a predominant involvement of public research in the upstream steps (pre-breeding, crossing schemes, advanced phenotyping) and a strong commitment of private partners for the agronomic evaluation. In particular, the end of the selection program consists of pursuing the observations of the best hybrids in a system close to the production conditions, with experimental orchards representative of various pedoclimatic contexts. This step of assessment of varietal behavior is based at the national level on the French variety evaluation system and at the European level on an international network composed of partners who evaluate the adaptation of the pre-selections to different pedoclimatic conditions. The NOVADI company (www.novadi.fr/en/), which groups thirteen French nurserymen producing apple material for professional producers, is the exclusive world editor/manager of the varieties resulting from this program.

■ Table 2. Main apple varieties adapted to organic production in France. The behavior against scab is mentioned, either resistance (*Vf(Rvi6)* gene), or tolerance, as well as the control of the variety distribution (managed = club) and the main market objectives (L/S = long and/or short circuit). Registered mark®, cultivar denomination and plant breeder right_{pbr}

Maturity	Registered mark	Denomination	Scab	Variety control	Distribution
Early	Antares®	Dalinbel _{pbr}	Resistance	Brand	L/S
Mid-early	Cœur de Reine®	Daliclass _{pbr}	Tolerance	Managed	L/S
Mid-early	Pixie Crunch®	Coop 33 _{pbr}	Resistance	Brand	L/S
Mid-early	Crimson Crisp®	Coop 39 _{pbr}	Resistance	Brand	S
Season	Les Naturianes®	Ariane _{pbr}	Resistance	Brand	L/S
Season	Evelina®	Roho 3615 _{pbr}	Tolerance	Managed	L/S
Season	Opal®	UEB 32642 _{pbr}	Resistance	Managed	S
Mid-late	Candine®	Regalyou _{pbr}	Resistance	Managed	L/S
Mid-late	Chouquette®	Dalinette _{pbr}	Resistance	Managed	L/S
Mid-late	Story®	Inored _{pbr}	Resistance	Brands	L/S
Late	Juliet®	Coop 43 _{pbr}	Resistance	Managed	L/S
Late	Swing®	Xeleven _{pbr}	Resistance	Managed	L/S
Late	Goldrush®	Coop 38 _{pbr}	Resistance	Brands	S

of notoriety on the retail markets. It should be noted that this risk can be amplified by the various brands existing for a same apple, without forgetting the numerous labels qualifying the production methods.

Faced with abiotic and biotic threats, an orchard design aiming at a better resilience

Increasing attention is being paid to the areas where apple orchards are planted to avoid those most prone to spring frosts, wet situations (low-lying areas, poorly drained

soils), or places where soils are too light or too alkaline. The issue of adaptation to climate change is on the growers' agenda, particularly by considering the choice of irrigable situations. As an example, apple trees in the Limousin region have been grown under natural rainfall for decades, while recent orchards in this area are now installed with the support of irrigation. Beyond this example, the creation of new orchards raises the crucial question of water resources. Indeed, outside of the existing collective irrigation networks, apple growers are confronted with

administrative or regulatory difficulties to create surface water reservoirs, especially in the context of individual farms. In 2021, this issue was in the French spotlight, during the meetings of the 'Varenne de l'Eau'. The public authorities are in favor of the creation of new collective water resources, made necessary by climate change or hazard control, and they support the emergence of water management territory projects (PTGEs in French). However, these projects must be implemented in compliance with wetlands legislation, which may reveal oppositions between the stakeholders (e.g., farmers vs. environmentalists).

The anticipation of mild winters unfavorable to the chilling requirement of tree (i.e., to the release of bud dormancy) has led to the evaluation of low-chilling apple varieties, notably issued from Brazilian breeding. These trials have not led to implementation to date because these very early flowering varieties are exposed to frost. The fight against spring frosts is leading more and more fruit growers to equip the orchards with means of active control, by overhead irrigation, heaters, and wind machines. To protect plantations from damage and production losses due to hail, losses for which insurance is prohibitive or even impossible, most French orchards planted since the early 2000s are protected by hail-netting (Figure 7). This type of protection, which can cost more than 12,000 euro ha⁻¹, not including installation labor, requires an annual deployment just after flowering and folding after harvest. Anti-scab plastic rain-roofs can be combined with these nets. Physical protection is also used for insect control. A growing number of orchards (especially organic) in the more exposed southern areas have adopted the 'AltCarpo' netting protection system to reduce codling moth damage. Netting can be placed directly on the tree row or installed as 'mono-parcel' (Figure 8). Some nets have a double action against hail and insects.

In most orchards, moreover, the search for the natural balances encourages the fruit tree growers to strengthen or set up agro-ecological infrastructures, source of biodiversity, which are often recommended or imposed by the specifications of production. Thus, the design of orchards is attentive to plant biodiversity with the implementation of grassing of the inter-row, up to 60% of the surfaces, the annual sowing of flowering fallows (Figure 9A), and the planting of wind-breaks. These vegetal structures, especially when they are multi-species, can have a meliferous (honey producing) interest and host a useful fauna (predatory or parasitic auxiliaries, pollinating insects), which facilitates biological control by conservation. With the same objectives, various specifications also



■ Figure 7. French apple orchards are predominantly protected by hail nets. Nets are stretched with bungee cords (A). In case of a hailstorm, the hailstones are retained by the structure (B) or fall into the inter-row, without damage to the vegetation (©Blue Whale).

recommend the installation of nesting boxes for insectivorous birds (e.g., tits) (Figure 9B), perches for birds of prey (vole predators), or even hedgehog shelters or insect hotels. These agroecological investments can be considered at the plot scale, or even at the supra-plot scale, by paying attention to inter-connection corridors at the farm or landscape level.

The actions of prevention and passive control of climatic damages and biotic aggressions must be conceived from the very beginning of the orchard system, to contribute to its later efficiency aiming at a sustainable fruit production. Given their partial effects, they require complements in terms of annual direct control, as much as possible by means of biocontrol available (e.g., mating disruption or biological control).

Innovative technical management of the orchard

A continuous evolution driven by economic factors and supported by research and development

The technical management of apple orchards in France has undergone a constant evolution since the 1960s-70s. At that time, hedge-row systems were adopted as a standard adapted to intensification through mechanization of cultural operations (interven-

tions made from the inter-rows, such as phytosanitary spraying) and assistance to manual operations by platforms (pruning, harvesting) (Figure 10). For economic reasons, high-density multiple row planting systems were then experimented (1970s-80s), followed by 'pedestrian' orchard concepts (1980s-90s). However, there has been no significant adoption, either because of excessive investment, or because of yield deficits at maturity. The objective of high-quality fruit production has also been more and more present, in response to markets' expectations. The first professional production charters date back to this period, especially for apples and pears. The initiatives of orchardists converged to lead to a National Charter of Integrated Fruit Production (1997), today known as Eco-friendly orchards, supported by the ANPP organization. These advances were made possible thanks to a systemic approach, consisting in synthesizing scientific and practical knowledge from research and development work in fruit production, carried out by INRAE, by CTIFL, and regional experiment stations, also fed by data from the networks of technical advisors, in close contact with orchardists.

Thus, in the mid-1990s, the work of the Mafcot group ("Maîtrise de la fructification concept et technique") co-animated by INRAE and technical advisors, disseminated inno-



■ Figure 8. A young organic apple orchard protected from codling moth attacks by an exclusion perimeter and cover netting ('mono-parcel' system). The mesh of the net, 5.5×2.2 mm, prevents the entry of the pest, and its egg-laying bites (©J.-L. Regnard).

vative concepts of apple tree management based on knowledge of varietal behavior and tree physiology, stemming in part from field observations, and aimed at regulating the fruit load and increasing control of biennial bearing (Lauri et al., 2004; Lauri and Simon, 2019). Meanwhile, other experimental approaches were developed, notably by CTIFL, more focused on adapting to mechanization, including a 'fruit wall' concept based on annual mechanical pruning of tree hedges (Masseron, 2002).

Nowadays, the increasing difficulty of recruiting qualified permanent staff in fruit farms oriented towards international varieties and long circuits seems to favor a return to a very simplified management of orchards, with higher density plantings than in the 2000s, aiming at quickly reaching the performance of adult orchards (Roche, 2020), which contributes to improve the return on investment. A high yield is a divisor of expenses per kilogram of fruit produced, which makes it possible to contain production costs despite the heavy initial investments (more than 50 k€ ha⁻¹). In recent plantations, the row of apple tree forms a narrow geometry known as 2D, in which pruning is simplified and facilitated; the fruit hedges generate less internal light gradients, which favors fruit homogeneity and improves the harvesting rate. The alleyways, which were classically 4 m wide, tend to become narrower, with row spacings of 3.00-3.50 m. As a consequence, the planting density increases, and can reach or exceed 3,000 trees ha⁻¹, which in turn increases the investments. With this orchard design, the linear meterage of fruit hedges per ha is also increased, which has an impact on mechanical operation times. The objective of mechanization remains more than ever on the agenda, with for example the practice of mechanical thinning of trees as soon as they bloom (Darwin® or Eclairvale® tools, especially in organic farming). Different forms seem appropriate to establish these new apple orchards, for example the two-branch tree (Bibaum® or Ypsilon®) installed at planting (Figure 11), thanks to the pre-formation of apple trees in the nursery, or to multi-leader training (Figure 12). The adoption of



■ Figure 9. A) Flower strip sown around the orchard. B) Tit nesting box placed within an apple orchard (©Blue Whale).



■ Figure 10. A) Apple harvesting organized from the ground, with direct deposit of apples in paloxes (®Blue Whale). B) Harvesting assisted by a self-propelled platform, carrying pickers located at different heights (©J.-L. Regnard). The trellised fruit hedge system is essential to the efficient organization of harvest.



■ Figure 11. Two-branched apple trees. A) Detail of the branching initially obtained in the nursery (©J.-L. Regnard). B) An adult orchard in production based on this type of tree, showing the porosity of the fruit hedge (©CTIFL).

these management methods also induces a change in the range of rootstocks, the vigor of the G11 types being considered adequate, superior to that of the M9 types, which is insufficient, especially in replanting. As a result, the traditional M9 range is tending to be replaced by new rootstocks favorable to rapid fruiting, with tolerance to telluric bio-aggressors and better anchorage.

Specifications and fruit production

In the 1980s, mass distribution influenced fruit production, with each distributor subjecting suppliers to its own specifications, before the European distributors of the Euro-Retailer Produce Working Group established a common reference framework of good agricultural practices (Eurep-Gap, 1997). Their practices aimed at safer food, based on sustainable production methods especially for fruits, and social responsibility. In 2007, this reference system evolved to become Global Gap, an essential standard for collective organizations of apple producers wishing to access the national market or especially for export. Faced with the demands of distribution, the organized fruit producers are asserting their own rules and try to have them recognized. Thus, the National Production Charter (late 1990s) evolved into the afore mentioned Eco-friendly orchards approach (2011) subsequently accredited as level 2 environmental certification, at a level compatible with the distribution benchmarks. This progress approach, oriented towards environmental, economic, and social sustainability, aims very quickly to achieve, for half of the fruit farms, the official French label of high environmental value (HVE in French) (Figure 4B). Other standards can be superimposed to the production charter to specify an additional feature; one, focused on the promotion of citizen produc-

tion with strong local roots, is represented by the 'Demain la Terre' (Tomorrow's Earth, from Nouveaux Champs collective) approach while the other, 'Bee friendly'®, aiming at protecting pollinating insects, has been adopted by various producers' organizations. These procedures are subject to self-controls, internal controls and independent controls by accredited third-party organizations.

Reduction in the use of pesticides

For pest control, the French apple orchard had already assimilated the principles of integrated fruit protection by the end of the 1970s, to overcome the impasses of a protection based exclusively on chemistry. This evolution, consistent with the objectives of fruit quality, was extended to the concept of integrated fruit production (IFP, 1990s), leading to Eco-friendly orchards today, in accordance with the expectations of distributors and markets.

Apple growers in France are subject to a very demanding regulatory context in terms of plant health, as the marketing authorizations for plant protection products are often more restrictive than those of other European countries, despite the same registration of active substances (Regulation (EC) No 1107/2009). The conditions of application of plant protection products are also highly regulated since 2006 (e.g., weather conditions, untreated areas, and residue management). Following a national consultation on a policy for the environment ('Grenelle de l'Environnement', 2007), France implemented measures to reduce the use of pesticides, through the Ecophyto I and II plans (2008 and 2014, respectively), which are the national declination of the European directive EC 2009/128. These plans have also led to the emergence of the DEPHY networks for fruit production, with a "Farm" system based on

volunteer farms for agroecological transitions, supported by network engineers, and an "Expé" system consisting of the exploration of innovative R&D systems. These actions have also stimulated the provision of decision support systems and dedicated tools, which allow the triggering of chemical interventions, the development of biocontrol methods, and more broadly alternative methods of regulating bio-aggressors. The French Fruits Scientific Interest Group (GIS Fruits) published a first summary of these methods for fruit producers and technicians (Laget et al., 2015).

The strict French regulation and the control plans that accredit its application are facilitators to reach the label zero pesticide residue, but the profession deplores that technical impasses appear when the arsenal of alternative methods to control orchard pests is insufficient and/or when the authorized products are too few or withdrawn (e.g., control of the rosy apple aphid, fruit flies, or new pests such as brown marmorated stink bug). Apple production, which aims at a more natural orchard pest control, is evolving towards more resilient orchard systems. These systems make room for varieties that show resistance or tolerance of bio-aggressors and are exploiting spatial inter- and intra-specific biodiversity (market garden orchard, or multi-specific orchard).

Precision agriculture to save resources and preserve the environment

For arboricultural practices, the time has come for the emergence of better reasoned and sized practices (e.g., adapting the volume of spray to the leaf surface deployed), which can be modulated within the framework of the plot, saving on inputs and energy, and thus bringing apple production into preci-



■ Figure 12. Multi-leader apple tree trial in France, established according to the Double Guyot training system (©CTIFL).

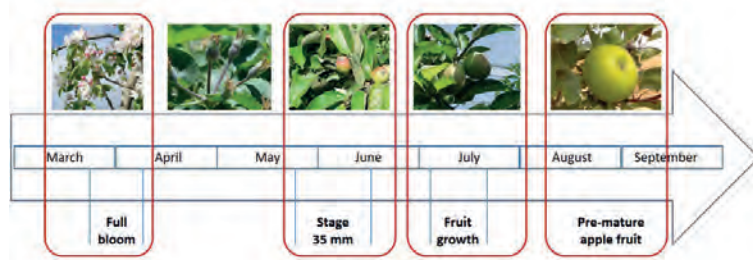
sion agriculture. One of the major French apple production groups (Blue Whale) has launched a project based on advances in precision imaging in the orchard to assist in decision-making. Based on four key periods for yield development (Figure 13), the current experiment consists of using mapped information at the plot level to help and/or adjust the farmer's decisions regarding thinning on blossoms or young fruit (end of March and June) as well as forecasting and preparing the harvest site (end of summer to fall). Beyond the "orchard edge", French apple professionals wanted to assess their contribution to climate change, to minimize the negative impacts of production. Thus, as part of a framework program (Green Go) supported by ADEME (www.ademe.fr/en), various major players in the apple sector have committed to a two-year program (Peren, 2021-22) that aims to improve the environmental performance of the apple chain. This program, co-piloted by the ANPP, and concerning table apples and apple sauce, covers the orchard production, upstream, and the postharvest stages of the fruit from the fruit station to the consumer, downstream. A previous study has shown that the postharvest steps (including the movement of consumers to the shops) can account for more than 70% of greenhouse gas emissions. The environmental performance of apples is included at the production stage, with the Eco-friendly orchards charter aiming for de-carbonized production by 2024. The Peren project allows to deepen the results of a previous project on the impacts of agricultural and food products (Agribalyse), which led to the development of life cycle assessment tools (Means-InOut). The Peren project provides an inventory of the major types of orchards and postharvest chains and proposes to identify the priorities to work on, in a multi-criteria approach, to improve the environmental performance of apple. Different action levers must be evaluated at the orchard stage in terms of eco-design and carbon footprint (e.g., impact of disease-resistant varieties, fertilization management, reduction of the number of tractor and other machinery pass-

es, and management of orchard biomass at the end of the cycle) but also at the packing station and in the supply chain. The technical and economic feasibility of the actions will be evaluated through multi-stakeholder workshops.

A dynamic fruit sector raising questions to better meet the challenge of sustainability

The sustainability of the apple sector is based on inseparable economic, social, and environmental pillars. At the economic level, the strong organization of the profession allows the sharing of the major challenges that it faces to prepare the campaigns and to implement performance strategies. The dynamic collective animation and the work in project groups aim to answer the economic challenges and technical stakes of the sector. Among the concerns of the moment, the attention of the professionals is focused on the evolutions of the distribution, the necessary control of the production costs despite the increase of energy

prices (mechanical interventions, storage, transport), the very strict French regulation on packaging and use of stickers, and the behavior of a consumer marked by a search for ethics and ecology, still remaining sensitive to the price. The producers committed to the Eco-friendly orchards demonstrate their willingness to communicate with consumers, explaining their objectives and their production methods during "open orchard" actions allowing for transparent exchanges (Figure 14). Even if this communication mode seems to answer the search for a healthy and local product, the ambition of apple production in France continues to be access to the national and export markets. Technical choices in production are made according to commercial positioning. A dominant trend is towards an intensive and high-yielding orchard, physically protected against hazards, designed to meet the challenges of international competition and low production costs. Its optimization is based on consistency between the parameters of initial design and increasing mecha-



■ Figure 13. Annual cycle of the apple orchard showing four key periods for geo-localized image acquisition (visible or laser scanner) whose rapid interpretation is the basis for decision support for a cultural intervention and its modulation according to the maps obtained (©Blue Whale).



■ Figure 14. Meeting between an apple producer committed to the Eco-friendly orchard charter and the public, during recent "open orchard" days (©ANPP).

nized management, seeking to compensate for the scarcity of labor, and offering an economically viable solution to increasing hourly labor costs. In contrast, more extensive orchard models are emerging, demonstrating a search for resilience. Based on new production paradigms, some of them are tested as prototypes (e.g., agroforestry orchard, or market garden orchard), giving a large place for interspecific diversity, ensuring natural pest regulation, thus minimizing the need for phytosanitary protection. In these orchards, economic profitability depends on a parsimonious use of resources (fertilizers, water, energy) and a better value for fruits pertaining to a mode of production explicitly agro-ecological, targeted on a qualitative niche, in short circuit. Meanwhile, agri-voltaic systems for carbon-neutral apple orchards are also being tested. Equipped with pivoting panels, these systems aim at offering a shelter mitigating the effects of summer heat waves, increasing the climate resilience, whereas ensuring a sustainable production of apples and a generation of solar power.

It should be noted that the distribution is likely to reference apples issued from one or the other production model, allowing a strongly segmented offer for this fruit. The choices of the fruit growers must, in any case, be in accordance with the production methods and the commercial targets.

Indeed, the different choices when creating the orchard are multi-faceted, and raise the question of varietal choice for the future. For fruit type, in addition to bicolor apples, the emergence of new high quality varieties with yellow skin (e.g., ‘Rubis Gold’®, ‘Opal’®) should diversify an offer mainly occupied by ‘Golden’ in this segment. Market niches are also possible for breakthrough innovations: red-fleshed apples or snack size apples adapted to nomadic consumption (e.g., ‘Rockit’®). Tolerance to biotic stresses is a strong trend (for example durable scab resistance to scab undertaken by INRAE), interesting for both conventional and organic production, which precedes the search for varieties that will be less sensitive to climatic hazards, showing good phenotypic plasticity, in a climate context marked by uncertainty. At the genetic level, traits of tree architecture, light interception efficiency, and response to abiotic stresses are largely independent. These traits are susceptible to recombination through selection (Coupel-Ledru et al., 2022). Among the current varietal issues, the evaluation of the efficient resource use is imperative. Will it be possible to select apple varieties for water-use and/or nitrogen-use efficiencies in the future? Already, increased attention is being paid to the “services” provided by orchards, not only in terms of agricultural production and employment, but also in

terms of ecosystem services and landscape (Bopp et al., 2019).

Finally, it should be emphasized that solving the numerous technical questions posed by apple production will require, more than ever, the support of multidisciplinary research and development efforts, which may fall under public/private partnerships, such as those established in France. Thus, GIS Fruits, created in 2012 and led by INRAE, brings together 22 partner institutions in the sector, including applied research (e.g., CTIFL), higher education and professional organization. GIS Fruits works on the priority themes of the fruit sector, allowing the emergence of new research questions. It stimulates collaboration and the emergence of projects between French partners, accompanies innovations and the agroecological transition. It supports the writing of syntheses on fruits (e.g., Legave, 2022, on climate change), helps to disseminate results of R&D projects, and contributes to enlighten public decisions.

Following the example of this national collaboration between partners, international scientific meetings, such as IHC2022 (www.ihc2022.org), with its various thematic symposia, will be able to facilitate the emergence of projects and international and interdisciplinary collaborations contributing to the sustainability of fruit production, and, in particular, that of the apple. ●

> About the authors



> Jean-Luc Regnard

Jean-Luc Regnard, Agronomist (PhD), Professor Emeritus at Institut Agro Montpellier, is a researcher at Agap Institute Research Unit, Montpellier University, France (<https://umr-agap.cirad.fr/en>), and member of the IHC2022 Educational Committee. As an eco-physiologist of fruit species, he is particularly interested in varietal response to climate change and innovative phenotyping approaches. E-mail: jean-luc.regnard@supagro.fr



> Claude Coureau

Claude Coureau, Agronomist, is responsible for apples and pears at CTIFL La Morinière Experimental Station (St Epain, France). She is the reference person for these products, especially in their pre- and post-harvest stages. E-mail: claudc.coureau@ctifl.fr



> Vincent Mathieu

Vincent Mathieu, Agronomist, is in charge of the apple programs at CTIFL Balandran Experimental Center (Bellegarde, France), and particularly committed in new varieties assessment and fruit thinning strategies. E-mail: vincent.mathieu@cofruidoc.fr



> Benjamin Gandubert

Benjamin Gandubert is in charge of the organic orchard at CTIFL La Morinière Experimental Station (St Epain, France). E-mail: benjamin.gandubert@ctifl.fr



> Jennyfer Lussan

Jennyfer Lussan, Agronomist, is part of technical department of Blue Whale SAS (Montauban, France) and is involved in precision orcharding. With a passion for agriculture, she is president of the association Parlons Ferme. E-mail: Jennyfer@blue-whale.com



> Frédéric Aubert

Frédéric Aubert is administrator (management staff) and manager of the technical department of Blue Whale SAS (Montauban, France), the first orchard in France. He is also an apple and kiwifruit grower in Lot-et-Garonne. E-mail: frederic@blue-whale.com



> Xavier Le Clanche

Xavier Le Clanche, Agronomist, is the technical manager of the Eco-friendly orchards charter for the French Apple and Pear Association (ANPP, Paris, France). He supervises the external controls, ensures the evolution of the specifications as well as a regulatory watch. E-mail: x.le-clanche@pommespoires.fr



> Sandrine Gaborieau

Sandrine Gaborieau, Marketing and Communication Manager, French Apple and Pear Association (ANPP, Toulouse, France), is more particularly involved in the promotion of Eco-friendly orchards. E-mail: s.gaborieau@pommespoires.fr



> Vincent Guérin

Vincent Guérin, Head of Economic affairs of the French Apple and Pear Association (ANPP, Beaucauzé, France), is particularly involved in market analysis. E-mail: v.guerin@pommespoires.fr



> François Laurens

François Laurens, Agronomist (PhD), INRAE, Research Institute on Horticulture and Seeds (IRHS, Angers, France), chairs the IHC2022 Executive Committee. As a geneticist, he has bred disease resistant apple varieties. He has led many international research projects (FP7 Fruit Breedomics, Climate-Kic Friendly fruit, H2020 Invite) and he co-leads the French Fruits Scientific Interest Group (www.gis-fruits.org). E-mail: francois.laurens@inrae.fr

References

- Bopp, M.C., et al. (2019). Rapport sur les services rendus par les cultures fruitières (GIS fruits), pp.40 (in French). www.gis-fruits.org/GROUPES-thematiques/Approche-syste-me/Rapport-Services-rendus-par-les-cul-tures-fruitieres
- Cavard-Vibert, P. (2020). Baromètre de la consommation des pommes en 2019. Image, usages. Rapport d'étude CTIFL, pp.95 (in French). www.ctifl.fr/Pages/Kiosque/DetailsOuvrage.aspx?idTheme=1&idouvrage=3960
- Collective. (2021). Variétés de pommes: 30 ans d'évolution et d'évaluation. Bilans et perspectives (in French). www.ctifl.fr/Pages/Agenda/DetailsEvenement.aspx?id=594
- Coupeledru, A., Pallas, B., Delalande, M., Segura, S., Guitton, B., Muranty, H., Durel, C.-E., Regnard, J.-L., and Costes, E. (2022). Tree architecture, light interception and water use related traits are controlled by different genomic regions in an apple tree core collection. *New Phytol* 234, 209–226. <https://doi.org/10.1111/nph.17960>
- FranceAgriMer. (2020). Les chiffres clés de la filière fruits et légumes frais et transformés en 2019 (in French). www.franceagrimer.fr/Eclairer/Etudes-et-Analyses/Chiffres-et-bilans (published December 2020).
- FranceAgriMer. (2021a). Achat de fruits et légumes frais par les ménages français pour leur consommation à domicile, données 2020 (in French). www.franceagrimer.fr/Eclairer/Etudes-et-Analyses/Chiffres-et-bilans (published March 23, 2021).
- FranceAgriMer. (2021b). Analyse de la compétitivité sur le marché international de la pomme en 2020 (données 2019) (in French). www.franceagrimer.fr/Eclairer/Etudes-et-Analyses/Etudes-et-syntheses (published July 23, 2021).
- Laget, E., et al. (2015). Guide pour la Conception de Systèmes de Production Fruitière Économes en Produits Phytopharmaceutiques (Paris: GIS Fruits et Ministère de l'Agriculture), pp.264 (in French). www.gis-fruits.org/Actions-du-GIS/Guide-Ecophyto
- Laurens, F., Aranzana, M.J., Arus, P., Bassi, D., Bink, M., Bonany, J., Caprera, A., Corelli-Grappadelli, L., Costes, E., Durel, C.-E., et al. (2018). An integrated approach for increasing breeding efficiency in apple and peach in Europe. *Horticulture Research* 5, 11. <https://doi.org/10.1038/s41438-018-0016-3>
- Lauri, P.-E., and Simon, S. (2019). Advances and challenges in sustainable apple cultivation. In *Achieving Sustainable Cultivation of Temperate Zone Tree Fruits and Berries*. Volume 2: Case Studies, G.A. Lang, ed. (Cambridge, UK: Burleigh Dodds Science Publishing).
- Lauri, P.-E., Willaume, M., Larrive, G., and Lespinasse, J.-M. (2004). The concept of centrifugal training in apple aimed at optimizing the relationship between growth and fruiting. *Acta Hort.* 636, 35–42. <https://doi.org/10.17660/ActaHortic.2004.636.3>
- Legave, J.-M., coord. (2022). Les Productions Fruitières à l'Heure du Changement Climatique: Risques et Opportunités en Régions Tempérées (Versailles, France: Quae), pp.464. ISBN: 978-2-7592-3251-2.
- Masseron, A. (2002). Pommier, Le Mur Fruitier (Paris, France: CTIFL), pp.112. ISBN: 2-87911-183-8.
- Roche, L. (2020). Pommiers, premiers résultats, le verger de demain. Paper presented at: Conférence 2 janvier 2020 (St Rémy-de-Provence: CTIFL). www.agrireseau.net/documents/101670/pommier-premier-resultats-le-verger-de-demain



© A.Lamoureux

Prepare your stay in France now



IHC 2022
31ST INTERNATIONAL HORTICULTURAL CONGRESS



14–20 AUGUST 2022
CONGRESS CENTRE
ANGERS–FRANCE

HORTICULTURE FOR A WORLD IN TRANSITION

EARLY BIRDS REGISTRATION ENDS
MARCH 30 2022

UNDER THE AUSPICES



www.ihc2022.org



#IHC2022

> Rose selection in France: a long and beautiful history

Jérémy Clotault, Fabrice Foucher, Agnès Grapin,
Laurence Hibrand-Saint Oyant, Valéry Malécot, Sophie Paillard,
Alix Pernet, Vanessa Soufflet-Freslon and Cristiana Oghina-Pavie

Introduction

A multitude of species provide ornamental plants for the embellishment of public spaces, gardens, balconies and homes and for the production of cut flowers. The genus *Rosa*, due to its popularity, history, and incredible diversity of traits (from flower shape, colour, scent, to architecture) is considered as the “queen of the flowers.” Its diversity of usage (cut flower, miniature indoor pot plant, garden shrub, climbing plant, but also perfume and some culinary tradition) can explain its high economic value which has earned it the title of the world’s favourite flower.

The genus *Rosa*, comprised of 150-200 species (Wisseman and Ritz, 2007) well distributed circumpolar boreal, presents a complex evolutionary history. At least 30,000 cultivars have been listed (Roberts et al., 2003), and many of them have a French origin (Figure 1). In France, the rose industry involves many actors, including private (breeders, producers) and public (research teams and horticultural technical institutes) entities.

The rose in France

Indigenous French species

Slightly less than 20 wild *Rosa* species are endemic in France, with the addition of the highly complex *Rosa canina* aggregate in which taxon delimitation is particularly complex. These species belong to subgenus *Rosa*, and are grouped predominantly in section *Caninae*, though some are members of sections *Rosa* or *Gallicanae*. A few ornamental taxa have escaped from cultivation, particularly *Rosa banksiae* W.T.Aiton and *Rosa rugosa* Thunb., and the most characteristic species is *Rosa gallica* L., protected at the national level but also source of numerous cultivars and old cultivated hybrids.

Roses are probably more numerous in France as a result of human practices.

Consumption

Roses are by far the leading ornamental product in France. More than half of the money spent on cut flowers by the French is for roses (€376.3 million in 2018). It is the leading flower for Mother’s Day, Valentine’s Day, as well as for Christmas. The rose is also the



■ Figure 1. A) ‘Aimée Vibert’ (1824, Vibert), B) ‘Belvédère’ (1829, Jacques), C) ‘Safrano’ (1839, Beauregard), D) ‘Triomphe de l’Exposition’ (1855, Margottin), E) ‘La France’ (1867, Guillot), F) ‘Etoile Luisante’ (1918, Turbat), G) ‘Raymond Privat’ (1935, Privat), H) ‘Papa Meilland’ (MElcesar, 1963, Meilland), I) ‘Paul Bocuse’ (MASpaujeu, 1997, Massad), J) ‘Red intuition’ (DELstiro, 1999, Delbard), K) ‘Brocéliande’ (ADAterhuit 2000, Adam), L) ‘Jardin de Grandville’ (EVanrat, 2010, André Eve) (Credit: 1A) Cristiana Oghina-Pavie, UA, 1B-L) Agnès Grapin, Institut Agro).

leading plant purchased for gardens, with a value of €50.2 million in 2018. This represents almost 5 million rosebushes bought by private individuals, to which must be added

roses for landscaping by local authorities (around 2 million). Miniature roses are in the top 3 of the indoor plants (2.8 million pots for €23.2 million) (<https://www.valhor.fr/>)

etudes-statistiques/etudes-de-marche-et-dopinion/infographies-vegetaux/). These demands are insufficiently covered by the French production. Actually, the balance of trade is strongly in deficit: approximately -€122 million for cut flowers and -€10 million for rose plants per year these three last years (<https://comtrade.un.org/data/>).

Production

The production of garden roses dominates and represents approximately 800 ha in France, with a large area of production in Doué-en-Anjou, close to Angers (Box 1). Cut flower production, estimated at 190 million stems in 2007, is essentially concentrated on the Mediterranean coast. The French Interprofession of ornamental horticulture, floristry and landscaping (Val'Hor) is a professional organisation, recognised by the

French State, uniting all the companies in the ornamental sector. It allows the financing of collective actions that contribute to the dynamism of the sector. In 2015, the 'Label Rouge' approach (guaranteeing a higher level of quality than that of other comparable products) was introduced for sale of rosebushes. About fifty cultivars are deemed eligible for the label. The introduction of the 'Fleurs de France' label in 2017 makes it possible to certify the origin and the eco-responsible process of production, responding to the development of a 'slow flower' movement. The production of rose in France would be incomplete without at least mentioning the cultivation of *Rosa × centifolia* for luxury perfumery, which is part of the skills related to perfume in the Pays de Grasse (Côte d'Azur), recognised as Intangible Cultural Heritage of Humanity by Unesco.

Selection

Rose breeding is particularly dynamic in France. Currently, some 20 breeders/creation companies are listed (https://societe-francaisedesroses.asso.fr/fr/filiere_roses/obteneurs.htm), with diverse profiles. Some of them are direct (Ducher) or indirect successors (via takeovers, e.g., Guillot with Sirphe company) from rose-growing families of the 19th or early 20th century (Box 2). Others, already well-known, have obtained their first creations over the last 30 years (Adam, Félix, Lebrun, for example). Rose plant breeding activities can be partially monitored by studying the number of Plant Variety Right (PVR) applications present in the CPVO Variety Finder database (Community Plant Variety Office, headquarters in Angers, France). Since 2001, an average of 20 French PVR has been registered for *Rosa* sp. per year,

Box 1. Production in Doué-en-Anjou, a production basin of garden roses for more than two centuries

Doué-en-Anjou (between Angers and Saumur) is the leader in France. In 2011, about 80 producers (500 ha) produced nearly 5 million rosebushes per year corresponding to around 15% of the European garden rose production. The Doué production benefits from a local terroir and a particular know-how in the grafted roses production on *Rosa multiflora* and on *Rosa* 'Laxa' rootstocks. The quality of the roses grown in the region is particularly adapted for the production of garden roses in pots. The varietal choice approaches the thousands of different varieties grown in the region. Research into new varieties and new cultivation techniques is ongoing to adapt to new market requirements: naturally resistant varieties grown with respect to the environment. In 2018, a collective of seven rose producers (Bardet, Bon Temps, Chastel, Harpin, La Saulaie, Leroi and Oriot) created the publishing company 'Select Roses SAS' to ensure the promotion of varieties of roses that will be exclusive 'Douessines'.



► Christophe Travers, manager of Les Pépinières de la Saulaie, receiving the participants of the VII International Symposium on Rose Research and Cultivation in 2017 (credit A. Grapin).



► Producers words: "I have been managing Chastel Nurseries since 2015. I am committed to modernising the company's production while maintaining the quality that has made its reputation for nearly 30 years. At Chastel Nurseries, we grow more than 600 varieties and maintain an expertise in the production of stem and weeping roses. Everything is done to ensure quality production from the best varieties, with an adapted cultivation itinerary that is constantly evolving to reduce our environmental impact." Jean-Loup Pohn, www.pepinieres-chastel.com (credit Chastel Nursery).

Box 2. Two well-known rose breeding companies in France

PÉPINIÈRES ET ROSERAIES
Georges Delbard

Malicorne, in the centre of France, is the location where the rose varieties are created by Georges Delbard nursery. Each year, more than 30,000 flowers are manually pollinated between April and June to create a total of 80,000 new genotypes of roses for cut flowers and 60,000 for garden roses. This is followed by a period of 8 to 10 years during which the roses will be carefully observed in different soil and climatic conditions and selected to result in a dozen varieties that will be marketed. Since 1935, Georges Delbard company is at the origin of many successful varieties. Some of them have won national and international awards, such as Château de Cheverny® Deljaupar, winner of the SNHF Grand Prix for roses in all categories in 2017 and elected 'Rose of the year 2021' by the prestigious Royal Horticulture Society. As part of its ongoing drive for innovation and continuous improvement, Georges Delbard company maintains a close relationship with public research. In particular, by collaborating on research projects, the company aims to achieve more sustainable management of pathogens (Robio project) or to gain precision in its varietal innovation programme by using modern molecular marker technologies with the scientific support of INRAE.



› Château de Cheverny® Deljaupar, 2014 (credit: Georges Delbard Pépinières et Roseraies).



› Arnauld Delbard, founder's grandson (credit: Georges Delbard Pépinières et Roseraies).



MEILLAND
JARDIN & PARFUM

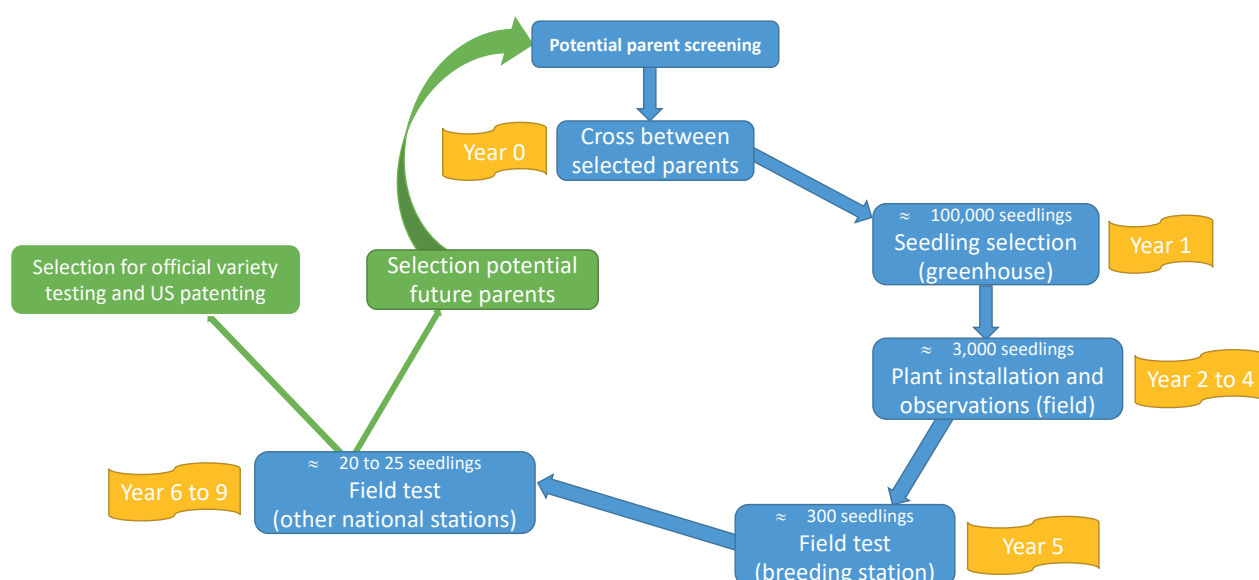
The rose is the emblematic flower of the Meilland Group. For six generations, they have been working with passion on colours, fragrances, shapes, resistance, etc., to make the rose ever more seductive. In the center in Le Cannet des Maures (France), research teams elaborate every year breeding programmes to improve the qualities of varieties. They rely on a long experience, a great expertise and an exceptional pool of genitors. Each year, between April and the end of July, 20,000 to 30,000 flowers are manually fertilised corresponding to 2,000 and 2,500 crosses. The harvested fruits allow to obtain about 150,000 to 200,000 seedlings. The plants obtained are then tested in about 15 test stations, in different climatic conditions. In the end, only ten or so varieties are marketed: an extremely demanding process that is rewarded by the fact that Meilland creations win prestigious prizes in international competitions every year. In order to value and secure investments in research, and thus continue to innovate, they take care to protect their creations. Meilland's varieties are the subject of patents, Plant Variety Certificates and trademarks to ensure their promotion in more than 40 countries. To date, Meilland holds more than 1,000 protection titles and a portfolio of 500 trademarks.



› 'Line Renaud' MEIclusif, 2005 (credit: Meilland Roses & Creation).



› Selection meeting in a test field in 2019 (credit: Meilland Roses & Creation).



■ Figure 2. Garden rose breeding scheme (French breeder recommendations).

representing 15% of the world's PVR of CPVO. France is thus the fourth leading breeder country, after the Netherlands, Germany and Denmark, with a very strong specialisation in garden rose breeding (Widehem and Plottu, 2020).

Rose breeding is a long process that can require as much as ten years (usually between 8 to 9 years) from the first hybridisation to the commercialisation of a new variety (Figure 2). Rose breeding programmes are divided into two phases: 1) selection among a large number of seedlings in the greenhouse during the first two years, and 2) performance testing and selection in the field for garden roses from the third year on. During the first year, breeders select against weak growth, for innovative traits that are not found in the released varieties, and for floral traits like colour attractiveness and longevity, wilted flowers that do fall properly and bloom shape (Zlesak et al., 2017). In

the following years, the breeders focus on floral traits, plant development and adaptability, disease and pest resistance, tolerance to diverse abiotic stresses and multiplication capacity. Today, breeding for garden roses is mainly focused on pest resistant plants. Black spot is a major pest causing foliage damages thus reducing the aesthetics of the plant (Leus et al., 2018).

Wild endemic genetic resources of roses are preserved in France by "Conservatoires botaniques nationaux" (i.e., national botanic conservatories). Varieties are preserved by public or private rose gardens, as Roseraie du Val de Marne in l'Haÿ-les-Roses near Paris, Roseraie Loubert in Gennes-Val de Loire, 30 km far from Angers, Roseraie du parc floral de la Beaujoire in Nantes, and Roseraie du jardin botanique de la ville de Lyon. Scientific resources like families for QTL mapping, and DNA of all types of accessions (wild, cultivated, scientific) are preserved by the BRC "Pip

fruit and roses" described by Roux-Cuvelier et al. (2021).

Rose gardens, in addition to preserve patrimonial genetic resources, also participate to the breeding process by organising competitions between new selections proposed by the breeders. Each competition has its own specificities. Competitions may be distinguished according to the number of locations where they take place and according to the season of the main rating. One-site competitions are organised by the rose gardens of Paris (Bagatelle, Figure 3), Lyon, Nantes and Orléans. In all cases, plants are rated by a specialised commission at different times over two years. The first three towns organise in June the final rating by a grand jury (Bagatelle and Lyon) or by a jury of perfumers (Nantes). Orléans invites in September a grand jury for the final rating, as a consequence, this competition especially distinguishes reblooming varieties. A multisite competition is organised by SNHF (Société Nationale d'Horticulture de France). New rose accessions are planted in seven different rose gardens throughout France, reflecting different types of climatic conditions. Only new varieties commercialised for less than five years may be presented by the breeders. Plants are rated during all seasons over the course of two years by specialists.

Research on rose genetics and selection in Angers

In France, many public and private players are working on research and development as in Lyon (on genomics and flower development) and in Saint-Etienne (on the metabolic pathways controlling scent production), as well as in Strasbourg with the experimental garden of the Erlén in Colmar. Angers is home to several of them.



■ Figure 3. Bagatelle (Paris) in June 2021 during the Concours International de Roses Nouvelles. It is the oldest international rose competition, first edition being in 1907 (credit Tatiana Thouroude, INRAE).

For 20 years, the Research Institute of Horticulture and Seeds (IRHS) (<https://www6.angers-nantes.inrae.fr/irhs>) has developed with the GDO team (Genetics and Diversity of Ornamentals) a genetic project to study the impacts of evolutionary history, natural selection and human activities on *Rosa* diversity and to understand genetic determinism of traits of interest.

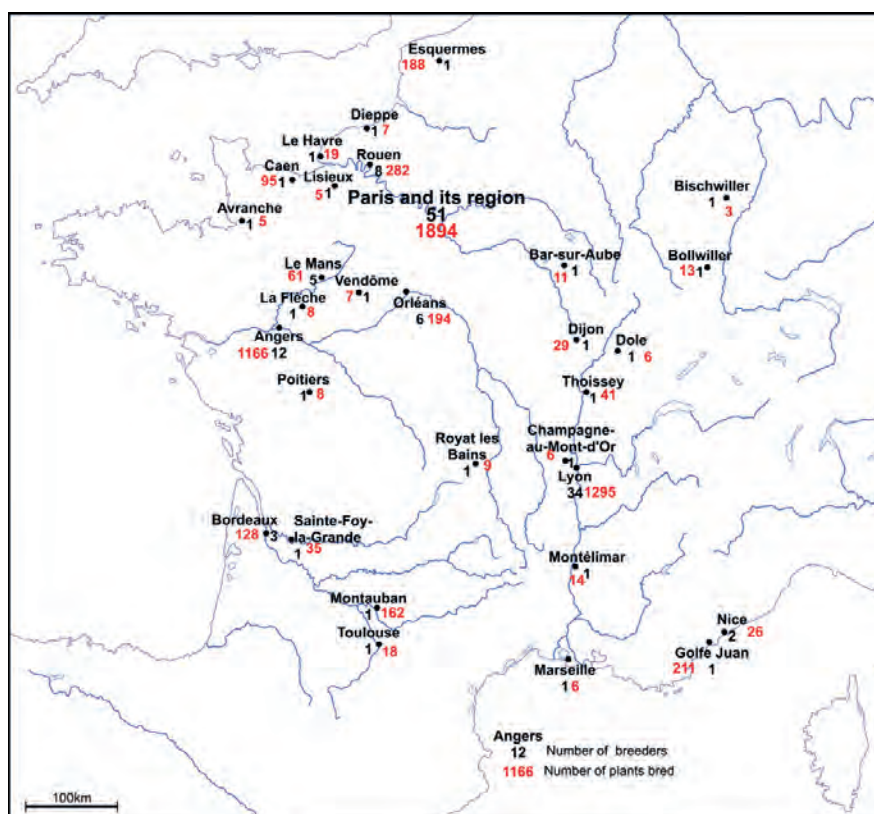
The genus *Rosa*: a complex genus for systematists and geneticists

The genus *Rosa* has more than 150 described species. Among these 150 species, about ten would have contributed to the cultivated roses that we find in our gardens or at our florists. Due to complex genetic processes (polyploidisation and interspecific hybridisation), the evolutionary history of the genus *Rosa* is still very poorly known. Using a phylogenomic approach and a step-by-step method, we were able to reconstruct a robust nuclear and plastid phylogeny of the genus, and to highlight interspecific hybridisation events and polyploidisation that generate its current diversity. We have thus resolved most of the evolutionary relationships between subgenera, sections and some species of the genus *Rosa*. For some species, such as *R. gallica*, *R. × damascena* or *R. canina*, we have proposed hybridisation scenarios using large genomic data (Debray et al., 2021)

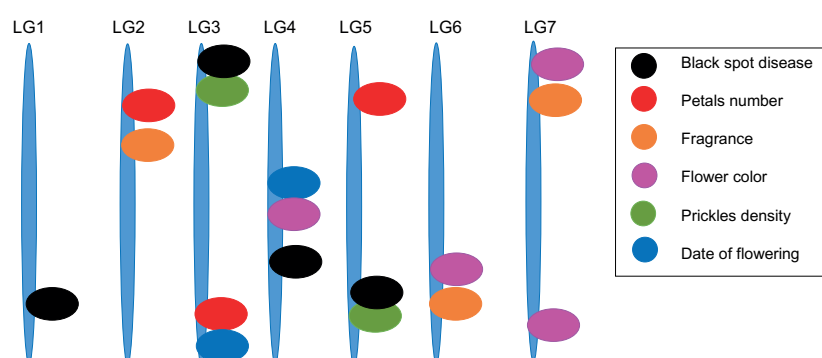
Historically, roses from the *Gallicanae* section were cultivated mainly for their therapeutic interests, in areas such as Provins, near Paris. Diversification of the *Rosa gallica* varieties increasingly developed in the first half of the 19th century and led to numerous varieties well phenotypically and genetically separated from wild accessions of French populations (see section below on rose selection during the 19th century). Questions regarding the origin of these French wild populations and more generally on the genesis (this is a putative allotetraploid) and diversity of the *Rosa gallica* species, as well as on the evolution of the relationship between the wild and the cultivated compartments through breeders' work are under investigation with C. Pawula PhD thesis (2020-2023).

Rose diversity and selection: a multidisciplinary approach

This history of rose breeding in France in the 19th century has been widely documented during the time of its protagonists (monographs, catalogues, etc.). Many roses obtained during this period are still preserved in rose gardens. This twofold observation is the starting point for the interdisciplinary approach that unites historians (TEMOS, <https://temos.cnrs.fr/>) and biologists (IRHS/GDO) to study together the creation of rose varieties over time. This began with the



■ Figure 4. Geographical distribution of breeders (in black) / number of varieties (in red) in France during the 19th century, according to Léon Simon and Pierre Cochet (1906). Cartography by Aurélie Hess.



■ Figure 5. Schematic representation of the seven rose linkage groups and the localisation of genes involved in major traits studied by the IRHS team.

FloRHiGe project (funded by the Pays de la Loire French Region) dedicated to the 19th century in France. Although roses have been cultivated since Antiquity, a strong interest in their diversification only emerged around 1800. The famous collection of roses gathered by Joséphine de Beauharnais in Malmaison in 1804-1815 (Joyaux, 2005), as well as gardening treatises, botanical writings and illustrated monographs, including the luxurious edition of *Les Roses* by Redouté and Thory (1817-1824), have fostered a new perception of the diversity of the genus *Rosa* and its horticultural potential. The popularity of roses quickly went beyond the elite's taste

for collecting plants and turned into a broad economic and cultural phenomenon: French rosomania. Initially supported by the Dutch nurserymen, rose breeding took on an unrivalled breadth in France throughout the 19th century. French breeders did not have a "type profile". The most renowned were nurserymen (Descemet, Vibert (Box 3), Jacques, Noisette, Laffay, Verdier, Schwartz, Pernet-Ducher, Guillot) or head gardeners (Hardy), but many successful varieties were due to amateurs: landowners, lawyers, retired officers, etc. The connoisseurs, both breeders and judges of novelties in horticultural shows, formed an almost exclusively male society.

Box 3. Jean-Pierre Vibert, a French breeder in the 19th century

Jean-Pierre Vibert (1777-1866) was the first French nurseryman specialised in the exclusive cultivation of roses. Former soldier in the Napoleonic army and hardware merchant (Joyaux, 2001), he acquired in 1814 and 1815 a part of Jacques-Louis Descemet's collection, consisting of 250 different kinds of roses and 10,000 seedlings. Vibert became a skilled and successful rose grower and the most prolific rose breeder, with more than 500 varieties bred and named by him, despite the misfortunes caused by the infestation of his collection by cockchafer grubs, which forced him to move his nursery in several locations near Paris. In 1839, he moved to Angers, before handing over his nursery to his head gardener, Robert, in 1851. Vibert also managed to describe his observations and practice as a breeder in some of the most informative pages of the rich literature on roses in the 19th century.

Vibert's words

"Oh, how happy was the one who first, having incidentally or intentionally placed seeds into soil, realised that nature could still vary and improve its production; but how much time one must have employed to achieve from this discovery some results less uncertain than those which mere chance would allow him! Modern worldly men, for whom the expectation of a dinner can occupy eight whole days, who only avoid boredom in the midst of the whirlwind of the great world, no, you will never conceive of such enjoyments, never will you believe that such simple pleasures can be bought by years of assiduous care. Too fortunate still if, as a price for such sustained zeal, nature does not refuse our efforts the only reward we seek! At the sight of so many marvels, how many ideas come to mind! What an astonishing spectacle offer to the good observer all these games, these variations of nature and this inexhaustible fecundity, provoked by industry, the limits of which cannot be assigned!" (our translation from Vibert, 1824).



► 'Aimée Vibert' bred by Jean-Pierre Vibert, 1828. Drawing by Annica Bricogne in Hippolyte Jamain, Eugène Forney, *Les Roses. Histoire, culture, description*, Rothschild, Paris, 1873, pl. 59, Bibliothèque Nationale de France- Gallica.

Few women-breeders received a real recognition for their merit. They were widows who ran horticultural establishments after the death of their husbands, like Marie Ducher and Marie-Louise Schwartz. The geographical distribution of French breeders (Figure 4) has evolved during the 19th century. Paris and its region constantly concentrate a high number of breeders. The North was a more active area in the first half of the century, while the South only became so after 1860. Angers was already an important centre in the 1820s, still active but surpassed by Lyon in the second half of the century.

The FlorHiGe project also highlighted the changes in horticulturists' aims and practices over the century and the path towards the quest for novelty by obtaining new rose varieties. The increase in the technical mastery of the practice of hybridisation (from hazard seedlings in the 1800s to controlled hybridisations at the end of the century) and, above all, the use of new genetic resources with innovative traits have resulted in major modifications to the phenotype of roses and

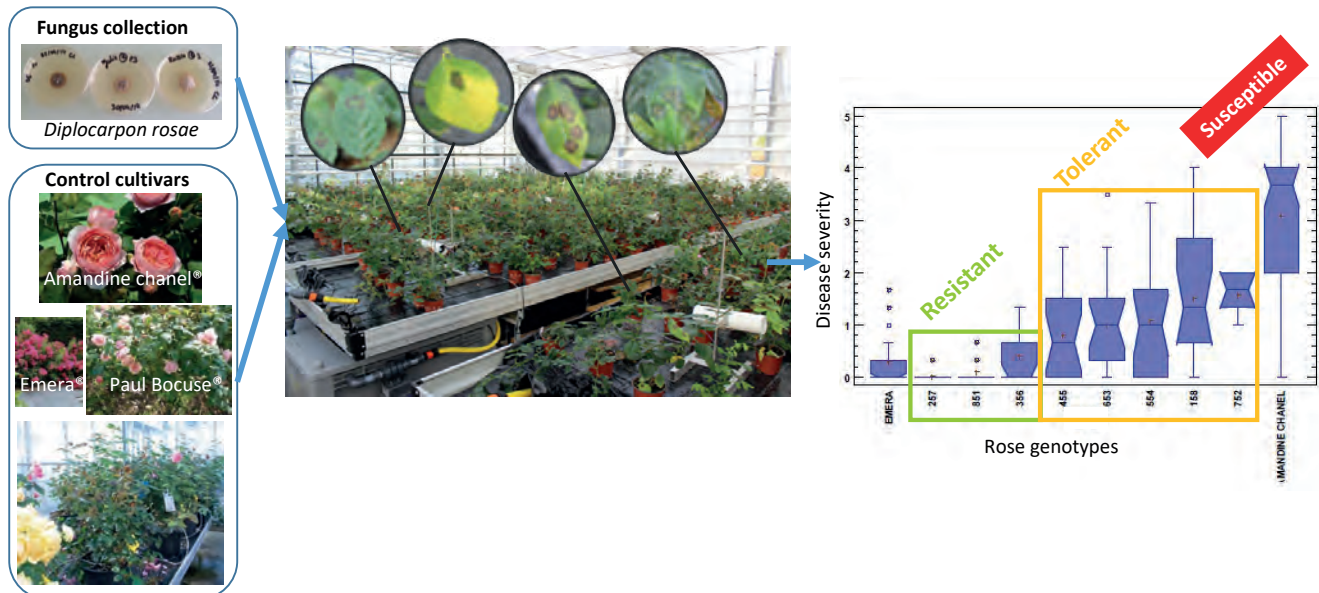
a profound change in their genotypes. It has been shown that the genetic background of European hybrid roses has gradually shifted from a genetic background close to that of ancient European roses (Gallic, Damask) to a genetic background close to that of Chinese roses, which notably gave the modern rose its perpetual blooming (Liorzou et al., 2016). Another experience of interdisciplinarity allowed the development with mathematicians from LAREMA of an approach to reconstruct pedigrees, in the context of roses with variable ploidy levels (Proia et al., 2019), during the PedRo project, conducted in the framework of the regional programme "Objectif Végétal, Research, Education and Innovation in Pays de la Loire".

RosesMonde, a recent interdisciplinary project (geography, history, sociology, economics, biology), funded by the French National Research Agency, has enabled us to broaden our understanding of the history of rose breeding and, more broadly, of the world of the rose, for the contemporary period of the 20th and 21st centuries. In addition to rose cul-

tivars, the study also focused on places and actors, in a context of market segmentation according to rose use, globalisation and standardisation of rose production and, more recently, heritage/patrimonial rose trend. The genetic work has led to an understanding of how segmentation by use and breeding time frame have structured the diversity of roses of this period.

Genetic determinism and French collaborations to understand rose black spot disease resistance

Using F₁ progeny and more recently a genome-wide association approach, several genetic studies were carried out to localise major genes and QTLs on the seven chromosomes of the rose genome, which are involved in the determinism of number of petals (Hibrand Saint-Oyant et al., 2018; Roman et al., 2015), seasonality of flowering (Iwata et al., 2012; Randoux et al., 2014; Soufflet-Freslon et al., 2021), flowering time (Kawamura et al., 2011, 2015; Roman et al., 2015), flower architecture (Kawamura et al.,



■ Figure 6. Whole plant assay in semi-controlled conditions (greenhouse) to assess the resistance of rose genotypes (Soufflet-Freslon et al., 2019; Marolleau et al., 2020).

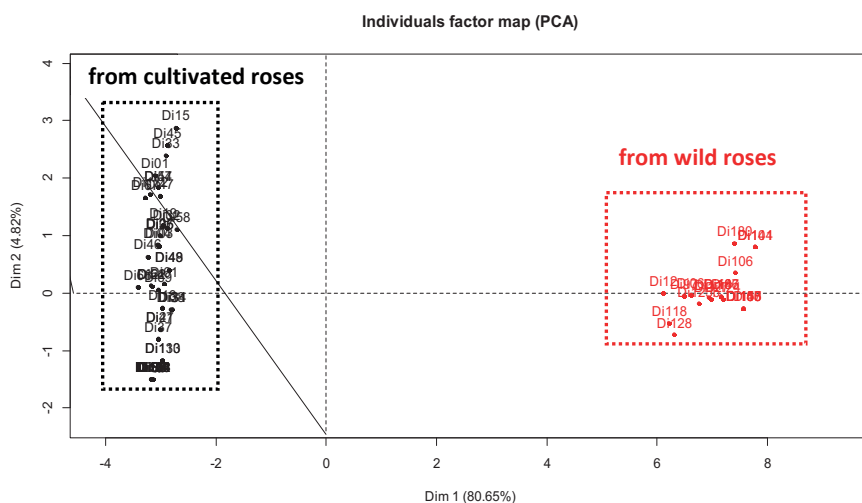
2011), plant architecture (Li-Marchetti et al., 2017), fragrance in collaboration with the university of St Etienne (S. Baudino team at the BvPAM) (Hibrand-Saint Oyant et al., 2019; Magnard et al., 2015; Sun et al., 2020), prickles (Zhou et al., 2020) and black spot disease resistance (Lopez Arias et al., 2020) (Figure 5). Moreover, the IRHS team coordinated a large international effort to obtain the first rose genome sequence of *Rosa chinensis* 'Old blush' (Hibrand Saint-Oyant et al., 2018), a strategic resource that will accelerate genetic research (identification of new genes, study of genome evolution). For several years, rose breeders have considered disease resistance to be one of the major traits that requires improvement in new cultivars. The need for resistant cultivars is strengthened by the need to reduce chemicals in the environment (Ecophyto plan).

Many have been prohibited in France since 2017, for landscape professionals (towns, landscape architects, public forest, roads and highways) and since 2019, for home-gardeners (Labbé, 2014). Several collaborations between French breeders, French producers, Astredhor technical institute, Vegepolys Valley (<https://www.vegepolys-valley.eu/>), IRHS-GDO and IRHS-Ecofun research teams helped to develop knowledge on black spot disease, one of the most important diseases of garden roses during several successive projects frequently supported by the French Ministry for Agriculture and Food. The "Rosa fortissima" project (2011-2013) allowed an investigation on the genetic determinism of black spot disease on F_1 cross-populations in different environments and during several years. These data were

used during the PhD of D. Lopez-Arias (2017-2020) to localise QTLs (common or specific year or environment). Notably, a meta-analysis (Biomecator, <http://moulon.inrae.fr/logiciels/biomecator/>) revealed two meta-QTLs located on linkage groups 3 and 5 (Lopez Arias et al., 2020).

Another project ("Belarosa", 2015-2016) allowed the establishment of a greenhouse assay to characterise the resistance level of rose cultivars against black spot disease. This pathotest was first realised on a few rose cultivars, known to be susceptible or resistant, and then performed on new varieties under registration (Soufflet-Freslon et al., 2019; Marolleau et al., 2020) (Figure 6). This assay in semi-controlled conditions was compared to the behaviour of rose genotypes to disease in field, which showed a good correlation between the greenhouse and the field observations (Marolleau et al., 2020). A fungal collection project ("DIRO", 2014-2015) contributed to create a collection of 77 strains of *Diplocarpon rosae* (the fungus responsible for black spot disease), sampled from cultivated and wild roses mainly from Asia and Europe (Figure 7). Two of these strains were sequenced and allowed us to develop a microsatellite set to characterise the fungus genetic diversity (Marolleau et al., 2020) (Figure 6).

The studies on black spot disease continue with the PhD of L. Lambelin (2021-2024), which identified candidate genes and mechanisms for the resistance QTLs identified by D. Lopez-Arias during her PhD, and a current research project on the development of biocontrol products ("ROBIO", 2021-2024) and conducted in collaboration with French producers, breeders, Astredhor and Vegenov (<https://www.vegenov.com/>).



■ Figure 7. Genetic diversity of 77 strains of *Diplocarpon rosae* isolated from cultivated or wild rose species in Europe and Asia. ACP was carried out using the data obtained with 27 microsatellite markers (Soufflet-Freslon et al., 2019).

Conclusions

Some important issues in research cannot be addressed in the usual model plants (e.g., *Arabidopsis*). Rose is an interesting model to investigate ornamental traits (such as seasonality of blooming or floral scent), durable resistance to diseases in vegetatively propagated shrubs, and to explore plant evolution (human and natural selections) in the

framework of interdisciplinary approaches (as history and genetics).

The challenge regarding foliar diseases is to develop durable resistance by obtaining pathogen resistant plants to limit the use of pesticides and developing alternatives to these (as biocontrol products, genetic resistance). These projects aim to produce fundamental knowledge on the diversification of

rose genetic resources as well as on resources on plant-pathogen interactions, but also some operational knowledge for rose garden curators, producers, gardeners and breeders thanks to the strong collaborations with different actors of the rose sector (rose gardens, technical institute, producers and breeders).

> About the authors



> Jérémie Clotault

Jérémie Clotault is associate professor at the University of Angers, France. He works on the study of the evolutionary history and genetic diversity of roses and their genomes in the GDO team. E-mail: jeremy.clotault@univ-angers.fr



> Fabrice Foucher

Fabrice Foucher is director of research at INRAE, France. His research is focusing on genomics of blooming and resistance. He has recently coordinated an international consortium (9 teams) leading to the publication of a high-quality rose genome in *Nature Plants* and has a large expertise in coordinating multi-disciplinary projects. E-mail: fabrice.foucher@inrae.fr



> Agnès Grapin

Agnès Grapin is associate professor at the Institut Agro in Angers, France, and carries out her research activities at the IRHS in the GDO team. Her research interests concern the study of the diversity of ornamental genetic resources (especially in rose), their conservation and their propagation. E-mail: agnes.grapin@agrocampus-ouest.fr



> Laurence Hibrand-Saint Oyant

Laurence Hibrand-Saint Oyant is research engineer at INRAE, France. She is working in the IRHS unit (Research Institute of Horticulture and Seeds) in the GDO (Genetics and Diversity of Ornamentals) team. Her research interests focus on genetic determinism of rose traits of interest and biotechnologies. E-mail: laurence.hibrand-saint-oyant@inrae.fr



> Valéry Malécot

Valéry Malécot is associate professor in botany at the Institut Agro in Angers, France, and carries out his research activities within the GDO team in the IRHS unit. His research interests focus on cultivated and wild plant taxonomy and nomenclature, as well as links between evolution, history, breeding and classification. E-mail: valery.malecot@agrocampus-ouest.fr



> Sophie Paillard

Sophie Paillard is a quantitative geneticist. She has a long-time experience in genetics of plant resistance to diseases. She joined the GDO team in 2019 to work on genetics and genomics (structural and functional) of the interaction between rose and *Diplocarpon rosae*. E-mail: sophie.paillard@inrae.fr



> Alix Pernet

Alix Pernet is a plant geneticist at INRAE, Research Institute of Horticulture and Seeds, Angers, France. She is particularly interested in the evolution of the diversity of rose, whether through natural selection or anthropic pressure. E-mail: alix.pernet@inrae.fr



> Vanessa Soufflet-Freslon

Vanessa Soufflet-Freslon is associate professor at the Institut Agro in Angers, France. She is working in the GDO team in the IRHS unit. Her research focuses on the rose durable resistance to foliar diseases, including genetic resistance and the use of biocontrol products. E-mail: vanessa.soufflet-freslon@agrocampus-ouest.fr



> Cristiana Oghina-Pavie

Cristiana Oghina-Pavie is a historian, associate professor in modern history at the University of Angers, France. Her research interests concern the relationship between horticultural practices and plant sciences in the 19th and 20th centuries in TEMOS unit. E-mail: cristiana.pavie@univ-angers.fr

> References

- Debray, K., Le Paslier, M.C., Bérard, A., Thouroude, T., Michel, G., Marie-Magdelaine, J., Bruneau, A., Foucher, F., and Malécot, V. (2021). Unveiling the patterns of reticulated evolutionary processes with phylogenomics: hybridization and polyploidy in the genus *Rosa*. *Systematic Biology* syab064. <https://doi.org/10.1093/sysbio/syab064>
- Hibrand-Saint Oyant, L., Rocchia, A., Cavel, E., Caissard, J.-C., Machenaud, J., Thouroude, T., Jeauffre, J., Bony, A., Dubois, A., Vergne, P., et al. (2019). Biosynthesis of 2-phenylethanol in rose petals is linked to the expression of one allele of RhPAAS. *Plant Physiology* 179 (3), 1064–1079. <https://doi.org/10.1104/pp.18.01468>
- Hibrand Saint-Oyant, L., Ruttink, T., Hamama, L., Kirov, I., Lakhwani, D., Zhou, N.N., Bourke, P.M., Daccord, N., Leus, L., Schulz, D., et al. (2018). A high-quality genome sequence of *Rosa chinensis* to elucidate ornamental traits. *Nature Plants* 4, 473–484. <https://doi.org/10.1038/s41477-018-0166-1>
- Iwata, H., Gaston, A., Remay, A., Thouroude, T., Jeauffre, J., Kawamura, K., Hibrand-Saint Oyant, L., Araki, T., and Denoyes, B. (2012). The TFL1 homologue KSN is a regulator of continuous flowering in rose and strawberry. *The Plant Journal* 69, 116–125.
- Joyaux, F. (2001). *La Rose, une Passion Française, Histoire de la Rose en France 1778-1914* (Bruxelles: Editions Complexe).
- Joyaux, F. (2005). *Les Roses de l'Impératrice. La Rosomanie Française au Temps de Joséphine* (Paris: Editions Complexe).
- Kawamura, K., Hibrand-Saint Oyant, L., Crespel, L., Thouroude, T., Lalanne, D., and Foucher, F. (2011). Quantitative trait loci for flowering time and inflorescence architecture in rose. *TAG Theoretical and Applied Genetics* 122 (4), 661–675.
- Kawamura, K., Hibrand-Saint Oyant, L., Thouroude, T., Jeauffre, J., and Foucher, F. (2015). Inheritance of garden rose architecture and its association with flowering behaviour. *Tree Genetics & Genomes* 11 (2), 22. <https://doi.org/10.1007/s11295-015-0844-3>
- Labbé, J. (2014). *LOI n° 2014-110 du 6 février 2014 visant à mieux encadrer l'utilisation des produits phytosanitaires sur le territoire national*.
- Leus, L., Van Laere, K., De Riek, J., and Van Huylenbroeck, J. (2018). Rose. In *Ornamental Crops*, Vol 11, J. Van Huylenbroeck, ed. (Cham: Springer International Publishing), p.719–767.
- Li-Marchetti, C., Le Bras, C., Chastellier, A., Relion, D., Morel, P., Sakr, S., Crespel, L., and Hibrand-Saint Oyant, L. (2017). 3D phenotyping and QTL analysis of a complex character: rose bush architecture. *Tree Genetics & Genomes* 13 (5), 112. <https://doi.org/10.1007/s11295-017-1194-0>
- Liorzou, M., Pernet, A., Li, S.B., Chastellier, A., Thouroude, T., Michel, G., Malecot, V., Gaillard, S., Briece, C., Foucher, F., et al. (2016). Nineteenth century French rose (*Rosa* sp.) germplasm shows a shift over time from a European to an Asian genetic background. *Journal of Experimental Botany* 67 (15), 4711–4725. <https://doi.org/10.1093/jxb/erw269>
- Lopez Arias, D., Chastellier, A., Thouroude, T., Bradeen, J., Van Eck, L., De Oliveira, Y., Paillard, S., Foucher, F., Hibrand-Saint Oyant, L., and Soufflet-Freslon, V. (2020). Characterization of black spot resistance in diploid roses with QTL detection, meta-analysis and candidate-gene identification. *TAG Theoretical and Applied Genetics* 133 (12), 3299–3321. <https://doi.org/10.1007/s00122-020-03670-5>
- Magnard, J.L., Rocchia, A., Caissard, J.C., Vergne, P., Sun, P.L., Hecquet, R., Dubois, A., Hibrand-Saint Oyant, L., Jullien, F., Nicole, F., et al. (2015). Biosynthesis of monoterpene scent compounds in roses. *Science* 349 (6243), 81–83. <https://doi.org/10.1126/science.aab0696>
- Marolleau, B., Petiteau, A., Bellanger, M.B., Sannier, M., Le Pocreau, N., Porcher, L., Paillard, S., Foucher, F., Thouroude, T., Serres-Giardi, L., et al. (2020). Strong differentiation within *Diplocarpon rosae* strains based on microsatellite markers and greenhouse-based inoculation protocol on *Rosa*. *Plant Pathology* 69, 1093–1107. <https://doi.org/10.1111/ppa.13182>
- Proia, F., Panloup, F., Trabelsi, C., and Clotault, J. (2019). Probabilistic reconstruction of

genealogies for polyploid plant species. *Journal of Theoretical Biology* 462, 537–551.

Randoux, M., Davière, J.M., Jeauffre, J., Thouroude, T., Pierre, S., Toualbia, Y., Perrotte, J., Reynoird, J.P., Jammes, M.J., Hibrand-Saint Oyant, L., and Foucher, F. (2014). RoKSN, a floral repressor, forms protein complexes with RoFD and RoFT to regulate vegetative and reproductive development in rose. *New Phytologist* 202 (1), 161–173.

Redouté, P.-J., and Thory, C.-A. (1817-1824). *Les Roses*, 3 vols. (Paris: Firmin-Didot).

Roberts, A., Debener, T., and Gudin, S. (2003). *Encyclopedia of Rose Science* (Oxford: Elsevier, Academic Press). eBook ISBN: 9780080917979.

Roman, H., Rapicault, M., Miclot, A.S., Larenaudie, M., Kawamura, K., Thouroude, T., Chastellier, A., Lemarquand, A., Dupuis, F., Foucher, F., et al. (2015). Genetic analysis of the flowering date and number of petals in rose. *Tree Genetics & Genomes* 11 (4). <https://doi.org/10.1007/s11295-015-0906-6>

Roux-Cuvelier, M., Grisoni, M., Bellec, A., Bloquel, E., Charron, C., Delalande, M., Delmas, M., Didier, A., Durel, C.-E., Duval, C.-H., et al. (2021). Conservation of horticultural genet-

ic resources in France. *Chronica Hort.* 61 (2), 21–36.

Simon, L., and Cochet, P. (1906). *Nomenclature de Tous les Noms de Roses*, 2nd edn (Librairie Horticole).

Soufflet-Freslon, V., Araou, E., Jeauffre, J., Thouroude, T., Chastellier, A., Michel, G., Mikanagi, Y., Kawamura, K., Banfield, M., Oghina-Pavie, C., et al. (2021). Diversity and selection of the continuous-flowering gene, RoKSN, in rose. *Horticulture Research* 8, 76. <https://doi.org/10.1038/s41438-021-00512-3>

Soufflet-Freslon, V., Marolleau, B., Thouroude, T., Chastellier, A., Pierre, S., Bellanger, M.N., Le Cam, B., Bonneau, C., Porcher, L., Leclerc, A., et al. (2019). Development of tools to study rose resistance to black spot. *Acta Hort.* 1232, 213–220. <https://doi.org/10.17660/ActaHortic.2019.1232.31>

Sun, P.L., Dégut, C., Réty, S., Caissard, J.C., Hibrand-Saint Oyant, L., Bony, A., Paramita, S.N., Conart, C., Magnard, J.L., Jeauffre, J., et al. (2020). Functional diversification in the Nudix hydrolase gene family drives sesquiterpene biosynthesis in *Rosa × wichurana*. *Plant Journal* 104 (1), 185–199. <https://doi.org/10.1111/tpj.14916>

Vibert, J.-P. (1824). *Essai sur les Roses*, 2 (Paris: Madame Huzard), p.42–43.

Widehem, C., and Plottu, B. (2020). Dynamiques de protection des variétés de rosier en Europe. Actes du colloque “Les Mondes de la Rose – Regards Croisés” (9 et 10 mars 2020, Paris). p.21–24.

Wisseemann, V., and Ritz, C.M. (2007). Evolutionary patterns and processes in the genus *Rosa* (Rosaceae) and their implications for host-parasite co-evolution. *Plant Systematics and Evolution* 266 (1-2), 79–89. <https://doi.org/10.1007/s00606-007-0542-1>

Zlesak, D.C., Nelson, R., Harp, D., et al. (2017). Performance of landscape roses grown with minimal input in the north-central, central, and south-central United States. *HortTechnology* 27, 718–730. <https://doi.org/10.21273/HORTTECH03681-17>

Zhou, N., Tang, K.X., Jeauffre, J., Thouroude, T., Lopez Arias, D., Foucher, F., and Hibrand-Saint Oyant, L. (2020). Genetic determinism of prickles in rose. *TAG Theoretical and Applied Genetics* 133, 3017–3035. <https://doi.org/10.1007/s00122-020-03652-7>

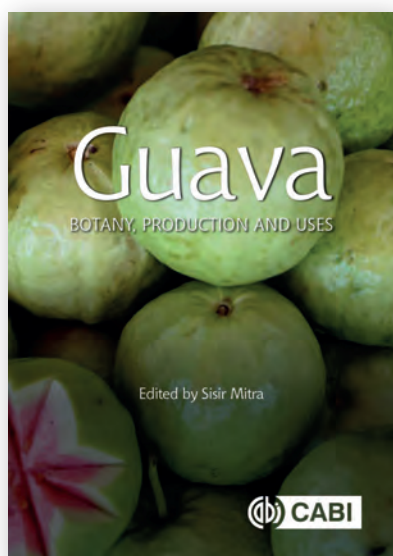


New Books
Websites

> 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



Mitra, S., ed. (2021). *Guava: Botany, Production and Uses* (Wallingford, Oxfordshire, UK; Boston, MA, USA: CAB International), pp.380. ISBN 9781789247022 (hardback). £135.00 / €155.00 / \$180.00.

A 25% discount will be received by entering the code “CCISHS25” when ordering through <https://www.cabi.org/bookshop/book/9781789247022/>

Guava is commercially grown in more than 70 tropical and subtropical countries and is the most important “minor tropical fruit,” ahead of lychee and longan. The world production of guava increased during the last decade and was estimated at 6.75 Mt in 2017. Simultaneously, the global trade in fresh and processed guavas is experiencing promising growth, in rela-

tion to the greater attention paid to this fruit by consumers.

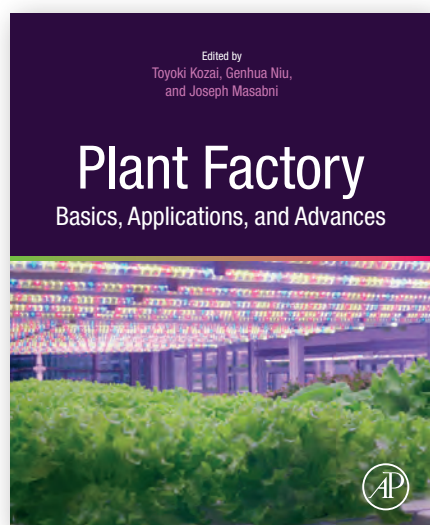
Despite this importance, there was a lack of publication compiling knowledge on guava biology and cultivation. The book edited by Prof. Sisir Mitra, published in 2021, in the series “Botany, production and uses” of CAB International, finally comes to meet this need. Thirty-two authors, recognized for their experience on guava and working in seven producing countries, wrote this comprehensive book covering the different aspects of guava biology, cultivation, production, and trade. The book contains sixteen chapters. Each chapter presents a comprehensive review of current knowledge, outlines future research directions, and provides a useful extensive list of old and recent references. Chapters 1 to 3 describe the taxonomy, possible origin, and relative species of the guava,

the production and trade, with a focus on the US and the European markets, and the guava fruit composition and processing. Chapters 4 to 6 deal with propagation, biotechnology, cultivars, and plant improvement. Modern molecular approaches for germplasm characterization, genes mapping, and breeding are detailed. The main cultivars grown in producing countries are described and illustrated with beautiful images. Chapters 7 and 8 talk about plant nutrition and irrigation, two practices of great significance for guava pro-

duction, and orchard management. Modern trends for orchard design and management, integrating high-density planting and tree training and pruning, are underlined. Chapters 9 to 12 deal with aspects of the development of fruit production and quality: flowering, fruit set development and maturation, physiological disorders, photosynthesis and productivity. Chapters 13 to 15 concern crop protection (pests, nematodes, diseases), with large focus on fruit flies, nematodes, and the destructive guava wilt. Chapter 16 provides

an overview of postharvest physiology and storage techniques, essential to maintain the quality of this highly perishable fruit. The book is well written and pleasant to read. It will find a large audience among researchers, teachers, students, extension officers, producers, and stakeholders of the guava industry.

*Reviewed by Frédéric Normand,
CIRAD, Réunion Island, France*



Kozai, T., Niu, G., and Masabni, J.G., eds. (2021). *Plant Factory Basics, Applications and Advances* (Cambridge, MA, USA: Elsevier, Academic Press), pp.449. ISBN 978-0-323-85152-7 (paperback) / 978-0-323-85922-6 (eBook). \$125.00 (paperback) / \$99.99 (eBook). <https://www.elsevier.com/books/plant-factory-basics-applications-and-advances/kozai/978-0-323-85152-7>

Plant factories with artificial lighting (PFALs, i.e., vertical farms) are increasingly being used for high-nutrient density edible, medicinal, and ornamental crops due to concerns with land scarcity, climate change, and water availability. While previous books are avail-

able in this field, the rapid evolution of both research and business enterprises underscores the importance of this new volume. This book provides the most current information with 24 chapters by 37 renowned co-authors from across the globe, including several chapters by the distinguished editors. The book is divided into four parts. The first part sets the stage by introducing plant factories, presenting definitions for PFALs and related concepts, and describes the role PFALs can play in contributing to international sustainability and development goals. The technical basics that underlie PFALs are the focus of part two. This section begins with lighting terminology, a description of LED lighting packages, and advances toward increasing LED energy efficacy. Part two continues with crop basics such as up-to-date information on plant responses to the environment plus hydroponic and aquaponic growing systems. Part three delves into economics with chapters on optimizing productivity, economics and profitability, and the business model and cost performance of a mini plant factory. Current PFALs often focus on leafy greens, so it was fascinating to find a chapter on the implementation of vertical farm tomatoes by 80 Acres Farms. The chapter includes schematic diagrams, systems selection, environmental parameters, and a table with specifications for electric energy consumption. Readers looking for scientific advances will find these in part four. Advances toward optimizing light spectrum using

LED lighting systems for crop productivity and nutritional compounds are covered first. A comprehensive chapter covers the production of young plants in plant factories followed by a case study on growing dwarf tomatoes transformed to produce high value enzymes. Energy use and maintaining environmental uniformity are one of the challenges in PFALs and these are addressed in a separate chapter. Readers will relate to a chapter on the human/sociological benefits of urban agriculture. One day PFALs may be designed with nature therapy in mind to reduce stress in workers. The book concludes with trends toward new crops (head vegetables such as cabbage and root vegetables), a summary of the last 20 years of development, and a perspective for the future. A strength of the book is its interdisciplinary look at this emerging industry. The book is realistic about both PFAL opportunities (agricultural and societal) and challenges (e.g., energy use, carbon footprint, and capital cost). Overall, the audience of this book (researchers, students, educators, engineers, and industry members) will find a thoughtful book with up-to-date research complemented by many instructive tables, figures, and detailed literature cited. Beyond serving as an excellent reference, this book inspires readers to play a role in the future of plant factories.

*Reviewed by Neil Mattson,
Cornell University, NY, USA*

> Courses and meetings

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

VII International On-line Course on Postharvest & Fresh-Cut Technologies, 15 February – 15 November 2022. Info: Prof. Dr. Francisco Artés-Hernández, Postharvest & Refrigeration Group, Universidad Politécnica de Cartagena, Murcia, Spain e-mail: postharvest@upct.es, web: <http://eventos.upct.es/go/7thPostharvestCourse>

Online Postharvest Technology Course, 5 April-31 May 2022. Info: Monique Tulp MSc, Wageningen Academy, The Netherlands, Phone: +31 317 48 22 98, E-mail: monique.tulp@wur.nl, web: <https://www.wur.nl/en/show/Online-Course-Postharvest-Technology.htm>



> XV International People Plant Symposium and II International Symposium on Horticultural Therapies

Division Horticulture for Human Health

#ishs_dhea

A joint in-person symposium of the Role of Horticulture in Human Well-being and Social Development had been scheduled for October 2020. It was to include the XV International People Plant Symposium, the II International Symposium on Horticultural Therapies, and the 48th American Horticultural Therapy Association Annual Conference, with the support of the College of Agriculture, Kansas State University (initially in Kansas City, Kansas, USA). This combined symposium was postponed due to the COVID-19 pandemic. Instead, a virtual symposium was held on 29-30 October 2021. The virtual symposium attracted 292 participants from 28 countries. This symposium provided a forum for researchers, educators, and practitioners to discuss, identify, encourage, and expand the research used by professional and trade associations to clearly demonstrate the benefits of horticulture in wellness and quality of life. This was achieved through six pre-symposium events, two keynote presentations, three invited speakers, seven oral sessions providing 29 presentations, four poster sessions providing 21 posters, and three workshops. Presentations were divided into six topic themes:

- Horticulture and the individual;
- Horticulture and the community;
- Theoretical frameworks for research, programming, and design;
- Research, programming, and application reports;
- The profession of horticultural therapy;
- Horticultural therapy education programming around the world.

To foster discussion and collaboration, Q&A was moderated in every session, there were moderated topical networking breaks both days, and a facilitated network discussion. The purpose of the moderated breaks and facilitated discussions were to discover ways that we can collaborate to advance the use of horticulture for therapy, rehabilitation, health, and well-being. Horticulture is an effective tool used by many different profession-



> Some of the 246 photos attendees shared through the symposium app.

als and volunteers for addressing diverse issues, but all are focused on enhancing health and well-being through active caring for plants. The discussions were to identify those shared concerns that can be addressed by people in the field. From these discussions, we have identified the following areas that attendees and organizers will work together to advance:

- Education: Educators see the need for collaborative training and online learning opportunities; educational opportunities for widely diverse audiences are needed to expand the application of horticulture for therapy, rehabilitation, health, and well-being.
- Research: Practitioners want to work with researchers and want research evidence to inform their practice; researchers want to collaborate with practitioners; both want to find funding for research; there is a need for research into the impact of responsibility for the cultivation of plants as well as nearby nature.
- Outreach and communication: Horticultural therapy began to be recognized in the 1940s and 1950s as a part of rehabilitative care of hospitalized war veterans and advanced in its use in a broad range of rehabilitative, vocational and community settings. However, as a profession, it is still referred to as

‘emerging’. Effective outreach to third-party payees (insurance and government), the healthcare community, and funding agencies were identified as key to advancing the profession.

- Terminology: Clarification of terminology internationally will facilitate collaboration and communication (i.e., horticultural therapy vs. therapeutic horticulture vs. therapy through horticulture vs. garden therapy vs. social horticulture). What kind of therapy is horticulture (clinical, adjunctive, rehabilitative)? Can activities using plant products be considered horticultural therapy (cooking, aroma therapy, crafts, art, walking in the garden, sensory stimulation) without programming that it includes the care of living plants? Can walks in the forest or garden be called horticultural therapy?
- Working with allied health professionals: Many allied health professionals (i.e., occupational therapists, recreation therapists, and social workers) use horticulture and gardening as tools in working with clients; supporting the role of horticulture in diverse treatment programs and collaboration with other professionals will advance horticultural therapy as a profession.
- Roles and responsibilities of volunteers: Historically, volunteers have had a critical

role in supporting horticultural therapy/therapeutic horticulture/garden therapy programming; going forward clarifying the role of volunteers and the training needs will be pursued.

A series of free webinars will be held monthly going forward to further discuss each issue and develop action teams.

At the closing session, the ISHS Young Minds Award winners were announced: Yu Hsin Tung from National Taiwan University, Taiwan, won for best oral presentation for her talk titled “Exploring the relationship between landscape features and brain activation using vision AI” and Timea Buru from the University of Agricultural Sciences and Veterinary Med, Romania, won for best poster presentation for her poster titled “Studies regarding the influence of therapeutic horticulture on the human-nature relationship and the increase of well-being.”

Candice Shoemaker



➤ **Winners of the ISHS Young Minds Awards:** Yu Hsin Tung, National Taiwan University (best oral presentation) and Timea Buru, University of Agricultural Sciences and Veterinary Med, Romania (best poster presentation).

➤ Contact

Candice Shoemaker, College of Agriculture, Kansas State University, 227 Waters Hall, 1603 Old Claflin Place, Manhattan, KS 66506, USA, e-mail: cshoemak@ksu.edu

➤ VIII International Conference on Landscape and Urban Horticulture

Division Landscape and Urban Horticulture
Division Protected Cultivation and Soilless Culture

#ishs_durb
#ishs_dpro

Italy had the opportunity to host the VIII International Conference on Landscape and Urban Horticulture. The conference, entitled “The role of science in reconciling ecology and technology in landscape and urban horticulture,” started by the consideration that scientific efforts are needed in order to improve the comfort and livability of urban areas. Ecology and technology must synergistically interact to overtake issues associated with the coexistence in limited spaces of biological organisms and man-made artefacts. In the conference, the most recent advances in urban green infrastructure and horticulture toward more sustainable and liveable cities were analysed and discussed. This happened in Catania, Sicily, Italy, in a virtual event held on 15-17 December 2021, via GoToWebinar, due to the COVID-19 pandemic travel restrictions. This conference was organized by the Department of Agriculture, Food and Environment (Di3A) of the University of Catania and National Research Council (Centro Nazionale delle Ricerche, CNR) of Pisa, under the auspices of the International Society for Horticultural Science (ISHS).

Despite the virtual format, the participants had the opportunity to listen to and see 29 oral and 45 poster presentations from 26 different countries.

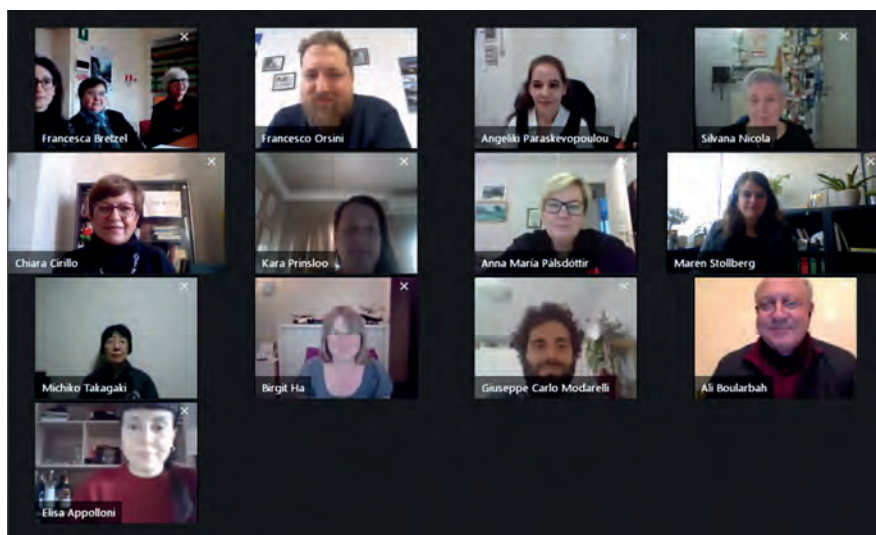
During the opening session, the conveners, Prof. Daniela Romano, Dr. Francesca Bretzel and Dr. Stefania Toscano, welcomed all participants. Immediately afterwards, the directors of the two departments, Dr. Carlo Calfapietra for CNR and Prof. Agatino Russo for Di3A, sent their welcome greetings. Prof. Silvana Nicola, ISHS Board Member, introduced the role of the International Society for Horticultural Science.

This event allowed to make a contemporary concept with six thematic areas on: (a) Urban horticulture benefits for people, (b) Historical landscape in urban areas, (c) Urban ecosystem and environmental engineering, (d) Planning, design and policies in cities, (e) Impact of the anthropic activities: interaction and synergies, and (f) Plant functionality and stress in the urban ecosystem.

The conference included two plenary lectures and seven invited speakers that addressed specific research topics. The first two days of the conference started with the two plenary lectures held by Prof. Angeli-

■ Table 1. Number of oral presentations and posters per topic.

Topics	Oral	Poster
Urban horticulture benefits for people	2	7
Historical landscape in urban areas	9	4
Urban ecosystem and environmental engineering	7	7
Planning, design and policies in cities	5	6
Impact of the anthropic activities: interaction and synergies	2	5
Plant functionality and stress in urban ecosystem	4	16



► Some of the conference participants.

ki Paraskevopoulou, Agricultural University of Athens (Greece) (entitled “Horticulture, design and ecology: how to deal with the urban environment”), and by Prof. Francesco Orsini, Alma Mater Studiorum, University of Bologna (Italy) (entitled “Can cities provide food in the XXI century?”).

The invited speakers, listed according to the programme, were: Anna Maria Palsdottir, Swedish University of Agricultural Sciences (Sweden) (“Sensory experience in nature for supporting human health”), Pietro Laureano, Urban planner and Landscape architect (Italy) (“Traditional water management in anthropic landscapes”), Ali Boularbah, University Cadi-Ayyad (Morocco) (“Trace element contents, microbial communities and enzymatic activities of urban soils. A case study from the city of Marrakech, Morocco”), Runrid Fox-Kämper, Research Institute for Regional and Urban Development of Federal State of North Rhine Westphalia (Germany) (“Policies for food production in cities: from ignorance to cooperation and strategic support”), Sarah Eberle, Landscape designer (United Kingdom) (“Urban gardens: a new oasis”), Elena Paoletti, Institute of Research on Terrestrial Ecosystems, National Research Council (Italy) (“Air pollution and urban green infrastructure”), and Sara Álvarez, Technological Agriculture Institute of Castilla y León (Spain) (“Benefits of applying deficit irrigation strategies in ornamental plants”).

At the end of the second day, an ISHS business meeting was organized by Prof. Francesco Orsini. During the closing ceremony, Prof. Daniela Romano announced the winners of the ISHS Young Minds Awards: Maren Stollberg from Hochschule Geisenheim University, Department of Urban Horticulture and Planting Design, Geisenheim, Germany, for the best oral presentation entitled “Plants and polyester: suitable plants for a textile-based living wall system”, and Elisa Appolloni, Ph.D. student at Department of Agricultural and Food Sciences, Alma Mater Studiorum, University of Bologna, Italy, for the best poster

presentation entitled “Beyond vegetables: effects of led light on secondary metabolites in medicinal and aromatic plants, edible flowers and microgreens”. The book of abstracts was distributed to all conference attendees. The proceedings of the conference will be published as an online volume of *Acta Horticulturae* after editorial review. On the third day, the conference hosted three workshops. The first one, entitled “International student competition UrbanFarm”, was chaired by Dr. Giuseppina Pennisi from the University of Bologna. The workshop included five oral presentations related to the International Student Challenge UrbanFarm (<https://site.unibo.it/urban-farm/en>), organized under the aegis of the ISHS. Students, who joined different editions of the challenge, presented their innovative and sustainable urban agriculture projects developed with their teams in the framework of the competition. The second workshop, entitled “Urban agriculture for circular cities. Space and logistic opportunities,” was organized by the Food and Agriculture Organization of the United Nations (FAO) and the European Bank for Reconstruction and

Development (EBRD), and was moderated by Prof. Francesco Orsini (University of Bologna) and Dr. Jacopo Monzini (FAO). The workshop aimed at identifying successful urban farming policies and initiatives developed by municipalities around the world. Over 130 participants from 40 countries gathered to discuss space and logistic opportunities in cities with representatives of innovative and pioneering municipalities, including Barcelona, Bologna, Brussels, Sofia, Istanbul, Paris and Milan among others. In the third workshop, entitled “The bright side of vertical farming: the first experimental experience at AlmaVFarm,” organized in collaboration with the European H2020 project FoodE (Food Systems in European Cities), students from the University of Bologna were invited to present their research project, as the final step of an innovative and co-designed educational experience realized within the vertical farm developed within the university.

The IX International Conference on Landscape and Urban Horticulture will be organized as part of IHC2022 symposium S9 “Urban Horticulture for Sustainable Food Security (UrbanFood2022)” on 14-20 August 2022 in Angers, France. ●

Stefania Toscano and Giuseppina Pennisi

► Contact

Dr. Stefania Toscano, University of Catania, Department of Agriculture, Food and Environment, Via Valdisavoia 5, 95123 Catania, Italy, e-mail: stefania.toscano@unict.it

Dr. Giuseppina Pennisi, Department of Agricultural and Food Sciences, Alma Mater Studiorum - University of Bologna, 40127 Bologna, Italy, e-mail: giuseppina.pennisi@unibo.it



► Winners of the ISHS Young Minds Awards: A) Maren Stollberg (best oral presentation), B) Elisa Appolloni (best poster).

➤ V International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions

Division Postharvest and Quality Assurance
Division Ornamental Plants

#ishs_dphq
#ishs_dorn



➤ Opening ceremony of PQMHP2021. From left to right: Top: Margherita Beruto (Chair ISHS Division Ornamental Plants), Omar Franco Mora (Convener), Salvador Fernández (Mexican Ministry of Agriculture and Rural Development), Heidi Trujillo (UTVT); Bottom: Alfredo Sánchez (UAEMEX), Patricia Zarza (UAEMEX) and Homero Ramírez (ISHS Council member).

During 6-8 October 2021, the Faculty of Agriculture of the Universidad Autónoma del Estado de México (UAEMEX) hosted and sponsored, at its 48th anniversary, the V International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions (PQMHP2021) completely in virtual mode. Under the general theme “Reliable Techniques for our People” and under the aegis of the International Society for Horticultural Science, PQMHP2021 presented seven keynotes with the participation of Michiko Takagaki (Japan), Zora Singh (Australia), Sandra Arifin Aziz (Indonesia), James Jiménez (Colombia), Jorge Fonseca (USA), Maria H. Pérez Barraza and Antonio Laguna Cerda (Mexico). Along with the keynotes, the PQMHP2021 audience joined 24 plenary talks and 23 poster presentations. Those 54 speeches were related to the main subjects of PQMHP2021,

which were: Quality of horticultural products and health promoting compounds, Postharvest physiology and technology, Innovative preharvest/postharvest interventions to reduce postharvest losses, Preharvest factor affecting postharvest storage life and quality, Plant diseases and pests affecting quality and postharvest life, and Postharvest potential of under-utilized tropical species. Special interest in neglected horticultural species from Latin America, Asia, and Oceania was observed among students and general attendees. In a region of the world that is very rich in horticultural species, PQMHP2021 gave the audience a new chance to appreciate the richness of plant genetic resources in developing countries. This richness might increase the possibilities of a better life not only for locals, but for the world community. Networking efforts from international researchers to improve reliable horticultural

techniques will improve the sustainable use of local plants. This is a natural treasure that might be used but should also be conserved. Moreover, during this conference, postharvest was exemplified as a discipline not only related to conserving fresh produce but to reducing food losses.

Due to the pandemic restrictions, the final decision to continue with a fully virtual event allowed that PQMHP2021 was broadcasted to the participants from 15 countries. To increase real time interchange of horticultural knowledge, the talks were scheduled at convenient times for the speakers. That implied that some participants were speaking very early in the morning, and others late at night. The chat room was another tool well appreciated by the attendants. Although everybody missed being together,



➤ Symposium Convener Omar Franco Mora (right), presenting the ISHS Young Minds Award for the best oral presentation to Itzel Rojas Puebla (left).



› Daniela Arrieta Flores, winner of the ISHS Young Minds Award for the best poster.



› Keynote of Dr. Antonio Laguna Cerda (UAEMEX) on Mexican orchids.

at the end of each working day, a recorded musical performance gave the audience a chance to remember the full sensation of ISHS in-person symposia.

Young scientist participation was encouraged. The ISHS Young Minds Awards were presented to Ms. Itzel Rojas Puebla from the Universidad Autónoma del Estado de México for the best oral presentation entitled "Adhesion capacity and biofilm formation of *Escherichia coli* and *Salmonella* in tomato (*Solanum lycopersicum* L.) in postharvest stage" and to Ms. Daniela Arrieta Flores from the Universidad Politécnica de Tlaxcala, Mexico, for best poster presentation, entitled "Chemical analysis and evolutionary relationship among four types of quelites". The Local Organizing Committee deeply thanks the main sponsor, Universidad Autónoma del Estado de México, and the co-sponsors,

Universidad Tecnológica del Valle de Toluca (UTVT), Gowan Colombia, and Química Foliar, for encouraging the participation of over 100 undergraduate Mexican students as attendants of PQMHP2021. As a further promotion of the ISHS activities around the world, the audience was informed on the event "My Ph.D. thesis in 3 minutes." These kinds of efforts increase the participation of young scientists in horticulture development. Costa Rica, Colombia, Trinidad and Tobago, and Sri Lanka were the previous venues of PQMHP, and during this fifth edition in Mexico, Colombia was elected as the venue for the sixth edition of this series. Finally, being one of the first fully virtual ISHS symposia, we believe that the PQMHP2021 experience for attendants and the international and local committees was enjoyable. Moreover, the experience for young students, starting

their careers, enhanced their dreams in getting involved in a more participative horticulture world. ●

**Omar Franco Mora and
Ana Tarín Gutiérrez Ibáñez**

› Contact

Omar Franco Mora, Laboratory of Horticulture, Facultad de Ciencias Agrícolas, Universidad Autónoma del Estado de México, Toluca, Mexico, e-mail: ofrancom@uaemex.mx

Ana Tarín Gutiérrez Ibáñez, Laboratory of Food Safety, Facultad de Ciencias Agrícolas, Universidad Autónoma del Estado de México, Toluca, Mexico, e-mail: atarini@uaemex.mx



› HortDialogues Horticultural science video series

www.ishs.org/hortdialogues

Interested in hosting a HortDialogues webinar yourself?
Contact info@ishs.org with your proposal.

> V Asia Symposium on Quality Management in Postharvest Systems

Division Postharvest and Quality Assurance

#ishs_dphq



> Onsite and virtual symposium participants.

King Mongkut's University of Technology Thonburi (KMUTT) held the first Asia Symposium on Quality Management in Postharvest Systems (AsiaPostharvest) in Thailand, in February 2012, under the aegis of the International Society for Horticultural Science. Since then, the AsiaPostharvest symposia were held in Laos PDR in 2013, Cambodia in 2015, and Korea in 2017. On 1-2 December 2021, the AsiaPostharvest symposium was organized by KMUTT again in Bangkok, Thailand. The symposium was organized in a hybrid format under the theme of "AsiaPostharvest2021: Forefront of Technology and Research for Society" in collaboration with Mae Fah Lung University, Thailand.

Research in postharvest technology is important in developing countries in the Asia-Pacific Region. There agricultural products are highly perishable and deteriorate easily. This leads to food loss, which impacts regional food security and economics. Food loss limits the competitiveness of developing countries in the global market. Awareness of food safety is more apparent because of the global COVID-19 pandemic restrictions. Thus, this symposium concerning postharvest technology provided an excellent opportunity to exchange information, engage in stimulating discussions, and initiate networking with

participants from Asia and other countries. The symposium program included special lectures, oral presentations, poster sessions, and discussions on postharvest technology, physiology, biochemistry, pathology, and supply chain of fruit, vegetables, flowers, and seeds. Eighty-seven participants (30 onsite and 57 virtual) from 19 countries, including Thailand, Japan, South Korea, China, New Zealand, Malaysia, Vietnam, Uganda, Philippines, United Arab Emirates, Sri Lanka, Turkey, Nepal, Ethiopia, Indonesia, South Africa,

Australia, Greece, and Egypt, attended the symposium. The findings reported at this symposium included 33 oral and 22 poster presentations.

The following research was highlighted during the symposium: stress treatments such as electric field treatment, LED irradiation, ultraviolet radiation, and heat treatment in postharvest supply chain of agricultural produce were introduced to maintain quality and reduce loss problems. These techniques might be a substitute for chemical treatments because of the increasing awareness of health issues by consumers and improving standards of living by economic growth. They might be practical techniques for commercial application in developing countries and might take part in food safety programs concerning the contamination of the COVID-19 virus. In addition, the application of plant bioregulators to improve fruit quality in citrus species was also widely discussed. This may improve both pre- and postharvest quality of fresh produce, especially for the product appearance, and the nutritional status.

AsiaPostharvest2021 provided an opportunity for young researchers to show their ideas, knowledge, and expertise in research. ISHS Young Minds Awards were given to Mr. Sitthisak Intarasit from Chiang Mai University, Thailand, for the best oral presentation entitled "Effects of SNP and cPTIO on oxidative membrane damage and pericarp browning of



> Winners of the ISHS Young Minds Awards: A) Sitthisak Intarasit (best oral presentation), B) Nichapat Keawmanee (best poster).

harvested longan fruit”, and to Ms. Nichapat Keawmanee from Shizuoka University, Japan, for the best poster presentation entitled “Characterization of pigments accumulation in Valencia orange during regreening”.

At the end of the symposium, during the ISHS business meeting, Japan was elected to host the next AsiaPostharvest2025. I congratulate

Prof. Dr. Masaya Kato of Shizuoka University, Japan, who will be the convener of the next symposium in this series. ●

Varit Srilaong

> Contact

Assoc. Prof. Dr. Varit Srilaong, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, 126 Prach-Uthit Rd., Bangmod, Thungkru, Bangkok 10140, Thailand, e-mail: varit.sri@kmutt.ac.th

> X International Symposium on Kiwifruit

Division Vine and Berry Fruits
Division Temperate Tree Fruits

#ishs_dvin
#ishs_dfu



> Opening session of the symposium: A) ISHS representative Guglielmo Costa (left) and Symposium Convener Arif Atak (right), B) Nevzat Birişik, General Directorate of Agricultural Research and Policies.

The X International Symposium on Kiwifruit was held in Yalova, Turkey, from 27-30 September 2021 as a virtual event. The symposium was organized in cooperation with the General Directory of Agriculture Research and Policy, Atatürk Horticultural Central Research Institute, under the auspices of the ISHS Working Group Kiwifruit Culture and Management (Division Vine and Berry Fruits). The symposium brought together almost 200 participants from 22 countries, who presented 52 oral presentations and 60 posters. The opening ceremony was led by Assoc. Prof. Arif Atak (Yalova Atatürk Horticultural Central Research Institute), Symposium Convener and Chair of ISHS Working Group Kiwifruit Culture and Management. Prof. Guglielmo Costa (Vice-Chair of ISHS Division Vine and Berry Fruits), Dr. Nevzat Birişik (General Directorate of TAGEM) and Dr. Yılmaz Boz (Director of Yalova Atatürk Horticultural Central Research Institute) joined the opening ceremony. These administrators welcomed the participants, extended their gratitude to the Organizing Committee, and recognized the organization by Turkey, where kiwifruit production has greatly increased in the last several decades, and represents a high continued growing potential. A short movie entitled “Agriculture,

Horticulture and Kiwifruit in Turkey” was shown during the opening ceremony. The symposium took place during four working days and included sixteen sessions of oral and poster presentations. A webinar from the sponsors was held on the last day. During this webinar the participants were informed about the work of the leading organizations of the Turkish kiwifruit industry from different sectors. In session 1 (Genetics and Breeding), Prof. Guglielmo Costa (Italy) gave a keynote presentation on “Recent changes in the kiwifruit (*Actinidia* L.) industry since its introduction:

Italy as a case study”, co-authored by Prof. Raffaele Testolin (Italy). This talk was followed by another three oral presentations focused on the breeding program in Romania and Japan. In session 2 (Genetics and Breeding), basic knowledge of the kiwifruit genome and its application in breeding programs were discussed. A total of five oral presentations were presented. The third session (Genetics and Breeding) consisted of poster presentations. A total of 13 poster presentations on genetics and breeding were presented. One talk on “The abundance of sex determination and other genetic studies in kiwifruit” was



> Screenshot during the ISHS Business meeting held on the last day of the symposium.



> Symposium Convener Arif Atak presenting the ISHS Young Minds Awards to A) Dr. Marta Nunes da Silva for the best oral presentation, B) Mr. Javier Martinez Perez for the best poster presentation.

particularly noteworthy. A total of 9 oral and 13 poster presentations were presented in the genetics and breeding sessions. Sessions 4 and 5 related with plant protection and IPM/organic and included 6 oral and 15 poster presentations. Studies on kiwifruit vine decline syndrome (KVDS), *Pseudomonas syringae* pv. *actinidiae* (Psa), and other kiwifruit diseases and pests were presented by participants from different countries. A keynote presentation on “Kiwifruit vine decline: a new disbiotic syndrome of *Actinidia*” was presented by Dr. Irene Donati (Italy). A comprehensive presentation was made about KVDS, which has become an important problem in recent years, all over the world, especially in Italy.

A total of 10 oral and 10 poster presentations on cultivation techniques, physiology and irrigation/fertigation in kiwifruit were presented in sessions 6, 7 and 8 of the symposium. In session 6, the keynote presentation “Factors influencing flower development in kiwifruit vines” was presented by Dr. Annette Richardson (New Zealand). In addition, presentations were made from different countries on the main topics of cultivation techniques, physiology and irrigation/fertigation. In particular, the studies on irrigation, pollination and cover protection system attracted attention.

Presentations on postharvest management were presented in sessions 9, 10, 11 and 16. Another issue that attracted attention was the high number of studies (15 oral and 15 poster presentations) on postharvest management in the symposium. It was seen that

the long-term storage of kiwifruit and the frequent testing of new products that affect the storage of kiwifruit are effective in this regard. In session 9, Dr. Jeremy Burdon (New Zealand) presented a keynote on “Understanding fruit physiology: why we can predict aspects of postharvest performance”. Topics included: problems associated with storage disorders and softening and with postharvest pathogens, the use of non-destructive tools, such as near-infrared spectrophotometry, quality assessment, and cold storage at 0°C in normal atmosphere compared with gaseous ozone.

Studies on fruit quality and food processing were presented in sessions 12, 13 and 14. A total of 9 oral and 4 poster presentations were presented in these sessions. A keynote presentation entitled “An overview of Zespri’s sustainability research journey” was presented by Dr. Octavio Perez-Garcia (New Zealand). A comprehensive presentation was made on the subject of sustainability, which has come to the fore in agriculture in recent years, on the example of kiwifruit.

In the last session of the symposium, 6 presentations (3 orals and 3 posters) were given on production, economic aspects, marketing and others. Two of these were keynotes, the first of which was presented by Assoc. Prof. Arif Atak (Turkey) on “Current status of the Turkish kiwifruit industry and the main problems of growers”. Information was given about the developments in the kiwifruit industry in Turkey and the main problems faced by kiwifruit growers. The second keynote was presented by Prof. Caihong Zhong

(China) on “The development status of kiwifruit industry in China”. In this presentation, detailed information was given about the kiwifruit industry and breeding studies in China, the world’s largest kiwifruit producing country.

On the last day of the symposium, a webinar was held where the sponsoring companies gave brief information about their activities. This webinar was organized with the participation of private companies from different sectors and Plant & Food from New Zealand. The latest developments in the sector were explained and company representatives answered the questions.

At the business meeting, in accordance with the decision taken at the previous symposium, it was confirmed that the XI International Symposium on Kiwifruit will be held in New Zealand on 20-25 February 2023, with Dr. Sarah Pilkington and Dr. Marisa Till as conveners. Dr. Pilkington briefly presented the symposium they will organize. In addition, Italy was elected for organizing the XII International Symposium on Kiwifruit with Prof. Bartolomeo Dichio as convener.

ISHS Young Minds Awards were given to Dr. Marta Nunes da Silva from Catholic University of Portugal, Porto, Portugal, for the best oral presentation entitled “Influence of the nitrogen source on the tolerance of *Actinidia chinensis* to *Pseudomonas syringae* pv. *actinidiae*” and to Mr. Javier Martinez Perez from John Innes Centre, Norwich, United Kingdom, for the best poster entitled “Identifying novel plant disease treatment in New Zealand kiwifruit orchards”. ●

Arif Atak



> Jeremy Burdon (left), chair of the symposium’s sponsors session, and Sarah Pilkington (right), convener of the next International Symposium on Kiwifruit.

> Contact

Arif Atak, Horticultural Central Research Institute, Department of Viticulture & Kiwifruit, 77102 Yalova, Turkey, e-mail: atakarif@gmail.com

> III International Organic Fruit Symposium and I International Organic Vegetable Symposium

Commission Agroecology and Organic Farming Systems
Division Protected Cultivation and Soilless Culture
Division Vegetables, Roots and Tubers

#ishs_cmor
#ishs_dpro
#ishs_dveg



> Some of the symposium participants.

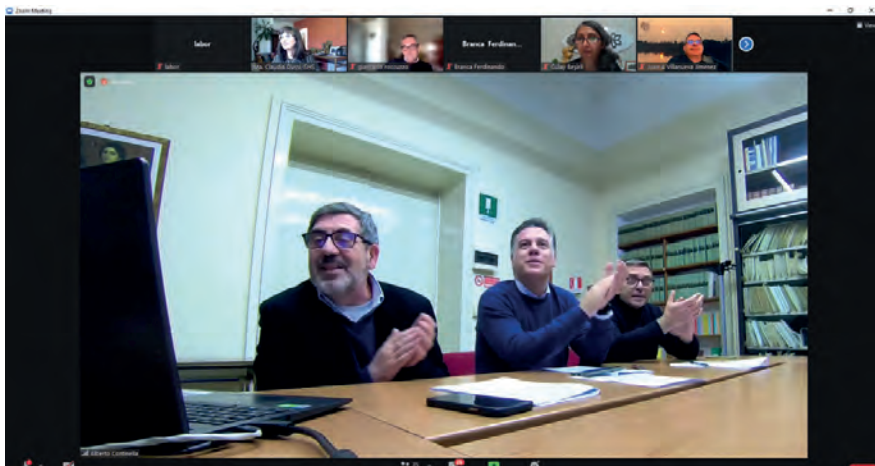
The III International Organic Fruit Symposium and I International Organic Vegetable Symposium (OrgHort2020, www.orghort2020.it) was hosted by the “Dipartimento di Agricoltura, Alimentazione e Ambiente” (Di3A) of the University of Catania, Italy, on 14-16 December 2021. The symposium addressed “Rural and urban well-being and agroecological perspectives for the horticultural supply chains.” It defined short, medium, and long

term visions for improving organic farming and related organic food chains. With this purpose, it established an active international network involving all the stakeholders interested in the ongoing focal topics and how to face the new challenges of climate change, which place the agricultural activities in a high responsibility position. Due to the COVID-19 pandemic travel restrictions, the OrgHort2020 event was organized by

webinar and took place at the Dipartimento di Agricoltura, Alimentazione e Ambiente (Di3A), University of Catania (UNICT), under the auspices of ISHS, Società Orticoltura Italiana (SOI), Società Entomologica Italiana (SEI), Società Italiana di Genetica Agraria (SIGA), Società Italiana di Patologia Vegetale (SIPaV), Consiglio Nazionale delle Ricerche (CNR), Accademia delle Scienze della Biodiversità Mediterranea (ASBM), and International Organisation for Biological Control (IOBC). It was sponsored by several partners and coordinated through the Breeding for Resilient, Efficient and Sustainable Organic Vegetable production – G.A. n. 774244 (EU H2020 BRESOV) project. Despite the virtual format, the symposium included 24 oral and 55 poster presentations from 28 different countries. Almost 100 participants attended the sessions.

During the opening session, the conveners Prof. Ferdinando Branca, Prof. Alberto Continella and Prof. Alessandro Tribulato welcomed all the participants. Immediately afterwards, the Rector of the University of Catania, Prof. Francesco Priolo, and the Director of Di3A, Prof. Agatino Russo, sent their welcome greetings to all the participants. They also pointed out the importance of the teaching and researching activities carried out in Catania and in Sicily in supporting the agriculture transition period towards more resilient and sustainable agroecosystems. Prof. Maria Claudia Dussi, Vice-Chair of ISHS Commission Agroecology and Organic Farming Systems, introduced the role of the International Society for Horticultural Science.

This event allowed for the discussion of six thematic topics during the three days of the symposium. Each session was opened by an invited speaker. On the first day, the first session on “Farming, growing methods and techniques” was opened by Prof. Miguel A. Altieri (University of California, Berkeley, USA), who presented the “Agroecological basis for the conversion of horticultural cropping systems.” The oral and poster presentations dealt with specific growing methods and techniques of interest for organic farming. The second session “Genetics and



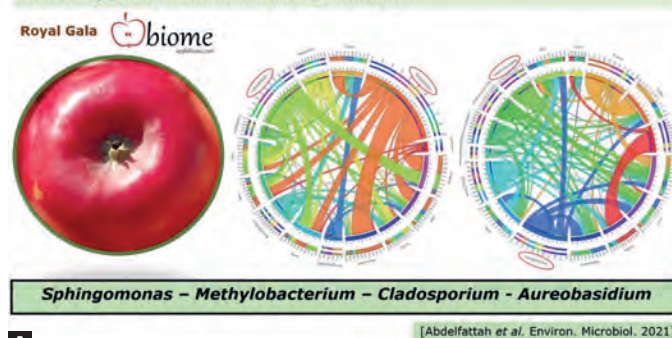
> The conveners: Prof. Ferdinando Branca, Prof. Alberto Continella and Prof. Alessandro Tribulato.

breeding” was opened by Prof. James Myers (Oregon State University, Corvallis, USA) with a presentation on the “NOVIC (Northern Organic Vegetable Improvement Collaborative) as a model for organic plant breeding and trialling to increase farmer choice for certified organic seed.” The other presentations dealt with the main results of the ongoing organic breeding projects. On the second day, the third session “Arthropods and pests control” was opened by Dr. Orlando Campolo (Department of AGRARIA, University of Reggio Calabria, Italy), who expounded on the “Essential oil-based green nano-insecticides: formulation, biological activity and application in ecofriendly pest control strategies.” For the fourth session, “Disease control”, Prof. Gabriele Berg (Institute of Environmental Biotechnology, Graz University of Technology, Austria), presented the “Microbiome research for supporting healthy food and supply chains.” The fifth session, “Crop physiology,” was opened by Lori A. Hoagland (Purdue University, Horticulture and Landscape Architecture, USA), who talked about “Organic vs. conventional cropping systems: impacts on root microbiomes and their functions.” On the third day, session six, “Produce quality,” was opened by Wilfried Schwab (Biotechnology of Natural Products, Technische Universität München, Germany). He lectured on “Bet v1-related allergens in fruit: impact of genotype, climate, and cultivation.” During the symposium, a workshop took place on “Holistic approaches for organic farming systems,” chaired by Stefano Canali (CREA, Italy). Dr. Canali introduced the invited speakers Dr. Veronique Chable (INRAE, Rennes, France), who presented the “Holistic approaches for organic systems based on biological, ethical and cultural foundations,” and Prof. Raffaele Zanolì (Università Politecnica delle Marche, Ancona, Italy), who gave a lecture on the “Sustainability assessment of organic and non-organic systems: a holistic perspective.”

The second workshop on the “Regulatory approaches for seeds and biostimulant registration” took place after the last session and was chaired by Dr. Jennifer Mark (Department of Crop Sciences FiBL, Switzerland). Dr. Mark introduced Dr. Monika Messmer (FiBL, Switzerland), who presented the “New EU Organic regulation (2018/848) on organic heterogeneous material, organic varieties suited for organic production and organic plant reproductive material,” and Dr. Benoit Planques (Hello Nature International, Italy), who talked about “Biostimulants: How to market them in Europe.”

To conclude the third day and the symposium, a round table coordinated by Mr. Bram Moeskops (IFOAM Europe, Brussels, Belgium) and Prof. Maria Claudia Dussi (Comahue National

3. The apple microbiome: the global core



> A) Presentation of Prof. Gabriele Berg on “Microbiome research for supporting healthy food and supply chains”. B) Dr. Monika Messmer talked about the new EU Organic regulation during Workshop 2.

University, Argentina) was held to discuss on the “Future perspectives for organic horticulture,” with the participation of the introducing speakers Prof. Uygun Aksoy (Association of Ecological Agriculture Organization, Ege University, Turkey), Laura Bargione (Rete Siciliana Fattorie Sociali, Italy), Rommel Betancour (Inter-American Commission for Organic Agriculture ICOA, Argentina), Micaela Colley (Organic Seed Alliance, USA), Matthew Grieshop (College of Agriculture and Natural Resources, Michigan State University, USA), Mary Rogers (University of Minnesota, USA), Andrew Hammermeister (Organic Agriculture Centre of Canada, Dalhousy University, Canada), and Srinivasan Ramasamy (World Vegetable Centre, Taiwan), and the participation of Gabriele Berg, Veronique Chable, Orlando Campolo, Lori A. Hoagland, Monika Messmer, and James Myers, who introduced several sessions and workshops of the OrgHort2020 ISHS symposium.

During the ISHS business meeting, Dr. Remi Kahane gave a presentation on the 31st International Horticultural Congress (IHC2022) and Prof. Maria Claudia Dussi presented IHC2022 symposium S15 “Agroecology and System Approach for Sustainable and Resilient Horticultural Production” that will be held in Angers, France. A host for the IV International Organic Fruit Symposium and II International Organic Vegetable Symposium has been identified: the National Institute of Horticultural Research (Instytut Ogród-

nictwa - Państwowy Instytut Badawczy), Warsaw, Poland.

At the end of the symposium, the winners of the ISHS Young Minds Awards were announced: Sophie Stein (Universität Hohenheim, Germany) for the best oral presentation entitled “Effect of leguminous green manure crops and N₂ fixation on cabbage (*Brassica oleracea* convar. *capitata* var. *alba*) growth in organic vegetable production”, and Birgit Lepp (Universität Hohenheim, Germany), for the best poster entitled “Impact of sulphur used as a plant protection agent in organic apple production on nutrient and heavy metal mobility in the soil”. The symposium ended with the congratulations of the conveners and the invitation to participate in the IV International Organic Fruit Symposium and II International Organic Vegetable Symposium in 2024 in Poland.

The event provided an opportunity to discuss important issues of organic farming, for example the application potential of microbial based treatments and the impact of studying the microbiome. The effects of the different organic farming systems were also discussed in comparison with conventional systems. The effects of these different growing techniques aimed to improve the yield and quality of organic products. Furthermore, several presentations have shown how molecular markers and the study of the transcriptome could be powerful tools

to select and improve valuable genotypes in organic farming. Another aspect of the discussion focused on how the organoleptic and nutraceutical traits of organic horticultural products can provide for the well-being of urban and rural communities. Moreover, from not only a scientific but also an application point of view, the two workshops and the round table offered interesting insights for the world-wide research community and for organic farmers, breeders, food communities, and food industries around the world. ●

Giulio Flavio Rizzo and Fabio Arcidiacono

> Contact

Giulio Flavio Rizzo and Fabio Arcidiacono, University of Catania, Department of Agriculture, Food and Environment, Via Valdisavoia 5, 95123 Catania, Italy, e-mail: giulio.rizzo@phd.unict.it and fabio.arcidiacono@studium.unict.it



> ISHS Young Minds Award winners: A) Sophie Stein (best oral presentation), B) Birgit Lepp (best poster).



From the
Secretariat

> New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Australia: Chris Brodie, Ms. Pragya Dhakal Poudel, Dr. Sundar Kalaipandian, Eveline Yee Yan Kong, Dr. Maha Mahadaven, Dr. Kare Mahmud, Mr. Samuel North, Mr. Federico Pucci, Ms. Katelyn Robertson, Mr. Matthew Stewart, Mr. Tatsuyoshi Takagi, Steve Wright; **Austria:** Doris Zeillinger; **Belgium:** Dhekra Abdouli, Mr. Nicolas Ancion, Dr. Tim Belien, Mr. Wael Ben Hmouda, Dr. Sofiene Ben Kaab, Hajer Darouez, Assist. Prof. Caroline De Clerck, Ms. Femke De Vis, Ms. Bérénice Foncoux, Ms. Esther Geukens, Ms. Hajer Ghozlen, Maroua Grira, Elien Guldentops, Noémie Hisette, Mr. Ashkan Hodaei, Ms. Roxane Huart, Ms. Amal Rabaoui, Ms. Elnara Sadigova, Mr. Gilles Stouvenakers, Ms. Iris Szekeky, Ms. Astrid Tempelaere, Mr. Yongjing Wang; **Benin:** Dr. Anicet Dassou, Prof. Polycarpe Kayodé, Mr. Rene Tokannou; **Brazil:** Prof. Lilian Amorim, Prof. Heloisa Costa, Mr. Gabriel Dias de Oliveira; **Bulgaria:** Ms. Anelia Popova; **Canada:** Laurent Carpio, Ms. Kathryn Carter, Arshdeep Singh Gill, Dr. Jason Lanoue,

Ms. Sara-Jane Quechuck, Mr. Md Sazan Rahman, Mr. Ben Simpson; **Chile:** Dr. Rodrigo Araujo, Maria Bas, Mr. Rolf During, Mr. Matias Kulczewski, Dr. Carlos Maldonado, Mr. Gustavo Salazar; **China:** Assist. Prof. Majid Amanibeni, Ms. Weijuan Han, Assist. Prof. Luyang Jing, Caihua Li, Prof. Dr. Nan Ma, Prof. Dr. Lihao Wang, Xujuan Zhang; **Chinese Taipei:** Assoc. Prof. Yu Chih Huang, Assist. Prof. Yu-Hsiu Huang, Assoc. Prof. Chien-Yau Lin, Yu-Ping Tsai; **Colombia:** María Isabel Restrepo Muriel, Assoc. Prof. Luisa Fernanda Rojas; **Congo:** Mr. Janvier Mugisho; **Costa Rica:** Mr. Noel Molina; **Cote d'Ivoire:** Kouamé Germain Koffi, Dr. Demby Laetitia Kouadio spouse Ouattara; **Croatia:** Dr. Tonka Nincevic Runjic; **Czech Republic:** Dr. Magdalena Bryksova; **Denmark:** Ms. Marija Horvat, Assoc. Prof. Lene Sigsgaard; **Ecuador:** Pedro Rodriguez; **Egypt:** Assoc. Prof. Doaa Elkassas; **Finland:** Mr. Javier Andrés, Guangxun Fan, Mr. Juha Jordan, Mikko Lehtonen, Dr. Anja Primetta, Nea Virta; **France:** Cecilia Aguirre,

Dr. Clément Aubry-Tardif, Roxane Baudoin, Ms. Annabelle Bergoend, Agathe Bombail, Ms. Amelie Braye, Christophe Bresse, Prof. Dr. Dominique Cardon, Emma Carrié, Dr. Amélie Chaigneau, Dr. Mathieu Coulis, Dr. Arnaud Dubois, Mr. Stéphane Duchamp, Dr. Anne-Laure Fanciullino, Amandine Faury, Prof. Dr. Florence Fontaine, Berline Fopa Fomeju, Mr. Henry Freulon, Dr. Jonathan Gerbore, Mr. Florent Glatard, Ms. Alix Gombert, Mr. Alain Grenet, Ms. Anne Guerin, Ms. Laura Guillouzo, Ms. Caroline Gutleben, Mr. Marcus Héry, Dr. Marc Labadie, Dr. Samuel Labois, Mr. Luc Lagarde, Dr. Weiji Lan, Mr. Jean Le Maguet, Dr. Agnès Lelièvre, Ms. Valérie Lemetter, Ms. Julie Mallet, Stephanie Mothes, Dr. Peter Biu Ngigi, Mr. Alain Normand, Servane Penvern, Shamsia Python, Ms. Coline Pons, Mr. Christian Rabin, Mr. David Ray, Mr. Juan Pablo Rojas Bustos, Anne Rollet, Ms. Faustine Ruggieri, Marie Ruillé, Mr. Frédéric Saby, Dr. Marie Sauvadet, Assoc. Prof. Raphaëlle Savoie, Ms. Miarka Sinkora, Marie-Cécile Vergneaud;

Georgia: Ms. Marika Kodua; **Germany:** Dr. Roxana Djalali Farahani-Kofoet, Dr. Ehsan Ebrahimi, Dr. Martin Ganai, Dr. Hildegard Garming, Ms. Charlotte Hubert, Ms. Marike Isaak, Mr. Kartik Khera, Luise Knauber, Dr. Bettina König, Mr. Raul Javier Morales Orellana, Dr. Karin Rather, Dr. Elisa Senger, Mr. Akshay Dagadu Sonawane, Adrian Vollmer, Pengyao Xie, Mr. Lars Zimmermann; **Greece:** Dr. Vasileios Anestis, Ms. Pinelopi Baltzoi, Assist. Prof. Persefoni Maletsika, Assoc. Prof. Maria Pappas, Dr. Giorgos Stamtsis; **Guadeloupe:** Steewy Lakhia, Ms. Nilda Paulo-de-la-Reberdière; **Hong Kong:** Mr. Benson Wu; **Hungary:** Assoc. Prof. Peter Honfi, Sundoss Kabalan, Dr. Szilvia Kisvarga, Assist. Prof. Veronika Szabó, Mr. Peter Szuvandzsiev; **India:** Mr. Sourabh Bagla, Dr. Iranagouda Biradar, Dr. Satish Danappagala, Prof. Dr. Kumaran Kalyanasundaram, Dr. Jeyabaskaran Kandallu Jayaraman, Mr. Sufiyan Ismail Khatri, Dr. Lincy Kirubadharsini, Dr. Bal Krishna, Prof. Dr. Loganathan Murugan, Dr. Karthic Raju, Dr. Prashanth S.J., Dr. Kalpana Sathiamoorthy, Dr. Vishwanath Yergenahalli; **Indonesia:** Mr. Rocky Pesik; **Ireland:** Mr. Eamon Kealy, Assist. Prof. Noeleen Smyth; **Israel:** Mr. Tal Duanis-Assaf, Dr. Atalya Keshet Sitton, Prof. Dr. Zvi Koren, David Nestel, Dr. Sayantan Panda, Dr. Adnan Sabehat, Or Shapira; **Italy:** Dr. Elisa Appolloni, Prof. Andrea Bellincontro, Prof. Francesco Beltrame Quattrocchi, Dr. Claudio Brandolli, Dr. Martina Carlessi, Ms. Laura Carotti, Mr. Vito Aurelio Cerasola, Mr. Cameron Cullinan, Assoc. Prof. Gaetano Distefano, Dr. Annamaria L. D'Ortenzio, Dr. Giulia Ferrari, Prof. Dr. Christian Fischer, Mr. Lorenzo Gatti, Dr. Isabella Ghiglieno, Veronica Giorgi, Mr. federico grignaffini, Ms. Francesca Grisafi, Ms. Farwa Jabeen, Dr. Alessandra Lombini, Mr. Roberto Marceddu, Dr. Annamaria Mincuzzi, Dr. Giulia Modica, Paolo Pagan, Tommaso

Pantezzi, Ms. Alice Petrini, Dr. Luca Regni, Dr. Michele Ricupero, Ms. Arleen Rodriguez Declet, Dr. Daniela Spina, Dr. Waed Tarraf, Dr. Simona Maria Tortorici, Ms. Caterina Valerio, Mr. Alessandro Zavatleri, Prof. Angela Zinnai; **Japan:** Fuki Fujiwara, Dr. Mareshige Kojoma, Tomo Matsui, Yuta Miyoshi, Ms. Rina Nakagawa, Mr. Kazuki Okada, Assist. Prof. Takanori Saito, Dr. Hiroyuki Tomiyama, Dr. Toshihiro Umebayashi, Sayaka Yamashita; **Jordan:** Assist. Prof. Mohammad Al-Salem; **Kenya:** Dr. Titus Magomere, Florence Olubayo; **Korea (Republic of):** Mr. Jwayeong Cho, Dr. Alvaro Fuentes, Ms. Dongjun Im, Seongnam Jang, Mr. Kyeong Kang, Dr. Jiah Kim, Mr. U-Su Lee, Byeonggyu Min, Ms. Dahye Ryu, Ms. Minji Shin, Hansol Sim, Yuri Um, Dr. Hong ki Yoon; **Latvia:** Signija Vintere; **Lebanon:** Mr. Paul Abi Nasr; **Lithuania:** Martynas Urbutis; **Malaysia:** Mr. Edric Liang Bin Ong; **Mexico:** Prof. Dr. Cristobal N. Aguilar, Prof. Dr. Fidencio Cruz, Prof. Dr. Julio Cesar Rodriguez; **Morocco:** Ms. Kawtar Ziane; **Nepal:** Mr. Hari Krishna Dhonju; **Netherlands:** Dr. Luyang Kang, Mr. Angelos Mouratidis; **New Zealand:** Ms. Nicola Campbell; **Norway:** Dr. Jahn Davik; **Poland:** Dr. Aleksandra Trzewik; **Portugal:** Mr. André Caeiro, Ms. Daniela Cordeiro, Ms. Cindy Dias, Anabela Fernandes-Silva, Ana Luisa Ferreira Faustino, Dr. Piebiep Goufo, Tércia Lopes, Dr. Liliana Marum, Ms. Mariana Neves, Ana Pedrosa, Joana Ribeiro; **Romania:** Dr. Nora Anghelescu, Mihaela Iordachescu, Nicolae Cristian Jipa, Ms. Emilia Moiescu; **Senegal:** Ndeye Hélène Diallo; **Sierra Leone:** Prof. Abdulai Jalloh; **South Africa:** Dr. Elma Carstens, Mr. Khaya Gould, Ms. Karien Lize Jafta, Dr. Muhali Jimoh, Mr. Nols Kotze, Mr. Norman Munyengwa, Mr. Avela Sogoni; **Spain:** Dr. Ingrid Aguiló, Mar Carreras-Sempere, Fernando Chiamolera, Mr. Pablo Fernández-Cancelo, Ms. Najla Ksouri, Mr. Jesus Llungueras, Dr. Paula Muñoz, Dr.

Juliana Navarro Rocha, Mr. Lorenzo Pérez; **Sri Lanka:** Ms. Darshani Wijayawardhana; **Sweden:** Prof. Olle Anderbrant, Dr. Michael Martin; **Switzerland:** Dr. Pascale Flury, Dr. Joelle Herforth-Rahmé, Matteo Magno, Xavier Simonnet, Louis Sutter; **Thailand:** Suyuporn Lertlam, Ms. Premkamol Nounbunma, Ms. Supornpun Srimat, Assist. Prof. Raheema Wamaedeesa; **Tunisia:** Ms. Rahma Jaouadi, Prof. Dr. Lazhar Zourgui; **United Kingdom:** Ms. Deb Bamford, Mr. Francis Baumont de Oliveira, Mr. Daniel Cudjoe, Mr. Jason Daff, Ms. Emma D'Arcey, Ms. Cindayniah Godfrey, Mr. Haodong Lin, Mr. Lance Mansell, Lucie Maskova, Dr. Danilo Melo, Karen Spurgin, Dr. Marcus Travers, Penny Walsh, Ms. Shonagh Wyatt; **United States of America:** Jaclyn Adaskaveg, Prof. Dr. James Adaskaveg, Mr. T.M. Abir Ahsan, Dan Ambrosi, Heather Andrews, Assoc. Prof. Eric Barrett, Justine Beaulieu, Dr. Matthew Bergen, Eric Bina, Andrew Blunk, Prof. Dr. Stephanie Bolton, Julie Cardon, Kristopher Criscione, Chelsea Dawson, Mr. Philip Engelgau, Melodie Floom, Mr. Rowland Gibson, Prof. George Heimpel, Seanna Hewitt, Ms. Ashley Hoppers, Dr. Nathan Jahnke, Archie Jarman, Sook Jung, Dr. Chandra Kamireddi, Shivani Kathi, Noah Langenfeld, Laura Lara, James Larson, Danielle Lazarus, Tie Liu, Mr. Scott Livingston, Dr. Srinivas Mandava, Dr. Peggy Mauk, Dr. Per McCord, Inga Meadows, Dr. Rene Mogollon, Grey Monroe, Morad Mortaz, Mr. Rainier Peters, Fabiola Guadalu Ramirez Torres, Marlon Retana Cordero, Dr. Jay Rice, Luis Rincon Mautner, Austin Rouse, Nick Sagan, Assist. Prof. German Sandoya-Miranda, Dakson Sanon, Jiyong Shin, Carolyn Sluis, Anne Sorensen, Evan Stowe, Greg Strutner, William Sullivan, Etaferahu Takele, Dr. Mathias Twizeyimana, Stijn Vanderzande, Jacob Wafler, Mr. Jeremy Welty, Nik Wiman, Nicholas Wooller, Dr. Jingsi Yoo.



www.facebook.com/ishs.org

> 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 2022

NEW

- May 23-25, 2022, Pula (Croatia): **VIII International Symposium on Edible Alliums**. Info: Smiljana Goreta Ban, Institute of Agriculture and Tourism, Department of Agriculture and Nutrition, Karla Huguesa 8, 52440 Porec, Croatia. E-mail: smilja@iptpo.hr E-mail symposium: allium2021@iptpo.hr Web: <http://allium2021.iptpo.hr>
- May 29 - June 2, 2022, Limassol/Lemesos (Cyprus): **VI International Symposium on Postharvest Pathology: Innovation and Advanced Technologies for Managing Postharvest Pathogens**. Info: Assist. Prof. Nikolaos Tzortzakakis, Dept. Agricultural Sciences, Biotechnology, Food Science, Cyprus University of Technology, 3036, Lemesos, Cyprus. Phone: (357) 25002280, Fax: (357) 25002838, E-mail: nikolaos.tzortzakakis@cut.ac.cy Web: <http://web.cut.ac.cy/postharvestpathology2021/>
- May 30 - June 3, 2022, Naoussa (Greece): **X International Peach Symposium**. Info: Prof. George Manganaris, Anexartias 57, PAREAS Building, P.O. Box 50329, 3603 Lemesos, Cyprus. Phone: (357)25002307, Fax: (357)25002804, E-mail: george.manganaris@cut.ac.cy or Dr. Athanassios Molassiotis, Pomology lab, Faculty of Agriculture, AUTH, 54 124 Thessaloniki, Greece. Phone: (30)2310 998882, Fax: (30)2310 998882, E-mail: amolasio@agro.auth.gr Web: <https://www.fruitsciences.eu/peach2021>
- June 12-15, 2022, Cordoba (Spain): **XV International Asparagus Symposium**. Info: Juan Gil, Plaza de la oca, 1, 2-1, Córdoba, Spain. E-mail: juan.gil@uco.es or Dr. Roberto Moreno, Universidad de Córdoba. Genetics Department, Campus de Rabanales. Edificio C5. 2ª planta, 14071, Córdoba, Spain. E-mail: g12mopir@uco.es or Dr. Patricia Castro, Universidad de Cordoba. Genetics Department, Campus de Rabanales Edificio C5 2 planta, 14071 Cordoba, Spain. E-mail: patricia.castro@uco.es Web: <https://www.ias2022.com/>
- August 14-20, 2022, Angers (France): **XXXI International Horticultural Congress: IHC2022**. Info: Dr. François Laurens, INRAE, Centre d'Angers, 49071 Beaucouzé, France. Phone: (33)2 41 22 57 63, Fax: (33)2 41 22 57 55, E-mail: francois.laurens@inrae.fr E-mail symposium: info@ihc2022.org Web: <https://www.ihc2022.org/>
- August 14-20, 2022, Angers (France): **International Symposium on Breeding and Effective Use of Biotechnology and Molecular Tools in Horticultural Crops**. Info: Dr. Vincent Gerardus Maria Bus, Plant and Food Research, Private Bag 1401, Havelock North 4157, New Zealand. Phone: (64)69758946, Fax: (64)69758881, E-mail: vincent.bus@plantandfood.co.nz or Dr. Mathilde Causse, INRA-GAFL, BP 94, 84143 Montfavet Cedex, France. E-mail: mathilde.causse@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s1-breeding-and-effective-use-of-biotechnology-and-molecular-tools-in-horticultural-crops/>
- August 14-20, 2022, Angers (France): **International Symposium on Conservation and Sustainable Use of Horticultural Genetic Resources**. Info: Dr. Tiziana Ulian, Royal Botanic Gardens, Kew, Wellcome Trust Millennium Building, Wakehurst, RH17 6TN West Sussex Ardingly, United Kingdom. E-mail: t.ulan@kew.org or Dr. Raphael Morillon, Station CIRAD de Roujol, Petit Bourg, 97170 Guadeloupe, Guadeloupe. Phone: (33)590386162, E-mail: raphael.morillon@cirad.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s2-conservation-and-sustainable-use-of-horticultural-genetic-resources/>
- August 14-20, 2022, Angers (France): **International Symposium on Quality Seeds and Transplants for Horticultural Crops and Restorative Species**. Info: Prof. Dr. Daniel Leskovar, 1619 Garner Field Rd., Texas A&M AgriLife Research, Texas A&M University, Uvalde Texas 78801, United States of America. Phone: (1)830-278-9151, Fax: (1)830-278-1570, E-mail: daniel.leskovar@agnet.tamu.edu or Prof. Dr. Olivier Leprince, 42 rue Georges Morel, 49070 Beaucouzé, France. E-mail: olivier.leprince@agrocampus-ouest.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s3-quality-seeds-and-transplants-for-horticultural-crops/>
- August 14-20, 2022, Angers (France): **International Symposium on In Vitro Technology and Micropropagated Plants**. Info: Dr. Sandra Correia, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)239240700, Fax: (351)239240701, E-mail: sandraimc@uc.pt or Prof. Dr. Stefaan Werbrouck, University Gent, Department Applied Biosciences, Valentin Vaerwyckweg 1, 9000 Gent, Belgium. Phone: (32)9 244 88 59, Fax: (32)9 242 42 79, E-mail: stefaan.werbrouck@ugent.be E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s4-in-vitro-techniques-and-micropropagated-plants/>
- August 14-20, 2022, Angers (France): **International Symposium on Innovations in Ornamentals: from Breeding to Market**. Info: Dr. Johan Van Huylbroeck, ILVO- Plant Sciences Unit, Applied genetics & breeding, Caritasstraat 39, 9090 Melle, Belgium. Phone: (32) 9-2722862, Fax: (32) 9-2722901, E-mail: johan.vanhuylenbroeck@ilvo.vlaanderen.be or Dr. Fabrice Foucher, UMR IRHS, Centre INRA, BP 60057, 49071 Beaucouze, France. E-mail: fabrice.foucher@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s5-innovations-in-ornamentals-from-breeding-to-market/>
- August 14-20, 2022, Angers (France): **International Symposium on Innovative Technologies and Production Strategies for Sustainable Controlled Environment Horticulture**. Info: Assoc. Prof. Youssef Roupheal, University of Naples, Via Università 100, 80055 Portici(Napoli), Italy. E-mail: youssef.rouphael@unina.it or Dr. Jean-Charles Michel, L2Institut Agro - Agrocampus Ouest, 2 rue Le Notre, 49045 Angers, France. Phone: (33)241225422, Fax: (33)241225553, E-mail: jean-charles.michel@agrocampus-ouest.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s6-innovative-technologies-and-production-strategies-for-sustainable-controlled-environment/>
- August 14-20, 2022, Angers (France): **II International Symposium on Greener Cities: Improving Ecosystem Services in a Climate-Changing World (GreenCities2022)**. Info: Dr. Vivian Loges, Univ.Federal Rural de Pernambuco, Rua José Bezerra de Albuquerque 38a, Recife, 54315-580,

Symposia at IHC2022:

- August 14-20, 2022, Angers (France): **International Symposium on Breeding and Effective Use of Biotechnology and Molecular Tools in Horticultural Crops**. Info: Dr. Vincent Gerardus Maria Bus, Plant and Food Research, Private Bag 1401, Havelock North 4157, New Zealand. Phone: (64)69758946, Fax: (64)69758881, E-mail: vincent.bus@plantandfood.co.nz or Dr. Mathilde Causse, INRA-GAFL, BP 94, 84143 Montfavet Cedex, France. E-mail: mathilde.causse@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s1-breeding-and-effective-use-of-biotechnology-and-molecular-tools-in-horticultural-crops/>
- August 14-20, 2022, Angers (France): **International Symposium on Conservation and Sustainable Use of Horticultural Genetic Resources**. Info: Dr. Tiziana Ulian, Royal Botanic Gardens, Kew, Wellcome Trust Millennium Building, Wakehurst, RH17 6TN

- Brazil. Phone: (51)8134624552, Fax: (51)8133206250, E-mail: vloges@yahoo.com or Mr. Philippe Faucon, 22 rue de l'Arse-nal, 17300 ROCHEFORT, France. Phone: (33)546991701, E-mail: p.faucon@cirt-horticole.com E-mailsymposium:sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s7-greencities2022/>
- August 14-20, 2022, Angers (France): **International Symposium on Advances in Vertical Farming.** Info: Eri Hayashi, 6-2-1 Kashiwanoha, Kashiwa 277-088, Japan. E-mail: ehayashi@npoplantfactory.org 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 E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s8-advances-in-vertical-farming/>
 - August 14-20, 2022, Angers (France): **International Symposium on Urban Horticulture for Sustainable Food Security (UrbanFood2022).** Info: Dr. Kathrin Specht, Arndtstrasse 15, 10965 Berlin, Germany. E-mail: kathrin.specht@ils-forschung.de or Dr. Kevin Morel, 16, rue Claude Bernard, 75231 Paris, France. E-mail: kevin.morel@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s9-urban-horticulture-for-sustainable-food-security/>
 - August 14-20, 2022, Angers (France): **International Symposium on Value Adding and Innovation Management in the Horticultural Sector.** Info: Dr. David Neven, FAOB605, Italy. E-mail: david.neven@fao.org or Dr. Syndhia Mathé, CIRAD-UMR Innovation / CSIR-STEPRI, P.O Box CT 519, Cantonments, Accra, Ghana. E-mail: syndhia.mathe@cirad.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s10-value-adding-and-innovation-management-in-the-horticultural-sector/>
 - August 14-20, 2022, Angers (France): **International Symposium on Adaptation of Horticultural Plants to Abiotic Stresses.** Info: Dr. Fulai Liu, Department of Plant & Environmental Science, University of Copenhagen, Hoeibakkegaard Alle 13, 2630 Taastrup, Denmark. Phone: (45)3533 3392, Fax: (45)35333478, E-mail: fl@plen.ku.dk or Dr. Bénédicte Wenden, INRA - UMR BFP - 71 avenue Edouard Bourlaux, 33882 Villenave d'Ornon Cedex, France. Phone: (33)557122549, E-mail: benedicte.wenden@inrae.fr E-mailsymposium:sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s11-adaptation-of-horticultural-plants-to-abiotic-stresses/>
 - August 14-20, 2022, Angers (France): **International Symposium on Water: a Worldwide Challenge for Horticulture!** Info: Brunella Morandi, Università di Bologna, Viale Fanin 44, 40127 Bologna, Italy. E-mail: brunella.morandi@unibo.it or Dr. Marcel Kuper, 361 rue Jean-François Breton, 34196 Montpellier, France. E-mail: kuper@cirad.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s12-water-a-worldwide-challenge-for-horticulture/>
 - August 14-20, 2022, Angers (France): **International Symposium on Plant Nutrition, Fertilization, Soil Management.** Info: Assoc. Prof. Lee Kalcsits, Washington State University, WSU-TFREC, Wenatchee, WA 98801, United States of America. Phone: (1)5096638181, E-mail: lee.kalcsits@wsu.edu or Prof. Patrice Cannavo, Agrocampus Ouest, Unité de Recherche EPHor, 2 rue André Le Notre, 49045 Angers, France. E-mail: patrice.cannavo@agrocampus-ouest.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s13-plant-nutrition-fertilization-soil-management/>
 - August 14-20, 2022, Angers (France): **International Symposium on Sustainable Control of Pests and Diseases.** Info: Prof. Lucia Zappala, viale tirreno, 31, 95123 Catania, Italy. E-mail: lzapppala@unict.it or Dr. Michel Peterschmitt, Campus International de Baillarguet, CIRAD, TA A-120K, 34398 Montpellier Cedex 5, France. E-mail: michel.peterschmitt@cirad.fr E-mailsymposium:sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s14-sustainable-control-of-pests-and-diseases/>
 - August 14-20, 2022, Angers (France): **International Symposium on Agroecology and System Approach for Sustainable and Resilient Horticultural Production.** Info: Prof. Dr. Maria Claudia Dussi, Universidad Nacional del Comahue, Facultad de Ciencias Agrarias, CC 85 (8303) Cinco Saltos, Rio Negro-Patagonia, Argentina. Phone: (54) 299 9 5719365, E-mail: mcdussi@yahoo.com or Dr. Sylvaine Simon, INRAE Gotheron, 460 Chemin de Gotheron, 26320 Saint-Marcel-lès-Valence, France. Phone: (33)432722206, Fax: (33)475588626, E-mail: sylvaine.simon@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s15-agroecology-and-system-approach-for-sustainable-and-resilient-horticultural-production/>
 - August 14-20, 2022, Angers (France): **International Symposium on Innovative Perennial Crops Management.** Info: Dr. Sara Serra, Washington State University, Department of Horticulture, Pullman, WA 99164, United States of America. E-mail: sara.serra@wsu.edu or Dr. Pierre-Eric Lauri, UMR SYSTEM, INRA, Place Pierre Viala, 34060 Montpellier, France. Phone: (33)499613054, E-mail: pierre-eric.lauri@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s16-innovative-perennial-crops-management/>
 - August 14-20, 2022, Angers (France): **International Symposium on Integrative Approaches to Product Quality in Fruits and Vegetables.** Info: Alyson Mitchell, Department of Food Science Technology, UC Davis, 1 Shields Ave, Davis CA 95616, United States of America. Phone: (1)5303046618, E-mail: aemitchell@ucdavis.edu or Dr. Nadia Bertin, UR 1115 PSH, INRA, Domaine St Paul, 228 route de l'aérodrome, Site Agroparc, 84914 Avignon, France. Phone: (33)0432722324, E-mail: nadia.bertin@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s17-integrative-approaches-to-product-quality-in-fruits-and-vegetables/>
 - August 14-20, 2022, Angers (France): **III International Symposium on Mechanization, Precision Horticulture, and Robotics: Precision and Digital Horticulture in Field Environments.** Info: Dr. Sindhuja Sankaran, Washington State University, P.O. Box 641020, Pullman Washington 99164, United States of America. Phone: (1)5093358828, E-mail: sindhuja.sankaran@wsu.edu or Prof. David Rousseau, Université d'Angers, 62 Avenue Notre Dame du Lac, 49000 Angers, France. Phone: (33)638291612, E-mail: david.rousseau@univ-angers.fr E-mailsymposium:sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s18-precision-and-digital-horticulture-in-field-environments/>
 - August 14-20, 2022, Angers (France): **International Symposium on Advances in Berry Crops.** Info: Dr. Susan McCallum, The James Hutton Institute, Errol Road, Invergowrie, DD2 5DA Dundee, Scotland, United Kingdom. E-mail: susan.mccallum@hutton.ac.uk or Dr. Béatrice Denoyes, 71 avenue Edouard Bourlaux, 33882 Villenave d'Ornon, France. E-mail: beatrice.denoyes@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s19-advances-in-berry-crops/>
 - August 14-20, 2022, Angers (France): **International Symposium on the Vitivinicultural Sector: Which Tools to Face Current Challenges.** Info: Prof. Dr. Ahmet Altindisli, Ege University Faculty of Agriculture, Department of Horticulture, 35100 Bornova Izmir, Turkey. Phone: (90)2323882622, Fax: (90)2323881865, E-mail: ahmet.altindisli@gmail.com or Assoc. Prof. Benjamin Bois, BiogéosciencesUMR6282CNRSuB, France. Phone: (33)662605225, E-mail: benjamin.bois@u-bourgogne.fr E-mailsymposium:sciences@ihc2022.org

Web: <https://www.ihc2022.org/symposia/s20-the-vitivicultural-sector-which-tools-to-face-current-challenges/>

- August 14-20, 2022, Angers (France): **XII International Symposium on Banana: Celebrating Banana Organic Production**. Info: Mr. Walter Ocimati, Bioversity International, Plot 106, Katalima Road, P. O. Box 24384, 256 Kampala, Uganda. Phone: (256)414286213, Fax: (256)414286949, E-mail: w.ocimati@cgiar.org or Dr. Thierry Lescot, CIRAD, RU GECO, Persyst Department, Boulevard de la Lironde, TA B26/PS4, 34398 Montpellier, France. Phone: (33)467615666, Fax: (33)467615821, E-mail: thierry.lescot@cirad.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s21-international-symposium-on-banana-celebrating-banana-organic-production/>

- August 14-20, 2022, Angers (France): **International Symposium on Natural Colorants from Plants**. Info: Assoc. Prof. Riikka Räisänen, Craft Studies P.O. Box 8, Finland. E-mail: riikka.raisanen@helsinki.fi or Ms. Anne de la Sayette, 22 rue de l'Arsenal, 17300 ROCHEFORT, France. Phone: (33)54699170, E-mail: arrdhor@wanadoo.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s22-natural-colorants-from-plants/>

- August 14-20, 2022, Angers (France): **International Symposium on Postharvest Technologies to Reduce Food Losses**. Info: Gustavo Teixeira, Av. José Adriano Arrobas Martins, 210, 14.883-298 Jaboticabal São Paulo, Brazil. E-mail: teixeiragha@yahoo.com.br or Dr. Florence Charles, Université d'Avignon, 301 rue Baruch de Spinoza, BP 21239, cedex 9, 84916 Avignon, France. Phone: (33)4.90.84.22.08, E-mail: florence.charles@univ-avignon.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s23-post-harvest-technologies-to-reduce-food-losses/>

- August 14-20, 2022, Angers (France): **IX International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2022**. Info: Assoc. Prof. Kaleab Baye, Bole Sub-city, Addis Ababa, Ethiopia. E-mail: kaleab.baye@aau.edu.et or Dr. Marie-Joséphine Amiot Carlin, INRAE, 2 place Pierre Viala, Campus La Gaillarde, 34060 Montpellier, France. E-mail: marie-josephe.amiot-carlin@inrae.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s24-horticulture-for-nutrition-and-food-security-health-and-well-being/>

- August 14-20, 2022, Angers (France): **International Symposium on Medicinal and Aromatic Plants: Domestication, Breeding, Cultivation and New Perspectives**. Info: Dr. Christoph Carlen, Agroscope, Route des Eterpys 18, 1964 Conthey, Switzerland. Phone: (41) 58 481 35 13, E-mail: christoph.carlen@agroscope.admin.ch or Mr. Philippe Gallois, ITEIPMAI, France. Phone: (33)475918146, E-mail: philippe.gallois@iteipmai.fr E-mail symposium: sciences@ihc2022.org Web: <https://www.ihc2022.org/symposia/s25-medicinal-and-aromatic-plants-domestication-breeding-cultivation-and-new-perspectives/>

- September 5-9, 2022, Corvallis, OR (United States of America): **X International Congress on Hazelnut**. Info: Prof. Shawn A. Mehlenbacher, Department of Horticulture, 4017 ALS Bldg., Oregon State University, Corvallis, OR 97331-7304, United States of America. Phone: (1)5417375467, Fax: (1)5417373479, E-mail: mehlenbs@hort.oregonstate.edu Web: <https://hazelnut2022.org/>

- September 26-29, 2022, João Pessoa, Paraíba (Brazil): **X International Congress on Cactus Pear and Cochineal**. Info: Mr. Mário Borba, 1571 Rio Grande do Sul Avenue, 58030021 João Pessoa-Paraíba, Brazil. E-mail: presidente@faepapb.com.br E-mail symposium: cactuscongress2022@faepapb.com.br Web: <http://www.cactuscongress2022.com>

- November 6-11, 2022, Mersin (Turkey): **XIV International Citrus Congress**. Info: Prof. Dr. Bilge Yilmaz, Cukurova University, Turkey.

Phone: (+90)3223386388, Fax: (+90)3223386388, E-mail: bilgeyil@cu.edu.tr E-mail symposium: secretariat@citruscongressturkey.org Web: <https://www.citruscongressturkey.org/>

- November 15-18, 2022, Molfetta (Italy): **XI International Symposium on Artichoke, Cardoon and their Wild Relatives**. Info: Prof. Giancarlo Colelli, Dip. DAFNE Università di Foggia, Italy. Phone: (39) 320 4394535, E-mail: giancarlo.colelli@unifg.it or Prof. Antonio Elia, Dip. DAFNE - University of Foggia, Italy. Phone: (39)0881589237, E-mail: antonio.elia@unifg.it E-mail symposium: info@artichoke2022.org Web: <https://artichoke2022.org/>
- December 15-18, 2022, Guangzhou (China): **IV International Orchid Symposium**. Info: Prof. Dr. Genfa Zhu, Enviromental Horticulture Research Inst., Guangdong Academy of Agricultural Sciences, No. 1 East Jinying Street 1, Wushan Road, Tianhe district, 510640 Guangzhou, China. E-mail: genfazhu@163.com Web: <http://www.ios2022.cn/>

Year 2023

- January 22-26, 2023, Stellenbosch (South Africa): **XIV International Pear Symposium**. Info: Dr. Elke Crouch, University of Stellenbosch, Horticulture, Consumer Sciences Building, Private Bag X1, 7602 Matieland, South Africa. Phone: (27)218084763, Fax: (27)218082121, E-mail: elke@sun.ac.za or Prof. Karen I. Theron, Department of Horticulture, University of Stellenbosch, Private Bag X1, Matieland 7602, South Africa. Phone: (27)218084762, Fax: (27)218082121, E-mail: kit@sun.ac.za
- January 29 - February 2, 2023, Stellenbosch (South Africa): **X International Symposium on Irrigation of Horticultural Crops**. Info: Prof. Stephanie Midgley, Research and Technology Development Service, Western Cape Department of Agriculture, Private Bag X1, Elsenburg, 7607, South Africa. Phone: (27)218085080, E-mail: stephaniem@elsenburg.com or Dr. Carlos Poblete-Echeverría, Stellenbosch University, Department of Viticulture and Oenology, Faculty of AgriSciences, SAGWRI, Matieland 7602, South Africa. Phone: (27)218082747, E-mail: cpe@sun.ac.za or Dr. Nicolette Taylor, Dept Plant Production and Soil Science, University of Pretoria, Private Bag X20, 0028 Gauteng Hatfield, South Africa. Phone: (27)124203666, Fax: (27)124204120, E-mail: nicolette.taylor@up.ac.za Web: <https://ishsirrigationsa2023.com>
- February 20-25, 2023, Tauranga (New Zealand): **XI International Symposium on Kiwifruit**. Info: Dr. Marisa Till, Zespri International Ltd., 400 Maunganui Road, 3172 BOP Mount Maunganui, New Zealand. Phone: (64) 21 344 559, E-mail: marisa.till@zespri.com or Dr. Sarah Pilkington, 120 Mt Albert Road, Mt Albert, 1025 Auckland, New Zealand. Phone: (64)21-809645, E-mail: sarah.pilkington@plantandfood.co.nz
- April 24-27, 2023, Murcia (Spain): **III International Symposium on Beverage Crops**. Info: Rocio Gil Muñoz, Avda Ntra Sra de la Asunción N24, 30520 Jumilla, Spain. E-mail: mariar.gil2@carm.es or Prof. Dr. Encarna Gómez-Plaza, Universidad de Murcia, Fac. Veterinaria, Dep. Tecnología Alimentos, Campus Espinardo, 30071 Murcia Murcia, Spain. Phone: (34) 868887323, E-mail: encarna.gomez@um.es or Prof. Dr. Cristina Garcia-Viguera, Phytochemistry and Healthy Foods Lab, Dept Food Science Technoloy CEBAS-CSIC, Campus Espinardo 25, Espinardo, 30100 Murcia, Spain. Phone: (34) 968396200, Fax: (32)9686213, E-mail: cgviguer@cebas.csic.es Web: <https://www.bevcrops21.es/>
- May 1-5, 2023, Uvero Alto, La Altagracia (Dominican Republic): **X International Pineapple Symposium**. Info: Mr. Joelin Santos, AsoproPimopla, C/ Altagracia 100, Monte Plata, Dominican Republic. Phone: (829)745-0318, E-mail: j.santos@asopropimopla.org E-mail symposium: xpineapple2020@gmail.com Web: <http://www.cedaf.org.do/eventos/xpineapple2020/>

- May 7-12, 2023, Davis, CA (United States of America): **VIII International Symposium on Almonds and Pistachios.** Info: Dr. Louise Ferguson, 2037 Wickson Hall, Plant Sciences Department Mail Stop II, UC Davis 1 Shields Ave. Davis CA 95616, United States of America. Phone: (1) 559 737 3061, Fax: (1) 530 752 8502, E-mail: lferguson@ucdavis.edu or Dr. Thomas M. Gradziel, Department of Pomology, University of California, 1 Shields Avenue, Davis, CA 95616-8683, United States of America. E-mail: tmgradziel@ucdavis.edu or Bruce Lampinen, Dept of Plant Sciences, University of California, 1 Shields Avenue, Davis, CA 95616, United States of America. E-mail: bdlampinen@ucdavis.edu Web: https://ucanr.edu/sites/Almond_Pistachio_2021/
- May 14-16, 2023, Wageningen (Netherlands): **XII International Symposium on Postharvest Quality of Ornamental Plants.** Info: Prof. Dr. Ernst J. Woltering, Wageningen UR, Food and Biobased research, PO Box 17, 6700 AA Wageningen, Netherlands. E-mail: ernst.woltering@wur.nl or Rob Schouten, Wageningen University, Horticulture and Product Physiology, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands. E-mail: rob.schouten@wur.nl Web: <https://www.wur.nl/en/show/Postharvest-Unlimited-Conference-Postharvest-Ornamentals-Symposium.htm>
- May 14-18, 2023, Wageningen (Netherlands): **VII International Conference Postharvest Unlimited.** Info: Prof. Dr. Ernst J. Woltering, Wageningen UR, Food and Biobased research, PO Box 17, 6700 AA Wageningen, Netherlands. E-mail: ernst.woltering@wur.nl or Rob Schouten, Wageningen University, Horticulture and Product Physiology, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands. E-mail: rob.schouten@wur.nl Web: <https://www.wur.nl/en/show/Postharvest-Unlimited-Conference-Postharvest-Ornamentals-Symposium.htm>
- May 21-25, 2023, Beijing (China): **IX International Cherry Symposium.** Info: Prof. Dr. Kaichun Zhang, Beijing Academy of Forestry & Pomology Sci., Jia 12, Ruiwangfen, Xiangshan Str, Haidian, Beijing, 100093, China. Phone: (86)1082596007, E-mail: kaichunzhang@126.com or Prof. Li Tianhong, No. 2 Old Summer Palace West Road, Haidian District, Beijing, China. E-mail: lith@cau.edu.cn or Assoc. Prof. Guohua Yan, Jia 12, Xiangshanruiwangfen, Beijing, China. E-mail: bigjohn6524@hotmail.com E-mail symposium: cherrysymposium9@126.com Web: <http://2021.cherries.org.cn/>
- May 23-26, 2023, 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 Brasília-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
- June 6-8, 2023, Almería (Spain): **X International Symposium on Soil and Substrate Disinfestation.** Info: Dr. Miguel de Cara, IFAPA-Centro La Mojonera, Camino San Nicolás, 1, 04745. La Mojonera, Almería, Spain. Phone: (34)671532026, Fax: (34)950558055, E-mail: franciscom.cara@juntadeandalucia.es
- June 11-14, 2023, Potsdam (Germany): **VII International Symposium on Applications of Modelling as an Innovative Technology in the Horticultural Supply Chain - Model-IT 2023.** Info: Dr. Pramod Mahajan, Leibniz Inst. Agric. Engineering, Dept. Hort. Eng., Leibniz Inst. Agric. Eng., (ATB), Max-Eyth-Allee 100, D-14469 Potsdam, Germany. E-mail: pmahajan@atb-potsdam.de or Dr. Martin Geyer, Inst. for Agricultural Eng. and Bioeconomy, Dept. Horticultural Engineering, Max-Eyth-Allee 100, D-14469 Potsdam, Germany. Phone: (49)3315699610, Fax: (49)3315699849, E-mail: mgeyer@atb-potsdam.de or Dr. Manuela

Zude-Sasse, Leibniz Institute for Agricultural, Engineering and Bioeconomy (ATB), Max-Eyth-Allee 100, 14469 Potsdam-Bornim, Germany. Phone: (49)3315699612, Fax: (49)3315699849, E-mail: mzude@atb-potsdam.de E-mail symposium: model-it2023@atb-potsdam.de

- June 13-15, 2023, Oslo (Norway): **IV International Symposium on Plant Cryopreservation.** Info: Dr. Dag-Ragnar Blystad, NIBIO - Norwegian Institute of Bioeconomy R, Division of Biotechnology and Plant Health, Høgskoleveien 7, No-1431 Ås, Norway. Phone: (47)90872588, E-mail: dag-ragnar.blystad@nibio.no Web: <https://nibio.pameldingssystem.no/cryo-2023>
- June 18-21, 2023, Zagreb (Croatia): **V Balkan Symposium on Fruit Growing.** Info: Prof. Dr. Boris Duralija, University of Zagreb Faculty of Agriculture, Department of Pomology, Svetosimunska 25, 10 000 Zagreb, Croatia. Phone: (385)12393726, Fax: (385)12393630, E-mail: bduralija@agr.hr or Prof. Dr. Martina Skendrovic Babojelic, Faculty of Agriculture University of Zagreb, Department of Pomology, Svetosimunska 25, 10000 Zagreb, Croatia. Phone: (385)1 23 94 070, Fax: (385)1 23 93 630, E-mail: mskendrovic@agr.hr
- June 26-29, 2023, Lugo (Spain): **VII International Chestnut Symposium.** Info: Prof. Santiago Pereira-Lorenzo, Universidad de Santiago de Compostela, Escola Politécnica Superior de Ingeniería, Avda. Benigno Ledo sn, 27002 Lugo (Galicia), Spain. Phone: (34)982823128, E-mail: santiago.pereira.lorenzo@usc.es E-mail symposium: ChestnutLugo21@gmail.com Web: <http://chestnutsymposium.com/>
- June 26-28, 2023, Almería (Spain): **International Symposium on Models for Plant Growth, Environments, Farm Management in Orchards and Protected Cultivation.** Info: 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 or Dr. Lorenzo Leon, IFAPA Centro "Alameda del Obispo", Avda. Menendez Pidal s/n, E-14004, Córdoba, Spain. Phone: (34)671532697, Fax: (34)957016043, E-mail: lorenzo.leon@juntadeandalucia.es E-mail symposium: horchimodel2021@ual.es Web: <http://www2.ual.es/horchimodel2021/>
- June 27 - July 1, 2023, Guangzhou (China): **VII International Symposium on Lychee, Longan and Other Sapindaceae Fruits.** Info: Prof. Dr. Xuming Mr. Huang, College of Horticulture, South China Agricultural University, Guangzhou 510642, China. Phone: (86)2085283086, Fax: (86)85282107, E-mail: huangxm@scau.edu.cn
- July 2-5, 2023, Genoa (Italy): **XXVII International Eucarpia Symposium Section Ornamentals - From Nature to Culture: Breeding Ornamentals for Sustainability.** Info: Mauro Mariotti, DISTAV, University of Genoa, Corso Europa 26, 16132 Genova, Italy. Phone: (39)3538139, E-mail: m.mariotti@unige.it
- July 3-7, 2023, Bari (Italy): **I International Symposium on Plant Propagation, Nursery Organization and Management for the Production of Certified Fruit Trees.** Info: Prof. Salvatore Camposeo, Università di Bari, Dipt. di Scienze Agro-Ambientali e Territor, Via Amendola 165/a, 70126 Bari, Italy. Phone: (39)0805442982, Fax: (39)0805442982, E-mail: salvatore.camposeo@uniba.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 or Prof. Vito Nicola Savino, University of Bari - Microbiologia Applic., Dip. Protezione delle Piante, Via Amendola 165a, 70126 Bari, Italy. Phone: (39)0805443069, Fax: (39)0805443608, E-mail: viton.savino@gmail.com E-mail symposium: info@certfruit2020.org Web: <http://www.certfruit2020.org>

For updates logon to www.ishs.org/symposia

> Available issues of *Acta Horticulturae*

Available numbers of *Acta Horticulturae* (print). In addition any *Acta Horticulturae* title is also available in the electronic **e-Acta Horticulturae** format for online access or on USB-drive. To order *Acta Horticulturae* or for more information on price and availability, including tables of content, please check out the 'publications' page at www.ishs.org or go straight to www.actahort.org

Acta Number	Acta Title	Price (EUR)
1334	II International Symposium on Tropical and Subtropical Ornamentals	97
1333	IX International Symposium on Mineral Nutrition of Fruit Crops	99
1332	X International Symposium on Kiwifruit	109
1331	IV International Symposium on Woody Ornamentals of the Temperate Zone	85
1330	XV International People Plant Symposium and II International Symposium on Horticultural Therapies: the Role of Horticulture in Human Well-being and Social Development	78
1329	VIII International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH 2021	62
1328	V International Humulus Symposium	61
1327	IV International Symposium on Horticulture in Europe - SHE2021	186
1326	VII South-Eastern Europe Symposium on Vegetables and Potatoes	86
1325	V International Symposium on Postharvest Pathology: From Consumer to Laboratory-Sustainable Approaches to Managing Postharvest Pathogens	92
1324	VIII International Scientific and Practical Conference on Biotechnology as an Instrument for Plant Biodiversity Conservation (Physiological, Biochemical, Embryological, Genetic and Legal Aspects)	106
1323	IV International Symposium on Postharvest Pathology: Next Generation Innovation and Commercial Solutions for Postharvest Pathology to Reduce Losses, Enhance Quality, and Ensure Product Safety	57
1322	XII International Symposium on Plum and Prune Genetics, Breeding and Pomology	93
1321	III International Symposium on Soilless Culture and Hydroponics: Innovation and Advanced Technology for Circular Horticulture	81
1320	VIII South-Eastern Europe Symposium on Vegetables and Potatoes	92
1319	IV International Conference on Fresh-Cut Produce: Maintaining Quality and Safety	75
1318	VIII International Symposium on Walnut, Cashew and Pecan	71
1317	II International Symposium on Growing Media, Soilless Cultivation, and Compost Utilization in Horticulture	95
1316	VI International Symposium on Tomato Diseases: Managing Tomato Diseases in the Face of Globalization and Climate Change	67
1315	I International Conference and X National Horticultural Science Congress of Iran (IrHC2017)	152
1314	International Symposium on Precision Management of Orchards and Vineyards	109
1313	International Symposium on Horticultural Therapies: Past, Present and Future	44
1311	VI International Symposium on Applications of Modelling as an Innovative Technology in the Horticultural Supply Chain Model-IT 2019	125
1310	VI International Symposium on Fig	67
1309	IX International Strawberry Symposium	230
1308	II International Symposium on Fruit Culture along Silk Road Countries	93
1307	XV EUCARPIA Symposium on Fruit Breeding and Genetics	108
1306	II International Symposium on Moringa	82
1305	III International Symposium on Growing Media, Composting and Substrate Analysis	124
1304	IX International Peach Symposium	87
1303	XIII International Pear Symposium	125
1302	II International Symposium on Vegetable Grafting	76
1301	XIII International Asparagus Symposium	67
1300	XI International Workshop on Sap Flow	63
1299	XXX International Horticultural Congress IHC2018: VII International Symposium on Tropical and Subtropical Fruits, Avocado, II International Symposium on Jackfruit and Other Moraceae and II International Symposium on Date Palm	108
1298	I International Symposium on Botanical Gardens and Landscapes	145
1297	XXX International Horticultural Congress IHC2018: V International Symposium on Plant Genetic Resources and International Symposium on Applied Functional Molecular Biology	150
1296	International Symposium on Advanced Technologies and Management for Innovative Greenhouses: GreenSys2019	254
1295	EUFRIN Fruit Thinning Working Group Symposium	39
1294	VI International Symposium on Cucurbits	74
1293	VI International Symposium on Lychee, Longan and Other Sapindaceae Fruits	76
1292	XXX International Horticultural Congress IHC2018: International Symposium on Fruit and Vegetables for Processing, International Symposium on Quality and Safety of Horticultural Products and VII International Symposium on Human Health Effects of Fruits and	99
1291	III International Symposium on Germplasm of Ornamentals	81
1290	XVII International Symposium on Apricot Breeding and Culture	68
1289	IV Balkan Symposium on Fruit Growing	74
1288	IX International Symposium on New Ornamental Crops	64
1287	XXX International Horticultural Congress IHC2018: International Symposium on Medicinal and Aromatic Plants, Culinary Herbs and Edible Fungi, IV International Jujube Symposium and VI International Symposium on Saffron Biology and Technology	98
1286	XXX International Horticultural Congress IHC2018: II International Symposium on Organic Horticulture for Wellbeing of the Environment and Population	75
1285	XXX International Horticultural Congress IHC2018: II International Symposium on Micropropagation and In Vitro Techniques	67
1284	X International Symposium on Artichoke, Cardoon and Their Wild Relatives	71
1283	XXVI International Eucarpia Symposium Section Ornamentals: Editing Novelty	68
1282	XXX International Horticultural Congress IHC2018: II International Symposium on Plant Breeding in Horticulture	101
1281	XXX International Horticultural Congress IHC2018: International Symposium on Cultivars, Rootstocks and Management Systems of Deciduous Fruit and Fruit Tree Behaviour in Dynamic Environments	147

For an updated list of all titles (in print, USB-drive or e-Acta Horticulturae format) logon to www.actahort.org

> *Chronica Horticulturae* author information

Chronica Horticulturae is the quarterly publication of the International Society for Horticultural Science (ISHS) and is received by all members of the Society and numerous libraries throughout the world. Members and non-members are urged to contribute articles for consideration. However, it needs to be understood that *Chronica* is not to be construed as a scientific journal that publishes original research. Research articles appropriate for *eJHS*, *Fruits* or *Acta Horticulturae* are usually inappropriate for *Chronica*. We seek horticultural articles of interest to a broad audience composed of ISHS members and the horticultural, scientific, and academic communities.

Chronica Horticulturae is currently made up of as many as nine sections as follows:

News & Views from the Board. This section is usually confined to editorials from Board Members as well as general announcements of the Society.

Issues. Articles of a broad focus that often involve controversial topics related to horticulture, including broad social issues and economic development, are appropriate for this section. These articles are intended to stimulate discussion. Often, guest writers are invited to contribute articles.

Spotlight on Honoured ISHS Members. ISHS Fellows and Honorary Members complete an interview on how they started and progressed in their careers, what affected their decisions and attitudes and how their involvement with the ISHS assisted them. In addition, they are invited to comment on how they see the future of horticultural science for young people. Articles in this section are by invitation only.

Horticultural Science Focus. This section is intended for in-depth articles on a topic of horticulture that is generally, but not always, scientific in nature. Many articles are mini-reviews and will provide up-to-date information on current topics of interest to the horticultural community. We encourage these articles to be illustrated.

Horticultural Science News. Shorter articles about current topics including horticultural commodities and disciplines are welcome.

History. This section includes articles on the history of horticulture, horticultural crops, and the ISHS.

The World of Horticulture. Articles in this section highlight horticultural industries and research institutions of particular countries or geographic regions throughout the world. Illustration with figures and tables is extremely helpful and highly advised. This section also includes book reviews that are requested by the Editor. Members who wish to recommend a book review should arrange for a copy of the book to reach the Secretariat.

Symposia and Workshops. Meetings under the auspices of ISHS are summarized, usually by a participant of the meeting. These articles are arranged by the symposium organizers.

News from the ISHS Secretariat. This section contains information on membership, memorials of deceased ISHS members, and a calendar of ISHS events. Brief memorials (up to 500 words) should be sent to the Secretariat.

Authors who wish to submit articles for publication in *Chronica* should contact ISHS headquarters and their request will be transmitted to the Editor. Authors should be aware that most articles should have a broad international focus. Thus, articles of strictly local interest are generally unsuited to *Chronica*. Illustrated articles are usually 1500 to 5000 words long. There are no page charges for *Chronica Horticulturae*. Photographs submitted should be of high resolution (≥ 300 pixels per inch). Send articles or ideas for articles to:

Kim Hummer, Editor, hummerk@oregonstate.edu
Kelly Van Dijck, Associate Editor, kelly.vandijck@ishs.org

