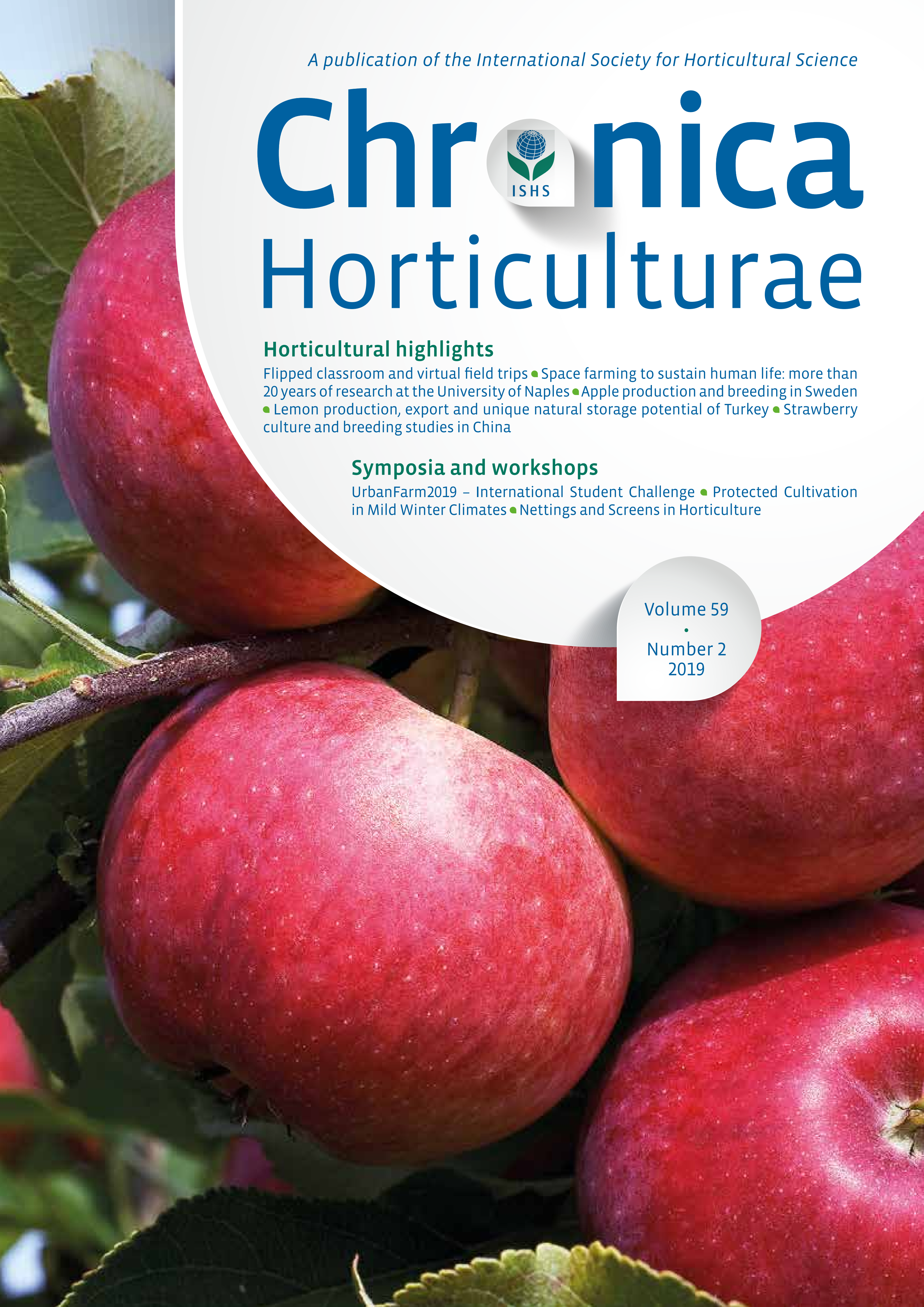
A publication of the International Society for Horticultural Science

Chronica Horticulturae

ISHS



Horticultural highlights

Flipped classroom and virtual field trips • Space farming to sustain human life: more than 20 years of research at the University of Naples • Apple production and breeding in Sweden • Lemon production, export and unique natural storage potential of Turkey • Strawberry culture and breeding studies in China

Symposia and workshops

UrbanFarm2019 – International Student Challenge • Protected Cultivation in Mild Winter Climates • Nettings and Screens in Horticulture

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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**.

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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**.

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

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Pubhort is a service of ISHS as part of its mission to promote and to encourage research in all branches of horticulture, and to efficiently transfer knowledge on a global scale. 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

Cover photograph: The home garden apple cultivar 'Gratia' was bred at Balsgård, Swedish University of Agricultural Sciences, and registered in 2017. It derives from a cross between another Balsgård cultivar 'Aroma' and a scab-resistant selection from USA, PRI-1858/102. Marketing is undertaken in co-operation with the Diocese of Linköping, and the name 'Gratia' (Grace) was chosen in commemoration of Martin Luther who nailed his 95 Theses on the Power of Indulgences in 1517, and also is known for the quote: 'Even if I knew that tomorrow the world would go to pieces, I would still plant my apple tree'. Photo: Lars Torstensson. See article p.21.

Giving a voice to Young Minds

Patrícia Duarte de Oliveira Paiva, ISHS Board Member Responsible for Young Minds and Representative of South America

› Patrícia Duarte de Oliveira Paiva

The world is changing rapidly, and the new generations wish to create a positive difference, to mitigate negative changes. This is a great challenge! How can one contribute to this using horticulture? "Giving a voice to young minds," by proving guidance, training, cooperation and encouragement using horticulture as a bridge, is a way to help them. The International Society for Horticultural Science (ISHS) has a very important role to promote young scientists by assisting in the development of their professional skills and scientific knowledge and by providing a global platform for an interchange of ideas, which would give us an opportunity to help them move towards their goals.

Harnessing the opinions of young minds

To understand the opinions about the Society and also horticultural science by the young scientists coming into the horticultural field, the questionnaire from the "Harnessing the opinions of young minds" project (reported in *Chronica Horticulturae 59* (*1*), 4–14) was studied by the ISHS Board. The aim of this questionnaire was to understand the motivations and expectations of young people with regards to horticulture and the Society. These answers reflect their impressions and are very important for us to consider in determining future actions.

Based on the answers from young horticulturists as they stated in their questionnaire responses, the choice of the horticultural area for their profession is mainly due to their "love of plants" and for horticulture "being an exciting career pathway." Also, for them, horticulture is a great field to work in since it contributes "to biodiversity, beauty and human health and wellbeing", and "to sustainable development" as well as being a tool to "sustain lives, livelihoods and landscapes". These opinions demonstrate how important horticulture is, and the actions that we take as a Society, should take these statements into consideration.

For the young respondents, being associated with ISHS provided opportunities to "link to researchers around the world" and also to universities. Younger scientists and students also felt that our Society should provide them with "knowledge/technology transfer", should promote connections, and act as a career center. Attending scientific meetings and Summer Schools (Training Courses) are exciting opportunities, which would be one of the Society goals for young scientists and students in the next few years.

ISHS Schools

Considering the success of the first Summer School, held in Germany in July/August 2018, this Board decided to continue this initiative. Initially named as a "Summer School", it is being changed to "ISHS Schools", to avoid miscommunication considering the different hemispheres and stations: summer/winter around the world. The idea of the ISHS Schools is to offer students worldwide an opportunity to learn and deepen their knowledge and experience in specific topics.

For each course, one different topic and location will be assigned. For ISHS, this will be a very important way to build network connections. Thus, the next edition will be hosted by the Federal University of Lavras (Universidade Federal de Lavras) in Brazil in mid-year of 2020. The theme of this course will be beverage crops, focusing mainly on coffee, orange, sugarcane, and grape. This will be a great opportunity for the participants, since Brazil is the world leader in the production of some of these crops. The participants will have a full schedule during a couple of weeks, with the opportunity to learn from expert speakers, group discussions, practical activities in laboratories, as well as many field trips to visit farms and industries, providing a complete overview of the entire production process.

Younger Co-conveners

Understanding that young scientists have a lot to contribute, this Board is promoting the idea to all ISHS symposia to include at least one young co-convener (student or young scientist) on their organization committee. This will be a great opportunity for young scientists to integrate, participate, and learn about a meeting organization, as well as to offer them a chance to have a significant connection with all attendees. More than anything, this is another way to let young scientists have a voice.

Awards

Young Minds Award

This is awarded to junior scientists during each ISHS symposium. The awards are given to the first author in two different categories: best poster presentation and best oral presentation. The awardees receive an ISHS Certificate and one-year complimentary membership. Also, as recognition, a photo and a brief summary on their research is published in *Chronica Horticulturae* or on the ISHS website.

International Student Challenge

This is a new award initiated from the Division Landscape and Urban Horticulture. This initiative was an international competition - *UrbanFarm2019,* in which teams created an urban farm, by designing innovative urban agriculture systems, integrating architectural and technological innovations for food production in urban environments in certain sites, aiming to join students coming from the faculties of engineering, architecture, biology and agriculture.

The final of the first edition was held on February 13-14, 2019, during the NovelFarm expo (www.novelfarmexpo.it/en/), in Venice, Italy. The winner was the PineCUBE team from Italy, the runner up was The Wanderers team from Egypt and Italy and the third place was the ReGenius Loci team from Italy. The three teams received from ISHS a certificate and all the participants of these three groups were awarded with one-year complimentary membership. There are some proposals under consideration for the coming years.

Communication

Data is crucial for science and one great challenge is how to communicate science properly. At the same time, the world is hungry for information and young scientists are wondering how to have a voice. They are also interested in integrated networks, to be connected with researchers worldwide, aiming to enhance their careers and increase their knowledge. The ISHS is increasing its efforts to improve communication and connections, besides offering different ways to deepen scientific knowledge. We need to provide possibilities for the new generation to allow them the tools for future action. We plan to organize workshops at our congresses to continue to listen to the voices of our young scientists about how we need to change our Society to cater to their needs.

Conclusion

The Society is promoting activities and benefits for young horticulturists. By being a member of the ISHS, students and young scientists may find space to improve their scientific knowledge, develop their professional skills, and enlarge their connections and networks. Overall, giving a voice to scientific young minds is a small way to start changing the world.

› Editor's note: a long tradition of *Chronica Horticulturae*

Editor	Term	Volume/Number
Jules Janick	2002-2011	42/3 to 51/3
Yves Desjardins	2011-2015	51/4 to 55/1
Jill Stanley	2015-2019	55/1 to 59/2
Kim Hummer	2019	59/2 onwards

For the past 59 years, this magazine has had a great tradition of bringing global horticultural information to our membership. After each ISHS Board election, the editorial responsibilities for *Chronica Horticulturae* are bequeathed to an incoming Board member. Beginning in 2002, Jules Janick assumed the Editorship of this publication with gusto. Under his aegis, *Chronica* blossomed into a new colorful format. Next, Yves Desjardins took on this responsibility, developing design and a new layout. In 2015, Jill Stanley began as Editor and developed new content, including promotion of young minds and interviewing our honoured members. Now, beginning with the June 2019 issue, Volume 59 number 2, Kim Hummer has become the next Editor for *Chronica*.

Since 2004, Kelly Van Dijck has served as Associate Editor throughout these transitions. Her continued invaluable assistance ensures the excellent technical quality and consistency of production. Peter Vanderborght, now our Executive Director, continues to provide technical support for production and circulation of ISHS publications, including *Chronica*. Kelly's and Peter's efforts are appreciated by all. As always, we look forward to hearing your comments and suggestions for improvement of *Chronica Horticulturae*.

Spotlight on Honoured ISHS Members

› Geoff Dixon

Position or previous position

Owner GreenGene International (biological and horticultural knowledge and information consultancy), Visiting Professor and Honorary Research Fellow, School of Agriculture, Policy & Development, The University of Reading, Berkshire, United Kingdom

ISHS honour

ISHS Honorary Member – bestowed August 2014

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

"Londoner" borne, bred, and proud of that great capital city, I arrived during the early Blitz. Somehow my mother organised a move to rural Buckinghamshire from where she originated. There, horticulture started for me on an uncle's fruit farm. Fruit and daffodils were picked, packed and taken by horse and cart to Bourne End Railway Station for sale in Covent Garden. The heady scent of daffodils in full bloom still lingers with me!

In 1950, we moved to Godalming in Surrey, where I gained my junior schooling and then attended Grammar School in Guildford. My father was a fine instrument engineer, my eldest brother was a production engineer and my elder brother an architect. My mother was a gentle and generous soul who proudly nurtured her family. Essentially therefore, I come from the "English Home Counties". Gardening is my lifetime hobby. I cultivated part of my father's gardens, and when old enough, I worked at weekends and school holidays on a flower and mushroom nursery.

My wife, Kathy, also comes from Godalming, having a similar family background and education. We share interests in the arts, theatre, history and current affairs. In 1965, "BA marries BSc" as the local paper termed it! Kathy taught English at the Ashford School for Girls while I was a postgraduate at Wye College. Subsequently, we have moved to Cambridge, Aberdeen, Glasgow and now Dorset. Our children were born in Cambridge and educated in Scotland. My daughter is an art historian and my son, an industrial chemist; we have three grandchildren.

Nearly fifteen years ago my wife and I took the momentous decision that after 30 years in Scotland we would move southwards. Fortunately, we found the ancient market town of Sherborne, Dorset. Dorset is an agricultural county, on the English Channel coast with rolling rural downland well described in Thomas Hardy's novels and the Jurassic Coast, a World Heritage Site. Sherborne boasts an Abbey founded in 705, with the finest English Fan Vaulting, an "old" castle from the Norman Conquest and a "new" castle built in the 16th century.

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

Horticultural science always fascinated me and my biology teacher at grammar school connected it and my love of gardening with Scholarship Level botany, zoology and chemistry. My *alma mater* is Wye College, London University's Faculty of Agriculture and Horticulture; when I entered in 1962 it was at the peak of its eminensce. Following a first class degree in Horticulture, my PhD focussed on the disruption of amino acid and protein metabolism in tomatoes colonised by the soil pathogen *Verticillium albo-atrum* and anatomical impacts of colonisation in the xylem.

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

My first professional appointment was Founder Vegetable Pathologist at the National Institute of Agricultural Botany (NIAB),

› Geoff when Vice-President of the Royal Society of Biology (RSB) with the then Science Minister, Lord David Sainsbury (third from left), and members of Affiliated Societies in 2000. Lord Sainsbury took a keen interest in the RSB, particularly its work which links biological science with politicians and civil servants.

› Geoff with the Principal, David Butcher, opening a research glasshouse at Writtle University College, Essex in 2006. As a longstanding External Examiner, Geoff encouraged the development of research capabilities in this newly emerging University.

Cambridge. Plant pathogens were in an accelerating epidemic phase, resulting from changes in crop husbandry and the advent of new hybrid cultivars encouraging the rapid appearance of aggressive virulences. Pathogens crossed green bridges, resulting in disease epidemics and increasing crop losses. Cambridge at that time was an exciting melting pot for academic and industrial pathologists, laced with emerging molecular biological knowledge resulting from Crick and Watson's work. My work gave me experience in pathogen biology, field disease epidemiology and an understanding of the farming and grower industries. My lifelong devotion to clubroot disease of brassica crops, caused by the protist *Plasmodiophora brassicae*, started here, subsequently forming the backbone of my research and industrial careers. As a result, I gained an international reputation as an authority in this pathogen and the brassica crops and served as chairman of the International Clubroot Working Group (ICWG).

After a decade in Cambridge, I received an offer that could not be refused. Aberdeen School of Agriculture appointed me as Head of their Horticulture Division. The Scottish System at that time broadly resembled that of the American Land Grant Colleges, with closely integrated research, education and advisory services. My responsibilities for horticultural research embraced berry fruits, daffodils, field vegetables and ornamentals with two research units. With my staff of advisors, I travelled widely across northern Scotland including the Western and Northern Isles. Clubroot is endemic in Scotland, which gave opportunities for more field studies and laboratory research. Brilliant postgraduates and post doctoral workers helped develop answers to the question "Why lime?", the standard but unexplained treatment. Over many years of careful study, the impact of environment on the pathogen's life cycle and disease development has been revealed. This work also resulted in the start of longstanding academic and industry friendships and the opportunity for a sabbatical at the University of Madison-Wisconsin.

Change called again after a decade and I was offered the Chair in Horticulture in the University of Strathclyde, Glasgow, associated with Headship and a Chair in the Scottish Agricultural College (now Scottish Rural University College, SRUC). Education figured very highly, with a large teaching department offering courses from early-learners to postgraduates. Postgraduates and post-docs investigated environmental interactions with pathogens and abiotic syndromes and clubroot studies still forged ahead.

This was a period of intense structural "rationalisation" in state funded education, research and advisory activity so I was also appointed Director of the privatising Scottish Horticultural Advisory Service.

Eventually, I focused my activities solely on my stress biology research group in the University of Strathclyde and founded my company, GreenGene International. This still delivers knowledge and information into primary and secondary industries and state funded projects. Moving south, the University of Reading very generously offered me an academic base from where research and review papers are produced with modest teaching loads.

During my career, I have taught in the von Humboldt University, Berlin, and El-Mansoura University, Egypt, and externally examined undergraduate and postgraduate students in the United Kingdom, Republic of Ireland, Europe, and Australia. An Erasmus network with six European countries widened the education gained by Strathclyde students. Combining excellence in plantsmanship and academic achievements resulted from integrating plantsmanship courses at the Royal Botanic Garden Edinburgh (RBGE) with Strathclyde degrees in a model similar to the Dutch system.

4. What do you consider were your greatest achievements?

Scientifically, improving knowledge of clubroot and its causal organism is something of which I am very proud. This knowledge helped eradicate the pathogen from an important watercress production system in Florida which supplies a large segment of UK supermarkets in 2010. Almost concurrently, clubroot appeared in the Canadian canola crop in Alberta and continues to spread epidemically from an initial focus discovered near Edmonton in 2003. That brought a large research program, giving me opportunities for collaboration. Canola oil is worth about CAD 20.0 billion to Canada's annual GDP.

› Geoff and Kathy at the presentation of ISHS Honorary Membership at the IHC in Brisbane 2014; this is very much a jointly shared achievement.

Throughout my career I have been associated with community activities that increase appreciation of horticulture, education and soil microbiology. In Cambridge this involved association with establishing the British Society for Plant Pathology. Cambridge had its own Mycology Club of which I was Secretary for some time. In Aberdeen, I was associated with founding the Institute of Horticulture (now Chartered Institute) and became a Fellow of the Institute. At national and local levels, I chaired the Education Committee and presided over the Scottish Branch and more recently the South West Branch. Colleagues elected me as President of the Institute, 2002-2004. The Royal Society of Biology made me a Fellow, I was elected as a Vice President and chaired the Agriculture Committee. The gardeners' charity Perennial (The Royal Gardeners Benevolent Society) invited me onto their Council and the Ways and Means Committee for some years. This was a very fulfilling task since the Trust provides accommodation, education, financial advice and support of gardeners of all ages who have fallen on hard times.

› Geoff meeting with Professor Dr. Nazim Gruda from the Bonn University, Germany, during the IHC in Brisbane 2014; sharing their mutual interests in soil biology and climate change.

Over many years I have supported and worked for the Royal Horticultural Society (RHS). This included representing them in Scotland, particularly in educational spheres such as with the Scottish Qualifications Agency. Within the Society, their Qualifications Board (and various iterations) has been a main focus of my attention. The RHS's Master of Horticulture (M. Hort.) is an MBA equivalent attesting to a combination of academic and practical expertise. Service on the Barrett Committee robustly ensured the survival of M. Hort. It is very gratifying that there are now vibrant numbers of students and that I remain their senior external examiner. Recently, I had the pleasure of chairing a review group charged with suggesting changes in the School of Horticulture of the Royal Botanic Garden, Kew.

Great Britian had Trades Guilds in medieval times, which guarded commerce within larger towns. These are now very substantial charities supporting pensioners, research and education. Membership brings with it the huge honour of Freedom of the City. In Glasgow, I was elected a member of the Incorporation of Gardeners of Glasgow, served on their Master Court and eventually became Deacon of the Incorporation. One of the great pleasure of "my year in the chair" was negotiating the admission of female members, overcoming 400 years of prejudice. My wife, daughter, and son are also members of the Incorporation and have Freedom of the City of Glasgow. The City of London has a much larger network of Guilds and I was fortunate in being made a Liveryman of the Worshipful Company of Fruiterers. As a result, the Lord Mayor of London bestowed on me Freedom of the City of my birth. These two Freedoms are something for which I am intensely proud.

For several years I have chaired the Trustees of the *Journal of Horticultural Science and Biotechnology* (JHSB). This journal was founded in 1919 with the aim of promoting the publishing of good science for the benefit of industry, in which it has been very successful. Forging a partnership with a major international publishing house, Taylor and Francis, has produced financial security. JHSB now enters its second century with an increasing impact factor, widening authorship and robust accounts.

Being appreciated by one's peers who work directly in consultancy and advisory activities with the horticultural industry is a great accolade. Some years back, I was made a member of the Vegetable Consultants Association (VCA), which only happens by invitation. The Association directly links between fresh produce growers and the UK's supermarkets, ensuring continuity in the supply chain. Membership is a privilege and chairing the Association for a couple of years was a tremendous honour.

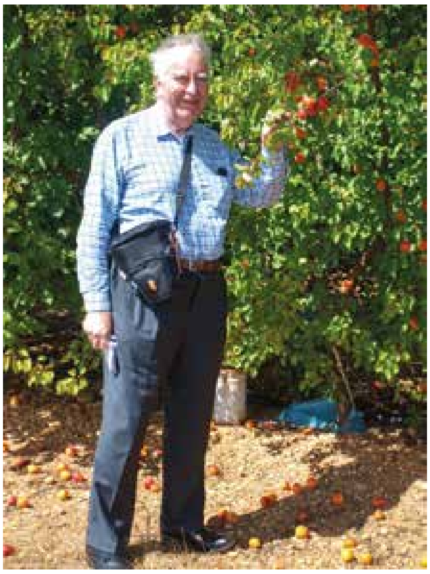
The South-West of England has a large population of horticulturists and we have formed a discussion group which visits centres of excellence across the region. Sherborne is a home for considerable numbers of scientists of all disciplines and we hold a monthly Science Café discussing a multiplicity of topics.

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

All careers encounter opportunities resulting from apparent difficulties. My very great fortune has been having some substantial authorities as mentors along the way. Deciding on career moves and the attendant disruption of family lives is not something taken lightly, especially when moving across two legal jurisdictions into and out of Scotland. In all these moves, I have had the unfailing support and encouragement of my wife and immediate family. Taking up a new post requires resolve and a determination for success. In Aberdeen, I arrived as a still very young "sassenach" (Englishman) who had to prove himself, despite being one quarter Scots. Always stand back and carefully assess situations before making changes and allow staff opportunities to seek *their* solutions for problems. Years previously, I was advised: "never ask someone to do something you cannot do yourself." That is invaluable advice; even farm staff found that "Prof." could drive tractors!

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

One of the biggest embarrassments is meeting people out of context. They know you and you cannot place them. A husband and wife caught up with me in the Big Tent at the Chelsea Flower Show one year, fully expecting that I would recognise them instantly! A



› Geoff examines new apricot breeding lines at COT International, Provence in 2017. Liverymen of the Worshipful Company of Fruiterers and their guests were treated to an impressive display of new cultivars and strains of apricot and other stone fruit destined for cropping in Europe and more widely.

non-commital conversation followed until they mentioned their flight from Kirkwall, the capital of Orkney, then the penny dropped! In Aberdeen, I took the mantle of advisor for the Northern Isles, Orkney and Shetland. Horticulture there is not huge but has interesting challenges and opportunities. This couple had a glasshouse nursery, which benefited from the long days and intense sunlight, producing high quality tomatoes that commanded a good local premium. Many times I enjoyed their Orcadian hospitality, but in Chelsea they were mysteries totally out of context! Working in the Northern Isles gave me valuable insights into the environmental impact of the Flotta and Sullom Voe oil terminals.

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?

Membership of ISHS is very important for me and started with the 1974 International Horticultural Congress in Poland. Congresses are wonderful opportunities for meeting with people from across the spectrum of horticultural disciplines and holding discussions with them; to me they are a cornucopia of knowledge. International Horticultural Congresses such as Davis, Brussels, Florence, Kyoto, Toronto, Seoul, and Brisbane have all been joyful, productive and stimulating meetings. Between these have been symposia, such as the International Symposium on Horticulture in Europe in Vienna and the whole series of International Symposia on Brassicas, where clubroot has figured highly. Becoming Chair of ISHS Commission Education and Training, member of the ISHS Executive Committee, and a United Kingdom representative on ISHS Council, which linked the UK Institute of Horticulture with ISHS, has been very fulfilling. There are few more important tasks than representing one's country in an international forum. Convening the first ever International Symposium on Education and Training in Horticulture on home ground, and having the great pleasure of entertaining about 100 delegates, was a huge responsibility and pleasure. ISHS Council elected me as an Internal Auditor in 2006, guarding members' interests internationally is a vitally important task, which I was proud to undertake. Subsequent bestowal of ISHS Honorary Membership is an overwhelming honour.

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

Go for it! You will not regret that decision. You join a worldwide profession of like-minded, generous and intelligent people fascinated by their discipline. Horticulture has a vast future in each of its sectors; production, environment, and social. Plant-based diets are becoming dominant, the intensive production of food crops is rising in importance, conserving environments and retaining biodiversity are becoming critically important, and enhancing human health and well-being is bringing horticulture increasingly into the forefront of the drive for preventative, non-interventionist medicine. Horticulturists know why and how plants grow in practice, thereby controlling germination, growth, flowering and fruiting. Increasingly, there are good careers, some very well paid commensurate with substantial responsibilities. One of my greatest pleasures is seeing and meeting young men and women who were my students and are now in mid-career in highly productive appointments.

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

Frequently, turning the pages of *Nature*, I wish I was 50 years younger! The opportunities that molecular science offers for resolving questions, which started perplexing me at Wye and in Cambridge, are legion. I like to think that the basic building blocks of my era are, however, still useful. Researchers do occasionally quote an aged publication of mine in their scientific papers!

Horticulture has always absorbed and used new science and technology very quickly. Now remote sensing, using satellites and robotics/automation, is replacing muscle power with electrons and who knows what quantum computing will deliver! Horticulture is a profession for the highly intelligent because it integrates from across a raft of basic sciences. Mitigating climate change, soil degradation and feeding people are all areas where horticulturists have critically important roles and exciting future careers.

Horticultural Science Focus

› Flipped classroom and virtual field trips

Kent D. Kobayashi and Kauahi Perez

Introduction

Engaging students in the classroom is critical for effective teaching (Yen and Halili, 2015), which can be challenging when faced with a technology-hungry student population (Lineberger, 2007). In fact, the work of Devlin and Samarawickrema (2010) suggests that effective teaching must continually evolve with the contexts in which learning is undertaken. Several teaching approaches can be used to engage students and effectively supplement or enhance lectures – flipped classroom, bring your own device (BYOD), and virtual field trips (Afreen, 2014; Harkess et al., 2007; Long et al., 2017; Roehl et al., 2013). Hence, the objective of this article is to discuss how the flipped classroom, BYOD, and virtual field trip approaches were used to promote and enhance student engagement in Tropical Production Systems (TPSS 300), an undergraduate (TPSS) course at the University of Hawaii at Manoa. From a broader perspective, this article exemplifies how different teaching approaches can be applied to enhance student learning in a variety of learning environments.

TPSS 300 is a four-credit course with three 50-minute lecture periods and a 2-hour laboratory period each week. Since the course's creation in 1997, the number of lecture periods each week and the length of the laboratory period have varied over the years. Offered each spring semester, TPSS 300 was once a required course for undergraduate students in our horticulture program, but is now an elective. Kent Kobayashi is the instructor for the course; Kauahi Perez is the graduate teaching assistant. Since 2008, when we first began teaching this course, the student enrollment ranged from 5 to 24, with an average of 13 students per class. Lectures are held in one of our department's classrooms. Depending upon the topic, laboratory periods are held in the classroom, at the Magoon Greenhouse Facilities, Pope Laboratory greenhouses, or at other on-campus and off-campus sites.

Flipped classroom and BYOD

In a typical university classroom, students hear a lecture and take notes. They then work on homework, projects, and other activities outside of class. However, the lecture style may not always be the best technique for student learning and engagement (Kay et al., 2018). In the flipped classroom, students review information pertaining to concepts outside of class and come to class prepared to discuss and apply the concepts (Young, 2011). In fact, studies have shown that the flipped classroom approach can improve student learning (Conner et al., 2014). BYOD is another technology-mediated approach that facilitates and enhances student learning experiences (Afreen, 2014). In addition to out-of-class use, the thought behind BYOD in an educational setting is that students can bring their laptops, smart phones, tablets, and other smart devices to class and use these as an in-class resource for learning. In our opinion, with careful guidance on conditions of student-use, incorporating this approach lends itself naturally to a university classroom setting.

To supplement our lecturing, the emphasis on instruction was shifted towards having students learn material outside of class through video segments, websites, articles, and online computer models and simulations. This helped free us from having to develop so many lectures, and we could now concentrate on developing relevant in-class activities for the students, fostering increased student-student collaboration and interaction (Figure 1). We noticed it required a lot more commitment and work up front as we needed to spend time finding and evaluating the online materials to be sure that they were appropriate for the students and that the material included all the information that would have been covered by our lectures (Long et al., 2017). Being mindful of student frustrations regarding video length (Kay et al., 2018), videos were brief, averaging 3 to 5 minutes long, to maintain student interest. YouTube© videos, websites, handouts, popular works publications, and scientific articles were assigned and later incorporated in small group and whole class discussions. Students were encouraged to bring their laptops, tablets, or smartphones to class to do internet searches on relevant information for discussions and hands-on activities. After discussing questions and points about the day's topics within groups, each group shared their answers with the rest of the class (Figure 2).

By creating small groups, each student had an opportunity to speak and interact with others. This helped in peer teaching and the sharing of personal experiences. It has been demonstrated that students learn much more from each other as they share and discuss their individual experiences (Wright et al., 2010). Their oral presentation skills also improved because every student from each group spoke in both in-group and whole class discussions. Laptops and mobile devices promoted internet search

Figure 1. Flipped classroom students used a variety of technologies to complete in-class activities. Photo: Kent Kobayashi.

Figure 2. A group of students sharing their in-class activity findings with the rest of the class. Photo: Kent Kobayashi.

skills. Information from the internet provided valuable knowledge that supplemented the lectures, guest speakers, and reading materials. In short, the flipped classroom approach enabled more structured in-class active learning activities for the students while increasing the depth of engagement on the day's topics.

However, we were careful not to depend on the flipped classroom approach so much that we forgot about the importance of lecturing (Kay et al., 2018). Some topics just lend themselves to lectures and explanations by the instructor. We were also aware not to keep using the same flipped classroom techniques repeatedly, to avoid students getting tired of it. We still used in-class assignments and allocated homework assignments to be done at home. Quizzes and in-class assignments were used to help ensure that students read and viewed the materials outside of class. We did not consider the idea that video and multimedia materials may not be accessible by students who did not have access to computers or mobile devices or students with disabilities (Young, 2011), but this has not been a problem so far.

BYOD played an integral part in the flipped classroom approach. Bringing a laptop, tablet, or smartphone to class enabled students to review assigned materials in class, share information with other students, and find new and supplemental resources on the internet, which was something that was not possible in previous years. Students sometimes came to class with multiple technologies and used a mixture of smartphones, tablets, and laptops. Even students with only a smartphone still managed to adequately view videos and search the internet.

Virtual field trips

Field trips, both on- and off-campus, play an important role in horticultural courses (Harkess et al., 2007). Visits to on-campus agricultural settings, farms, and nurseries provide students with firsthand knowledge of agricultural enterprises and help to reinforce concepts introduced and discussed in class (Figure 3). However, instructors face instructional and logistical constraints that can sometimes hinder their planning and conducting of actual field trips including expense, liability, safety issues, and lack of administrative support (Wright et al., 2010).

An alternative is the virtual field trip, which is a computer-based, multimedia simulation of actual field trips. Virtual field trips can stand alone and be used in place of actual field trips. They can also help students prepare for an actual field trip, or they can be used in classroom discussions after an actual field trip (Kobayashi, 2017; Wright et al., 2010). Harkess et al. (2007) developed fifteen DVD-based virtual field trip videos of greenhouse operations across eight U.S. states. The use of Second Life, an online 3-D virtual world, enabled student participation in real-world simulations (Leggette et al., 2012). Meezan and Cuffey (2012) developed the Virtual Field Trip of California Geomorphology, which integrates Google Earth, Google Maps, and field site photographs. The augmented reality geospatially oriented Grand Canyon Expedition field trip game modules for mobile smart devices also enhanced student interest in learning geosciences (Bursztyn et al., 2017). These are all examples of virtual field trips that we like to incorporate when discussing the topic of virtual field trips in this class.

Since first taught in 1997, TPSS 300 has had traditional field trips during its laboratory session. However, student course evaluations of TPSS 300 indicated that students were not satisfied with the course, particularly with the duplication of TPSS 300 field trip visits with those of other TPSS courses. In our first teaching of the course in 2008, to address the duplication of visits, different sites were selected for traditional field trips and the use of virtual field trips was implemented (Kobayashi and Perez, 2009). In addition to introducing the concept of virtual field trips, we also created a virtual field trip as a class assignment which served as an alternative to an actual class field trip or having the owner guest lecture in class about their business.

The goal of the virtual field trip assignment was for each student to create an oral presentation of a farm or nursery so that it would simulate the idea that the whole class was going on a field trip to that agricultural enterprise. Students individually or in pairs chose and visited a commercial farm or nursery, interviewed the owner or manager, took photos, and learned about the operations of the enterprise. It was the students' responsibility to select a farm or nursery, contact the owner, and arrange transportation to the enterprise. They needed to ask permission before taking photos. If photos were not allowed, then that farm or nursery could not be used for the assignment. Once a farm or nursery was selected, no other student could choose it for their assignment, thus avoiding duplication. Using PowerPoint™, each student or pair of students gave an oral presentation in class about the enterprise and submitted a written report. The written report answered a previously given set of questions, which required them to carefully interview the owners to obtain the answers. This kind of scaffolding encouraged students to observe the farm or nursery operation in detail, assess the enterprise, and ask questions. Thus, the on-site tour was not passive but active.

Students selected a diverse range of commercial farms and nurseries (Figure 4). Several students visited some of the larger well-known farms and nurseries on Oahu such as Nalo Farms, Sumida Watercress Farm, Aloun Farms, and Mari's Gardens, while others went to smaller farms such as Once Again Hawaii, Metro Grow Hawaii, and Green Hands of Aloha. Students have even gone to a neighboring island to farms such as Waipoli Hydroponic Greens on Maui and

Figure 3. A traditional on-campus field trip where students learned about aquaponics systems. Photo: Kent Kobayashi.

Kauai Coffee on Kauai. In addition, students have done their virtual field trips on farms in other U.S. states including Lindsfors Farm in San Diego, California, and Little Acres Farm in Glastonbury, Connecticut, and other countries such as Albano Ranch in San Pablo, Philippines.

The virtual field trip assignment allowed the farm owners or managers to show the student certain production areas that would normally be restricted in a large group tour, such as a restricted area of a greenhouse or working in an aseptic tissue culture transfer hood. This one-on-one kind of visit encourages networking between the student and the farm or nursery owner, which has led to future internships and job opportunities for students.

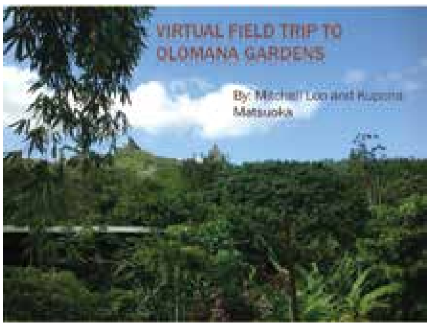


Figure 4. A virtual field trip PowerPoint™ presentation made by a student group showcasing a farm in eastern Oahu, Hawaii. Photo: Mitchell Loo and Kupono Matsuoka.

The virtual field trip oral presentations in class enabled other students to "visit" farms and nurseries that they would not normally get a chance to experience because these agricultural enterprises are not near the University of Hawaii or on the island of Oahu. Virtual field trips enabled students to learn about many different farms and nurseries without actually having traditional field trips, which would have necessitated charging a lab fee for the course and using up some of the valuable laboratory periods. Virtual field trips like these could also help disabled students learn about other farms and nurseries that they could not go to on traditional field trips (Healey et al., 2002).

The virtual field trip assignment let students select businesses that they were interested in learning more about. Instead of selecting some of the larger well-known farms and nurseries that were visited in other TPSS courses, students selected smaller farms and nurseries that the instructor and most of the other class members were not aware of. Seeing the diverse majors of the students who have taken TPSS 300 over the years, virtual field trips may have helped stimulate these students to get a minor in TPSS or switch majors to TPSS.

As a note of caution, the virtual field trip assignment can be used to supplement traditional field trips, but not replace them entirely. In fact, Spicer and Stratford (2001) and Wright et al. (2010) found that students felt that virtual field trips could not and should not replace real field trips. Rather, they argue that virtual field trips could be most effective in preparing for or revisiting after a real field trip. Wright et al. (2010) also reported that virtual field trips could supplement existing traditional nursery field trips.

In course evaluations, students commented on the flipped classroom and virtual field trip approaches. The students found the manner in which the material was presented to be most valuable. One said: "The hands on, outside of classroom, via internet, discussion, presentation [approach] using different examples to identify with, helped me to remember." Others indicated "I think he's doing a great job of teaching in this new way." "He showed us videos from YouTube in and outside of class. Very knowledgeable of content and enthusiastic." Another said: "Kent was a great professor in teaching us the subject. He really involved the class in activities together and made use of visual learning." Regarding small group and class discussions, "He was great; always asked questions that seemed to escape the rest of the class." Two students responded to a question regarding what they would remember most about this course: "Learning what virtual field trips are" and "I will remember the virtual field trips."

Conclusion

Flipped classroom methods promoted student engagement through in-class activities and small group discussions in which each student had the opportunity to speak. Some students commented that although this was a novel teaching style, they enjoyed it. This also facilitated peer teaching, sharing of

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personal experiences, and the improvement of oral communication skills. Flipped classroom assignments outside of class and BYOD improved internet search skills. Virtual field trips supported direct interaction between the students and the owners and helped students gain firsthand experience of agricultural enterprises. In some instances, the virtual field trips encouraged students to learn how to finally use PowerPoint™, and gain experience in developing presentations, and practice presenting to an audience. In short, we believe that the flipped classroom, BYOD, and virtual field trip approaches helped to promote and enhance student knowledge. These teaching strategies, when used appropriately, may also further improve the quality of student learning experiences in other horticultural classes.

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› Space farming to sustain human life: more than 20 years of research at the University of Naples

Roberta Paradiso and Stefania De Pascale

The “UniNa team”, a group of high skilled scientists, operating within the Department of Agricultural and Food Sciences of the University of Naples Federico II, Italy, has been working for decades in challenging research on the cultivation of higher plants in space.

The UniNa team, composed of the authors together with Giovanna Aronne, Carmen Arena, Veronica De Micco, Antonio Pannico and Youssef Rouphael, has expertise in agronomy, horticulture, plant biology, physiology and biochemistry, and food quality. Thanks to many projects funded in the last twenty years by the Italian Space Agency (ASI), the European Space Agency (ESA) and other institutions, the team has gained fundamental knowledge on several aspects of growing higher plants to sustain human life in space.

Presently, all the resources needed for short-term space missions are brought from Earth; but for economic and practical reasons this will not be possible for longer missions. For instance, using current propulsion systems, a round trip to Mars would take from 6 to 8 months. However, since Mars and Earth come close to each other only once a year, crews will travel for 18 months at least, before returning. Scientists of the National Aeronautics and Space Administration (NASA) of the United States of America calculated that, with the present physical-chemical regeneration systems, each astronaut will need an average of 15 kg of resources per day, including food, water and oxygen. To even consider a Mars mission of only 500 days, about 7.5 tons of consumables in total will be required per person. As a consequence, even frequent consumable re-supply would be costly and logistically difficult.

In this scenario, maximizing the self-sufficiency and minimizing the need for resupply from Earth are imperative goals to enable human space missions beyond the low Earth orbit. A feasible alternative to bringing resources from Earth, by making a continual resources recycling, could be the development of bioregenerative life support systems (BLSSs). BLSSs are artificial ecosystems in which appropriately selected organisms are assembled by combining their metabolic routes in consecutive steps of recycling, to reconvert the waste produced by the crew into nutritional biomass, oxygen, and potable water.

Many BLSSs containing biological regeneration components, e.g. bacteria, microalgae, higher plants and fishes, have been proposed. At present, the most promising bioregenerators are microalgae and higher plants. Central to the regenerative concept is the use of photosynthetic organisms and light as sources of energy. In addition, higher plants have a complementary interrelationship with humans: in a simplistic vision, plants recycle human waste and provide nutrients to humans, while humans recycle plant waste and provide nutrients to plants. More specifically, higher plants represent an optimal tool for multiple functions: atmospheric regeneration, by means of CO_2 reduction and O_2 emission in photosynthesis, waste water purification through transpiration, and recycling of waste products through mineral nutrition. Furthermore, plants would provide fresh food, helping to preserve the astronaut’s wellbeing, also by contributing to create an Earth-like environment in space, thus mitigating psychological stress of the mission and isolation conditions.

Research projects

The UniNa team pursues research topics on numerous biological, agronomical, and environmental issues to understand plant cultivation considering the multiple constraints of the space environment. These issues include:

- Selection of candidate plant species and cultivars, and water and nutrient management in soilless systems (hydroponics);
- Environmental control in growth chambers (with a special focus on light quality);
- Effect of space factors, e.g. microgravity and ionizing radiation, on plant growth and reproduction, and the photosynthetic behaviour under photo-inhibiting conditions, e.g. suboptimal irradiance;
- Factors constraining the completion of the seed-to-seed cycle (reproductive ecology);
- Plant interactions with beneficial microorganisms and biostimulants;
- Nutritional aspects of plant fresh food in the crew diet, including innovative leafy vegetables, e.g. salad mix microgreens.

Plant responses have been investigated under real or simulated microgravity and simulated space ionizing radiation (Arena et al., 2013, 2014; De Micco et al., 2014a), with a specific focus on morphological and functional aspects. Moreover, different critical aspects related to space constraints have been analyzed to contribute towards achieving the seed-to-food cycle, with the aim of producing high quality fresh food over a long period as well as being able to regenerate resources onboard space vehicles and outposts. Finally, several technological issues have been pursued, by developing modular systems for space-oriented life support.

The objectives of relevant research projects are summarised below. Within the ASI projects, both “Morphological and physiological response of plant roots to a low-gravity environment” (1997-2000) and “Morphological and physiological response of seedlings to a low-gravity environment” (2001-2002) aimed to better understand the effects of simulated microgravity on plant growth and development, especially at the root level, in seedlings from bean seeds germinated on a rotating clinostat in aeroponic conditions (Aronne et al., 2001, 2003).

The project “SGH – Space GreenHouse” (ASI, 2002-2003) aimed to design a small space greenhouse, as a prototype of a cultivation module to be tested onboard the International Space Station (ISS). The SGH was equipped with an environmental control system, including software and probes for monitoring and control of temperature, relative humidity and CO_2 concentration in the air, and an LED (light emitting diodes) panel as a source of red-blue light to provide light energy for plant photosynthesis.

Later, the project “CAB – Controllo Ambientale Biorigenerativo (Bioregenerative Environmental Control)” (ASI, 2007) was based on a feasibility study to set up a higher plants-based BLSS for food and oxygen production, CO_2 removal and water purification.

The ESA project “SAYSOY – Space Apparatus to Yield Soybean sprouts” (2004-2006), was successfully conducted in a flight experiment

■ Figure 1. Logo of the SAYSOY project and successful launch of the rocket from the Baikonur cosmodrome on 31 May 2005. Modified from De Micco and Aronne (2008).

during the Foton-M2 campaign (31st May to 16th June 2005) (Figure 1). The work of the team had two main objectives: to design and build a small growth chamber, which was autonomous in terms of power and electronic control, for germinating seeds and growing seedlings on unmanned space platforms; and to investigate the effect of microgravity on soybean seedling development, with special emphasis on the anatomy and cytology of the vascular system and storage tissues (De Micco and Aronne, 2008).

Beginning in 2009, the research group has been involved in the ESA projects "MELiSSA – Micro-Ecological Life Support System Alternative – Food Characterization Phase I and Phase II". The MELiSSA project (https://www.esa.int/Our_Activities/Space_Engineering_Technology/Melissa) aims to conceive an artificial bioregenerative ecosystem for resource regeneration in long term manned space missions and on planet surfaces, based on both microorganisms and higher plants. In Phase I, a two-step approach was applied to select the most suitable European cultivars of soybean for hydroponic cultivation: a) the development of an objective theoretical procedure for a preliminary identification of four candidate cultivars and b) the evaluation of the plant behavior of the selected cultivars in an on-purpose designed soilless system, based on a recirculating nutrient film technique (NFT), under controlled environmental conditions (reviewed in Paradiso et al., 2014a). The overall analysis of results indicated good performance in hydroponic cultivation of the four cultivars chosen in the theoretical selection phase (De Micco et al., 2012; Paradiso et al., 2012). The NFT system and the nutrient solution management adopted in the experiment proved to be efficient in growing healthy soybean plants, with no nutrient deficiency or other kind of stress, e.g. anoxic condition for the roots. Data showed that hydroponic cultivation improved the nutritional quality of soybean seeds with regard to fats and dietary fiber (Palermo et al., 2012), also suggesting that specific cultivars could be selected to obtain the desired nutritional features of the soybean raw material depending on its final use (production of seeds, sprouts, soymilk, or okara). Phase II aimed to evaluate the possibility to optimize the plant growth and yield performance of soybean in hydroponics by applying a selected consortium of beneficial microorganisms. In this part of the project, the team collaborated with experts in food biochemistry, to examine the healthy properties of food bioactive compounds in depth (Paradiso et al., 2014b, 2015, 2017).

In 2013, the UniNa team became an official partner of the MELiSSA Consortium (https://www.esa.int/Our_Activities/Space_Engineering_Technology/Melissa/MELiSSA_Consortium_-_1993), involving independent organizations in the fields of space research and production (universities, research centers, small and medium enterprises, leader industries).

In 2013, the research group worked on the project "Effects of ionizing radiation on tomato growth: food countermeasures to sustain human life in space", funded by the University of Naples and the San Paolo Foundation within the Funding for starting original research (FARO) Programme. The dwarf tomato cultivar *Lycopersicon esculentum*

■ Figure 2. Higher plant chamber (HPC) of the MELiSSA pilot plant (external and internal view) at the University of Barcelona (Spain). Opposite openings equipped with air-lock accesses and gloves access system permit staggered sowing and transplanting with minimal air contamination.

Figure 3. Lettuce plants in subsequent stages of development during the ACSA experiments in the higher plant chamber (HPC) of the MELiSSA pilot plant at the University of Barcelona (Spain).

'Microtom', chosen because of its reduced size and short cultivation cycle, which are fundamental requirements in BLSSs, was used as a model to test radio-resistance when exposed to various doses of X-rays at different plant phenological phases (seed, vegetative stage, reproductive stage). Potential positive effects triggered by irradiation at low doses as well as detrimental outcomes due to high doses were analyzed in terms of plant growth, resource use efficiency and nutritional aspects of fruits (De Micco et al., 2014b; Arena et al., 2017, 2018).

More recently (2016-2017), within the ESA project "Compartment IVb improvement: air and canopy sub-compartment analysis (ACSA)", UniNa participated in upgrading the climatic control system of the higher plant chamber (HPC) of the MELiSSA pilot plant (MPP), at the University of Barcelona. The MPP is a laboratory dedicated to the physical realisation on the ground of the MELiSSA closed loop, through the connection of bioreactors, operating at pilot scale. The HPC is a sealed chamber, consisting of a 5-m^2 growing area (Figure 2), equipped with a closed hydroponic system and prearranged for gas, liquid and solid connections with the loop, and suitable for staggered plantations, which allows for measurement of water and nutrient use, gas exchange and volatile compounds, in a precisely controlled environment. Recent improvements in the heating, ventilating and air conditioning (HVAC) system were tested through cultivation tests on lettuce (Figure 3), by applying two different configurations of air distribution (balanced and unbalanced).

In the same period, the team collaborated with other teams in the ESA project Precursor of Food Production Unit (PFPU), phase A system study, to design, build and test a prototype for cultivation of tuberous crop (e.g. potato and sweet potato) in microgravity. The first phase (2016-2017) focused on the definition of the PFPU architecture and conceptual design, as well as the individual breadboard design and testing of the critical modules. Following on from this, the second phase of the project (2018-2020) aims to develop a payload for tuber growth onboard the ISS. This payload is composed of several modules, aimed at providing all the needed resources for plant growth. One of the modules, the root module (RM), which hosts the substrate, represents a critical component of the system because it has the complex task of correctly distributing water, nutrients and air, in order to host the tuber seeds and the plant roots, thus allowing the plant to grow and enabling the harvest of edible tubers (Figure 4).

Currently, the team is involved in the ESA project "Plant characterization unit for closed life support system – engineering, manufacturing and testing" (PacMan, 2018-2019), which concerns the need to measure the variables required for modelling of the higher plant compartment, which implies the necessity to develop a plant characterization unit (PCU) for crop life cycle. The PCU consists of a completely sealed growth chamber, equipped with a closed loop hydroponic system and sensoring and control systems. This will allow precise monitoring and control of the cultivation environment, including both the hydroponic module (root zone) and the atmospheric module (plant aerial part), for precise scientific investigations. The PCU will work in a space devoted laboratory, under construction at the UniNa facilities in Naples, located at the Royal Palace in Portici (Naples, Italy).

As the space research makes continuous progress throughout the world, in 2016 the ASI call "Closed loop bioregenerative system: state of the art and technologic/scientific gap" required a comprehensive analysis of literature on bioregenerative systems. Accordingly, the project Explotec (2017-2018), proposed by UniNa, provided an updated review of the state of the art in research and technological development of higher plants-based bioregenerative systems, also defining the actual gaps, with special attention on the technology readiness level of the agro-technologies available in Italy and on the potential synergies that research institutions and industrial partners could establish to overcome them.

Starting from February 2019, the UniNa team has been coordinating the ASI project "Rebus – in-situ resource bio-utilization for life support system (2019-2021)". A national research programme will be launched to develop a BLSS based on the use of selected

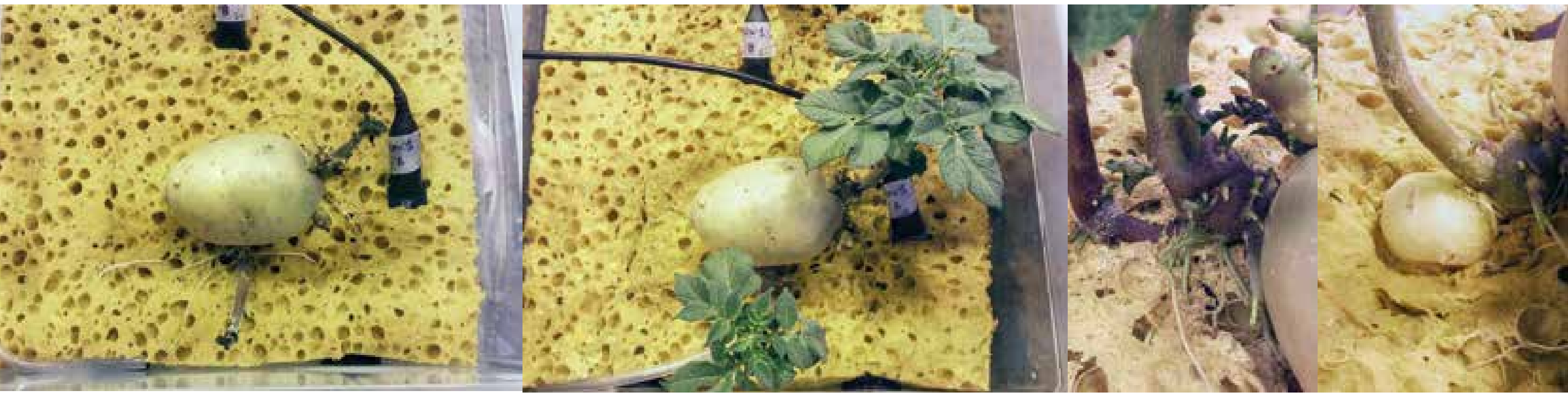

Figure 4. Leaf and stem development and stolon and tuber formation in potato plants grown on cellulosic sponge as a degradable organic substrate, during the experiments of the PFPU project.

organisms (higher plants and decomposer microorganisms) to maximize the use of in situ resources, i.e., lunar and Martian soils, and the recycling of organic matter from the plant cultivation system and the crew (residuals of plant cultivation and human faeces and urine). The project will include other Italian universities and research institutions as well as several industrial partners, to cover all expertise required to develop plant-based systems for Martian and lunar outposts. Planetary soils will be used as the cultivation substrate and mission waste as amendments, fertilizers or biostimulants, to produce fresh food for the crew diet as well as novel functional foods, e.g. microgreens (Figure 5) (Kyriacou et al., 2017). These will be used as countermeasures to degenerative diseases induced by space factors such as cosmic radiation. After the phases of design, realization and testing on Earth, the prototype of a cultivation module will be moved to the ISS to validate the ground observations in space conditions.

Educational partnership

In parallel to the research activity, UniNa scientists participate in several ASI educational projects, to disseminate the results to high school students, through seminars and texts, on the main aspects of human and plant life in space. During the years 2014-2015, within a series of ASI initiatives to connect the education system to the research field, the project "EPO (Education and Public Outreach) – HiP (Higher Plants)", performed in connection to the ISS mission 42/43 "FUTURA", led to the publication of the e-book LISS: Lessons on the ISS (https://www.asi.it/it/educational/liss-a-lezione-sulla-iss). In the same project, the team was also involved in the development of the mission website page (http://avamposto42.esa.int/), dedicated to the Italian astronaut Samantha Cristoforetti, as well as to the post-flight tour (https://www.astronautinews.it/2015/09/il-calendario-ufficiale-del-post-flight-tour).

In 2016-2017, two educational projects were matched to the ISS Expedition 52/53 "VITA": the "Youth ISS Science" project MULTI-TROP (MULTI-TROPism), and the project "EXPLORA – Human and robotic exploration of space". Within the first project, an experiment on the ISS involving the Italian astronaut Paolo Nespoli, aimed to investigate the interaction among the main factors affecting the direction of root growth in the absence of gravity, which is the dominant stimulus on Earth (gravitropism). Specifically, the study investigated the possibility to drive the root growth through the presence of only water (hydrotropism) or water and nutrients (chemotropism). The second project aimed to create a connection between high school students and the scientific and industrial institutions involved in space research through a series of seminars and the ebook "Explora" (https://www.asi.it/it/educational/a-scuola-di-scienza/explora-esplorazione-umana-e-robotica-dello-spazio).

Figure 5. Microgreens species belonging to the families of *Apiaceae* (coriander), *Brassicaceae* (cress, kohlrabi, komatsuna, mibuna, mustard, pak choi, radish, tatsoi), *Lamiaceae* (green and purple basil), *Malvaceae* (jute), and *Chenopodiaceae* (Swiss chard) grown in a phytotron at the UniNa facilities in studies on phytochemical composition.

Conclusions

Extensive research performed within space plant biology has enabled us to conclude that higher plants are able to adapt to space conditions, at least during one cycle from seed to seed. However, the information about the long-term effects of space conditions on fundamental plant processes, including the effects of plant exposure to radiation, to a weak magnetic field and to reduced gravity, is still limited. More experimental data are required for the successful integration of higher plants into a BLSS and there is a need for science-driven technological innovation that will contribute to move towards a more sustainable agriculture and food production system on Earth.

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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.

Architecture and fruiting of the apple tree in agroforestry systems – coupling architectural development, flowering, fruiting and sap flow

› Benjamin Pitchers

Agriculture has evolved tremendously to increase productivity and quality in the past decades. It was often achieved by plant breeding and at the cost of an increasing dependence on external inputs, i.e., water, fertilizers and pesticides. Apple orchards are no exception. Society is now questioning the means used because of the generated environmental pollution and health issues. Different solutions have been considered to reduce this dependence including redesigning agrosystems to rely on ecosystem-based services. Multispecies AgroForestry Systems (AFS), such as the association of tailored perennial and annual crops and possibly animals in one field, could increase income sources, enhance pest control, improve resource use efficiency and buffer extreme climatic events. Since 2016, an AFS located in the south-east of France, characterized by a Mediterranean climate, has been designed to achieve these objectives. It includes three strata: walnuts grown for timber at the higher stratum, apple trees at the intermediate stratum, and a pulse crop at the lowest stratum. This AFS presents a good opportunity to study the effect of such agrosystems on apple tree architecture, physiology and production. In addition to the aforementioned interests, these systems would be potentially interesting in the Mediterranean area to limit the harmful effects of recurrent excessive summer radiation (light and temperature). The aim of my research is to acquire a detailed knowledge of the tree's architectural development, its flowering, the quality of its fruiting and the daily and annual dynamics of sap flow along a competition gradient induced by the walnut trees. Using a functional-structural plant models approach, data collected during the third and fourth years of tree growth are analysed based on mutli-scale tree graph, to decipher whether and how the apple tree's responses to its environment significantly affect its architecture and fruit production over consecutive years. Apart from acquisition of knowledge, a potential output of my PhD work will be the proposal of assembling rules, at spatial and temporal levels, to optimize the design of such apple tree-based AFS.

Benjamin Pitchers won an ISHS Young Minds Award for the best oral presentation at the International Symposium on Evaluation of Cultivars, Rootstocks and Management Systems for Sustainable Production of Deciduous Fruit Crops at the IHC2018 in Turkey, in August 2018.

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Floral induction, fruit growth and photosynthesis are differentially affected by local variation in source/ sink relations

› Fares Belhassine

Fares Belhassine is a PhD candidate studying alternate bearing of apple trees (*Malus × domestica* Borkh.), at the French National Institute for Agricultural Research (INRA), in the Architecture and Functioning of Fruit Tree (AFEF) team, Montpellier, France. Fruit trees are prone to alternate bearing and the inhibition of floral induction (FI) under high crop load conditions. The competition for non-structural carbohydrates (NSC) between vegetative and reproductive organs and the inhibition by gibberellins (GA) produced by seeds, are the most likely mechanisms that determine alternate bearing. However, their relative influence on FI remains unclear. My research focuses on the effect of distances between FI promoting organs, such as leaves and fruits, and targets, i.e. meristems, within 'Golden Delicious' apple trees on FI. I examined how leaf and fruit removal treatments that were performed at different scales of tree organization, e.g., shoot, branch, half-tree, affect FI and mean fruit weight (MFW). Photosynthesis was associated to starch concentration in leaves and regulated by crop load at the tree scale, independently on distances. FI proportion in shoot apical meristems (SAM) and MFW were sensitive to competition and distances among organs. Both FI and MFW of remaining fruit decreased when leaves were removed and increased when other fruit were removed, the effect increasing with the distances to the SAM and remaining fruit. SAM of fruiting and non-fruiting tree parts presented different FI rates and GA9 content but no variation in NSC content. Similarly, different FI rates were found in SAM of foliated versus defoliated tree parts, but there was no localized variation in NSC content. This suggests that GA rather than carbon could be a main regulator of FI and that a signal other than NSC originated from leaves to promote FI. This other signal could be the flower integrator FLOWERING LOCUS T, known for that action in many other species. These results are currently integrated in a functional-structural plant model for apple tree and used to calibrate carbon and signal transport distance effects and antagonistic impacts on FI. Studying the interactions between model components is expected to improve our understanding of apple tree alternate bearing under different conditions. Fares Belhassine won an ISHS Young Minds Award for the best oral presentation at the International Symposium on Understanding Fruit Tree Behaviour in Dynamic Environments at the IHC2018 in Turkey, in August 2018.

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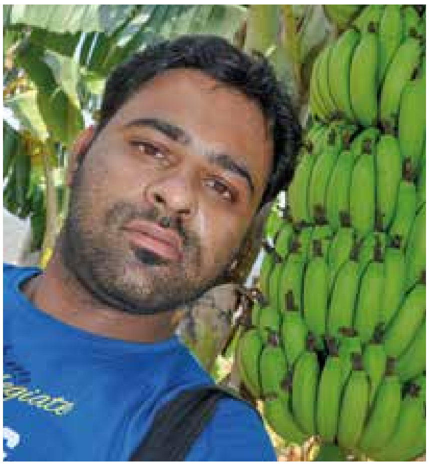
Induction of somatic embryogenesis in recalcitrant *Musa* spp. by media manipulation



› Kumaravel Marimuthu

In banana (*Musa* L.), somatic embryogenesis (SE) is a high throughput technique for mass propagation of quality planting material, genetic transformation and induced mutations. Through SE, a large number of plantlets can be generated from 1 mL settled cell volume of embryogenic cell suspension (ECS). Although SE is well reported in selected banana cultivars, most of the commercial cultivars are recalcitrant to SE. Knowledge of the genes responsible for SE is important to induce SE in recalcitrant cultivars. So attempts were made to identify the genes responsible for embryogenic callus (EC) induction, regeneration and germination of somatic embryos in 'Grand Naine' (subgenome: AAA) through proteomic approaches. Based on the results of proteomic analysis, the callus induction and somatic embryo germination medium was modified and validated in four recalcitrant cultivars ('Red Banana' - AAA, 'Monthan' - ABB, 'Karpuravalli' - ABB and 'Ney Poovan' - AB) with one potential 'Grand Naine' as control. It was observed that tryptophan supplemented media induced more EC in two recalcitrant cultivars, 'Ney Poovan' and 'Monthan', than the others. Greatest EC was induced for 'Red Banana' using media supplemented with kinetin, whereas it was greatest using $CaCl_2$ supplemented media for 'Karpuravalli'. The above results revealed that EC induction in banana is not only genome specific but also cultivar specific. ECS was successfully established in all recalcitrant cultivars tested in the experiment. Simultaneously, different media were tested for germination success. The highest proportion of germination for 'Grand Naine' was achieved in media supplemented with naphthalene acetic acid and gibberellic acid, whereas for 'Rasthali', more somatic embryos germinated in $CaCl_2$ enriched media than in others. Further analysis of available proteomic data will be useful to the scientific community for the establishment of SE in other commercial cultivars. The ECS obtained will be further multiplied using bioreactors for large scale production of quality planting material. As a result, more plantlets will be efficiently produced in a shorter time, thus reducing costs for small and marginal farmers. The results obtained from the present study will help meet the growing demand for quality planting material, and improve commercial cultivars through genetic transformation and mutation breeding.

Kumaravel Marimuthu won an ISHS Young Minds Award for the best poster at the XI International Symposium on Banana: ISHS-ProMusa Symposium on Growing and Marketing Banana under Subtropical Conditions at the IHC2018 in Turkey, in August 2018.

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Mechanical thinning of apples reduces fruit drop

› Martin Penzel

Martin Penzel is a PhD candidate in the Working Group of Precision Horticulture of the Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB), Potsdam, Germany. For his doctoral study he is focusing on precision thinning of apples and the gas exchange patterns of pre-harvest fruit and leaves. His goal is to determine the optimum crop load according to the carbon balance of the trees. The effect of mechanical thinning on fruit drop and final fruit number of 'Elstar', 'Gala' and 'Pinova' apples was investigated in 2011 and 2014. Mechanical thinning was carried out at the balloon stage, at a constant vehicle speed of 8 km h^{-1} with rotational frequencies of 200, 240, 280, and 320 rpm of the rotating arms. By calculating the kinetical energy at the end of a string, such thinning treatments equaled 0.68, 1.01, 1.42 and 1.89 J, respectively. The absolute number of removed flowers per tree was proportional to the initial number of flowers per tree (flower set) and increased with enhanced rotational frequency. In 2014, natural fruit drop was reduced on 'Elstar' and 'Gala' when thinning treatments of 1.42 J or more were applied. We suggest this was because of a reduced number of sinks competing for available carbohydrates. Fruit drop was more consistently enhanced on trees with high flower set than on trees with low flower set in every trial. When trees had 200 flowers or less, the final fruit set was below the target crop load of 125 fruit per tree on the control. The trees with higher initial flower set, >200, were thinned above frequencies of 1.01 J. Therefore, the concept of precision thinning shows an encouraging potential to balance the heterogeneity of flower set within an orchard by means of adaptive thinning intensity for each tree by varying the rotational frequency based on the initial flower set.

Martin Penzel won an ISHS Young Minds Award for the best poster at the International Symposium on Understanding Fruit Tree Behaviour in Dynamic Environments at IHC2018 in Turkey in August 2018.

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Pedicel effects on final fruit size in apple

› Seval Taskin

Regulation of fruit size is a major economical factor for numerous horticultural crops. Specifically, in apple (*Malus* × *domestica* Borkh.), increases in fruit size will result in increased market value. Many factors play a role in determining final fruit size in apple, some of which have been well studied. Besides being responsible for the attachment of fruit to the tree, the pedicel also provides a connection between the fruit and the source of water and nutrients. Therefore, we hypothesized that the pedicel can be a factor that is involved in the regulation of apple fruit size. Accordingly, this study was conducted to determine the relationships between final fruit size and pedicel size and anatomy. We used 10 apple genotypes differing in fruit size from 1 to 336 g. During two consecutive years, apple fruit size and both pedicel diameter and length were measured and analyzed. Our results demonstrated that among the genotypes, pedicel diameter was positively correlated with final fruit weight at harvest. In contrast, pedicel length was significantly negatively correlated with fruit weight. Additionally, the number of tracheary elements in the pedicel was positively correlated with fruit size among the genotypes. In conclusion, genotypes with large fruit size had a large diameter, short pedicel, with both large and numerous tracheary elements.

Seval Taskin won an ISHS Young Minds Award for the best poster at the International Symposium on Evaluation of Cultivars, Rootstocks and Management Systems for Sustainable Production of Deciduous Fruit Crops at the IHC2018 in Turkey, in August 2018.

She is a horticultural engineer currently working in fruit crops production and breeding at Erzincan Horticultural Research Institute. She completed her BS and MS degrees at Adnan Menderes University, Turkey, in 2008 and 2012, respectively. She was then awarded a full scholarship from the Turkish Ministry of Education for a second MS degree. She obtained her second MS degree at Purdue University, Department of Horticulture in West Lafayette, IN, USA, in 2017. She now continues her Ph.D. study at Ataturk University in Erzurum, Turkey.

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Apple production and breeding in Sweden

Hilde Nybom

Can you really grow apples so far north?! Isn't it MUCH too cold? These are common questions, but we actually do produce delicious apples in Sweden in spite of being situated at latitudes 56 to 68°N (for comparison, St. Petersburg, Russia, and Anchorage, Alaska, are at about 60°N). Now let me tell you how we do it...

Market potential

Swedish people do love their apples, and have grown and eaten them for centuries. Still, I must confess that most of the fruit and berries consumed in Sweden are produced elsewhere. Thus, only 20-25% of the commercially marketed fresh apples originate from domestic orchards. Processed fruit and berry products are imported to an even larger extent, including juice, cider, wine, vinegar, jam, sauce, yoghurt, muesli, and tea.

Fortunately, this situation may change in the near future. Many customers now show an increasing interest in food quality and other aspects linked to the choice of foods. This concern includes fruit and berries as major contributors to a healthy diet. Media have latched on to this development, and most young people would rather share a photo of themselves eating an apple than lighting a cigarette! In connection with the awareness of global warming and the need for environmental-friendly production methods, there is also an increased willingness to buy locally and/or organically produced foods. Typically, Swedish apple quality parameters have been defined as having particular characteristics, for example having a thin peel, and a strongly aromatic and refreshing flavour, as opposed to the sometimes "bland" or overly sweet apples from countries with a warmer climate. In an effort to meet customer demand, a number of large retail stores have improved the overall quality standards of the domestic apples offered, and the segment of domestic fruit has actually grown somewhat in recent years.

› The Swedish climate is especially challenging for late-maturing cultivars.

In short, the market potential is apparently much larger than the current Swedish apple harvest, and consumer attitudes can certainly help to promote an increase in the sales of domestic fruit. This positive development is, however, dependent on the successful implementation of a competitive cultivation and marketing programme.

Apple production

Climate and weather

Summer temperatures in Sweden are quite similar to those in areas at the same latitudes in North America and Asia. Winters are, however, much milder in Sweden due to the strong influence of the Atlantic Ocean and the Gulf Stream. Daily weather is often quite difficult to predict because it is dominated by western winds from the Atlantic Ocean. These winds are notoriously variable, carrying competing masses of cold and warm air, and sometimes leading to prolonged periods of cool and moist weather, or contrasting periods of high temperatures and severe drought.

Almost all of the commercial apple production (c. 90%) is located in the coastal areas of the southernmost province, Skåne (latitude 56-57°N), with the most prominent apple-growing district Österlen in the southeastern part of Skåne. Here, warm soils are provided by the gravelly and stony substrate, while a prolonged autumn season is obtained through the closeness to the sea. A few, mostly smaller, commercial orchards are also found along the large lakes (Vättern

› In the supermarkets, imported fruit (to the left, 'Golden Delicious' and 'Granny Smith') are usually sold at a lower price than domestic fruit (to the right, 'Gloster').

and Mälaren) in southern Sweden and up to the Stockholm area (latitude 59°N). In addition, apple trees produce much appreciated fruit in home gardens, also in the inland of southern Sweden, and along the coast all the way up into the northern parts of the country (latitude 65°N).

In Skåne, the average growing season is 220 days (somewhat longer in recent years). The yearly precipitation in the apple-growing areas is 550-750 mm, fairly evenly distributed throughout the year. Average daily temperature in January is around 0°C (but generally plummets to -20°C for a few nights every winter) while the corresponding value for July is just below 20°C, with mid-day temperatures seldom reaching above 30°C. Year-to-year fluctuations are, however, very pronounced, and apple tree full bloom ranges from the last week of April until the last week of May. Time of fruit harvesting is usually less variable, with commercial apple picking in most years starting with 'Discovery' in the last week in August and ending in mid-October with cultivars such as 'Ingrid Marie', 'Elise' and 'Frida', or sometimes a couple of weeks later if the weather is mild.

In most years, the main reason that many well-known international apple cultivars don't do well in Sweden is the poor fruit development in our comparatively short and cool summers. Although the average temperatures have increased in Sweden, especially in autumn and winter (for the country as a whole, the first autumn frost now arrives 25 days later than in 1961), the year-to-year

› Modern Swedish apple orchard with 'Rubinola' some weeks before harvesting. Photo: Lars-Olof Börjesson.

› Commercial harvesting usually starts with 'Discovery' at the end of August. Photo: Lars-Olof Börjesson.

fluctuations have so far obscured some of the long-term effects of global warming. Therefore, growers are still reluctant to plant cultivars with an unknown ability to withstand adverse weather conditions. A single, very cold winter, or an unusually dry spring with fluctuating temperatures, cannot only obliterate an entire harvest because of frost-damaged flowers but can also destroy numerous trees in an orchard that would otherwise have been expected to produce for many more years.

Orchard management

The total area of commercial apple production in Sweden is only about 1,600 ha, with a mean volume of 20,000 tonnes, produced by c. 300 mostly family-owned businesses. Organic orchards are seldom more than 10 ha whereas some integrated production (IP)-orchards are considerably larger. Peak production in a well-maintained IP-orchard is around 40 t ha^{-1} (occasionally reaching 70 t in especially good years), while a corresponding organic orchard produces around 20 t ha^{-1}. Mean annual production value for all the commercial apple growers in Sweden has been estimated as 20-30 million euro, which is the second highest after strawberry in the fruit and berries segment. Being considerably more sensitive to both pests and fungal diseases, the quantity of home garden-grown fruit varies greatly between years, but probably reaches the same size as the commercial harvest in an average year. In years that have beneficial weather conditions, home garden fruit therefore compete with commercially grown fruit during the first months after harvest.

› Machine-harvesting is used in a few orchards; 'Amorosa' (sport of 'Aroma') is one of the most widely grown cultivars in the Nordic countries. Photo: Lars-Olof Börjesson.

Apple trees for commercial orchards are obtained mainly from plant nurseries in Belgium and France, where they are budded on clones of M9 or M26, sometimes with an interstem. In these countries, the climate together with the application of plant hormones (prohibited in Sweden), results in vigorous trees with a superior scaffold compared with the trees that can be produced in Sweden. Some of these nurseries have their own mother trees of the most popular cultivars designated for Swedish customers.

The most important commercial cultivar is the Danish 'Ingrid Marie' followed by 'Aroma' (and its red-fruited sport 'Amorosa'), which was released from a Swedish apple breeding programme at Balsgård in the late 1960s. Other commonly grown cultivars are 'Alice', 'Frida' and 'Katja' from Balsgård, 'Cox's Orange Pippin' and 'Discovery' from England, 'Elise' and 'Santana' from The Netherlands, 'Gloster' from Germany, 'Gravenstein' (unknown origin), 'Rubinola' from the Czech Republic, and 'Rubinstar' (sport of the American 'Jonagold'). Some of the above-mentioned cultivars are also planted in many home gardens. In spite of a sometimes superior climate adaptation, old domestic cultivars are almost never grown in commercial orchards. Some of them are grown in a few home gardens but numbers are also apparently decreasing there because of their overall insufficient quality attributes, particularly yield, fruit quality and storage capacity.

The commercial orchards are usually planted with 2600-3200 trees ha^{-1} (the lower number mainly in organic orchards). Support systems, with large wooden stakes at the end of rows and smaller stakes and wires in between, are commonly used. Drip irrigation has been installed in most of the larger orchards.

› Up and coming cultivar 'Frida' from Balsgård, cross between 'Aroma' and a scab-resistant selection from the Purdue, Rutgers, and University of Illinois programme in USA.

Pollination is usually accomplished by the inter-planting of small *Malus* trees and access to bee-hives in the neighbourhood. Pruning and harvesting is mainly conducted by hand.

Pests and diseases

The apple orchards are kept for at least 20 to 30 years, sometimes much longer although fruit quality decreases with increasing tree age. This leads to a build-up of high concentrations of detrimental pests and diseases, especially in orchards where the use of chemical pesticides and fungicides is avoided or at least kept to a minimum. Sufficient tolerance to the major pests and diseases is a prerequisite for cultivars in organic production but of high importance also in IP-orchards. Apart from the ubiquitous apple scab *Venturia inaequalis*, and powdery mildew *Podosphaera leucotricha*, major problems are caused by apple canker *Neonectria ditissima*, which thrives in a cold and moist climate. This disease kills entire trees and also destroys fruit during storage. The most prominent storage diseases are, however, *Neofabraea* spp. (syn. *Pezicula*), *Colletotrichum* spp. and *Penicillium expansum*, but considerable damage is caused also by *Botrytis cinerea, Monilinia fructigena* and *Fusarium* spp.
Among insect pests that affect production in Sweden, aphids of the genus *Dysaphis* are especially problematic. Codling moth, *Cydia pomonella*, is a common problem, while *Argyresthia conjugella* becomes especially detrimental in some years, with major damage on the very popular cultivar 'Aroma'.
In contrast to most countries with a more beneficial climate, Swedish orchards have experienced only a few minor outbreaks of the bacterial disease fire blight, *Erwinia amylovora*. Attacks of most of the fungi and pests have also been comparatively moderate but are likely to worsen when the weather conditions are increasingly affected by global warming.
Almost all fruit production conforms to the European IP regulation while less than 5% of the harvest is produced organically. Access to plant protection chemicals is quite restricted compared with many other countries in Europe. Altogether about 15 applications of plant protection compounds are carried out per year in an IP-orchard and 10 applications per year in an organic orchard. The majority of these target apple scab and insects. Application of any kind of chemical is prohibited on fruit after harvest, including the use of fungicides against storage rots. This results in a significant reduction in final packout because of storage diseases in many cultivars. Swedish-grown apples are usually certified with IP Sigill or Krav (organic fruit). Both of these certification systems are somewhat more stringent than the corresponding EU regulations.

Apple marketing

The largest fruit packing facility is managed as a co-operative with approx. 100 growers ('Förenade Frukt ekonomisk förening'). Together with 10 other fruit packing businesses, they supply about 60% of the commercial harvest under the brand name 'Äppelriket'. Storage is, to an increasing extent, carried out in modern ultra low oxygen (ULO) facilities, which presently extends the sales season well into May or even June.
Unfortunately, apple marketing in Sweden is heavily influenced by a very small number of supply managers representing the dominating retail chains, and business takes place almost exclusively on computer screens, with little human interaction. Expected profit margins are extremely important, with quality playing an inferior role, and customer satisfaction is seldom followed up. In the shops, it is not uncommon to see large boxes of small and bruised Swedish apples side-by-side with trays containing large and attractive imported fruit, and with the latter often priced 50% lower than the domestic fruit! Fortunately, the increasing consumer interest in local (or at least domestic) produce, has now spawned a growing interest in Swedish fruit, and some shops offer a diversity of good quality fruit with prominently displayed cultivar names.
Up until recently, all apple orchards in Sweden have targeted the fresh fruit market. The grower receives much less for industrial-grade fruit (approx. 0.2 euro kg^{-1}) than for first-grade fruit (approx. 0.6 euro kg^{-1} IP-fruit and 1.2 euro kg^{-1} organic fruit) and there has been little incentive to produce fruit primarily for juice production. Lately, an increasing number of growers have diversified into the production of juice and other culinary apple products. At Balsgård, Swedish University of Agricultural Sciences (SLU), the recent implementation of a centre for innovative beverages has initiated a large number of co-operative projects with growers and small-scale producers of high-quality fruit- and berry-based products. A number of small businesses have also taken up cider production, and there is now some emerging interest in planting apple cultivars that are especially suitable for juicing and/or that have the characteristic bitterness needed for craft apple ciders.

› Apple canker caused by *Neonectria ditissima* kills many trees every year.

Plant breeding

Considerably more than half of the commercial Swedish apple harvest is based on cultivars developed in Sweden or Denmark in the last century. Apart from yield and quality attributes, these cultivars are also appreciated for their marketing advantage as 'typically Swedish'. Nevertheless, growers still require further improved cultivars with even higher yields as well as excellent eating and storage quality. In addition, climate change together with the ever-increasing restrictions in the use of fungicides and pesticides, has prompted a renewed interest in apple breeding. As an example, there is apparently a need for enhanced tolerance to the bacterial disease fire blight (*Erwinia amylovora*), which is likely to become more detrimental as the climate becomes warmer and wetter.

Plant breeding at Balsgård

The only apple breeding facility in Sweden is Balsgård, implemented in the 1940s and part of SLU since 1970. The Balsgård apple cultivar

› Crosses are made by dipping the styles of emasculated apple flowers into a vial with pollen. Photo: Lars Torstensson.

› Balsgård cultivar 'Gratia' was released in 2017; sibling of 'Frida' with especially crisp and sweet flesh and a hint of aniseed flavour. Photo: Lars Torstensson.

'Aroma' has had an enormous impact on present-day production, especially in Norway and Sweden, where it is the first and second largest cultivar, respectively, but to some extent also in Denmark and Finland. Other successful Balsgård cultivars include 'Alice', 'Frida' and 'Katja' ('Katy' in Great Britain) as well as the very winter hardy 'Rödluvan' for northern latitudes and 'Fredrik' for home gardens.

Apple breeding is undertaken with 100% public funding and presently amounts to approximately 150,000 euro per year (which is expected to cover all salaries, rent of facilities and amenities), including a three-year grant for a new programme on breeding cultivars especially suited for juice and cider. This is very low in comparison with publically or privately/publically funded breeding programmes conducted in most other European countries, and the programme is consequently very small with an average over the last two decades of only 500 new seedlings planted in the field each year.

› Award-winning juice produced from fruit harvested in Sven-Anders Persson's orchard is marketed as 'A local beverage to be proud of'. Photo: Kimmo Rumpunen.

Apple breeding is a lengthy process, and the time taken from conducting a cross to registering a new cultivar from that cross is usually 20-30 years. Crosses are therefore mainly conducted between well-known, high-quality cultivars that can produce commercially attractive offspring already in the first generation through beneficial recombination of the parental genes. Some of our crosses include parents that are especially winter-hardy, with the aim of extending the commercial apple cultivation further north in the country. Occasionally, crosses are also made with red-fleshed accessions to produce high anti-oxidant cultivars. Choice of parents and evaluation of the resulting seedlings is augmented by the use of molecular markers when available, such as the locus-specific markers for apple scab, the QTLs for fire blight resistance and the various markers associated with fruit texture. Data from biochemical analyses and food processing experiments (mainly juice-making qualities) are valuable for the newly implemented addition to the breeding programme focusing on juice and cider cultivars.

The most promising seedlings, after field and postharvest evaluations, are propagated onto dwarfing rootstocks and planted in observation trials both at Balsgård and, at a later stage, also in commercial orchards. In a recently planted field trial, about 30 foreign cultivars and advanced selections are being grown together with a handful of the most promising Balsgård selections. These plantings have been repeated in commercial orchards, allowing most of the accessions to be exposed to both IP and organic production methods. Some of the foreign cultivars will hopefully prove to be useful for commercial production just as they are, while several more may have long-term value in the breeding programme.

Genetic resource collections and pre-breeding projects

A prerequisite for plant breeding is the availability of collections of carefully identified and evaluated plant genetic resources, i.e. gene banks, having germplasm that can be used as parents for the crosses. In contrast to the more easily managed seed-propagated crops, responsibility for the collection and preservation of vegetatively propagated crops like fruit and berries, is often unclear and the funding inadequate. The Nordic Gene Resource Centre, NordGen, collects, stores and distributes seed for a large number of seed-propagated agricultural and horticultural crops. The situation is different for clonally propagated crops. In the case of apples, NordGen takes responsibility only for the keeping of information databases and the supervision of a joint Nordic pre-breeding project, but the actual preservation of the plant material is left to national agencies.

As in many other European countries, the recently popularized concept of "heirloom cultivars" has resulted in earmarked funding in Sweden for selected cultivars that are either indigenous or have (or used to have) considerable socio-cultural interest within the country. The major aim is to preserve these cultivars for future generations, and to provide the general public with propagation material and educational experiences such as field demonstrations and fruit exhibitions. In contrast, possible importance for current plant breeding programmes is seldom a concern when the status of heirloom cultivar is bestowed. A genebank with approximately 200 heirloom cultivars has recently been planted at Alnarp, SLU. There are two trees of each cultivar, propagated on the very vigorous rootstock A2. The trees receive fertilization and insecticide treatments like in a conventional orchard, but chemical fungicides and herbicides are avoided. Many of these cultivars are also conserved in one of the smaller fruit tree collections scattered around the southern half of Sweden.

The largest Swedish apple collection is maintained at Balsgård, with approximately 500 cultivars including some foreign selections. Here, two trees are usually preserved but on less vigorous rootstocks, mostly M26. Funding for this collection is very inadequate, and long-term survival is by no means guaranteed. Nevertheless, this collection has played a major role, not only for the breeding programme, but also for plant breeding-related research. In addition to many national projects, parts of these collections were also used in the international EU-funded Fruitbreedomics project, in which phenotyping (physiological and pomological traits) and genotyping (SSR loci and SNP-arrays) were carried out to study genetic relatedness and structure of European apple germplasm, as well as to identify important genes through GWAS (genome-wide association studies).

Balsgård also participated in a Public Private Partnership project in 2012-2017, “Prebreeding for future challenges in Nordic apples”, targeting two of the most detrimental diseases in Nordic apple production: storage rots and fruit tree canker. The project was conducted jointly by Graminor in Norway, National Resources Institute Finland (LUKE) and SLU in Sweden. Genetic variation in disease tolerance among some important and/or promising apple cultivars was investigated using different inoculation tests. Some of this work will now be continued in a follow-up project “Pre-breeding for future challenges in Nordic fruits and berries” in 2018-2020.

› Hilde Nybom.
Photo: Lars Torstensson

› About the author

Before her recent retirement, Hilde Nybom was a Professor of Horticultural Genetics and Plant Breeding, SLU, and has also been responsible for the applied apple breeding programme at SLU for more than 30 years. She has been a representative for Sweden on the ISHS Council for 18 years. E-mail: hilde.nybom@slu.se

› Lemon production, export and unique natural storage potential of Turkey

Okan Özkaya

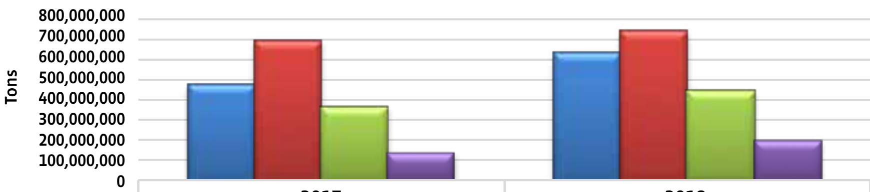
Introduction

Citrus production is the largest of any fruit group in the world (Faostat, 2017). In 2017, this production reached 146,599,168 tons. The largest producing country in the world is China, followed by Brazil, USA, India, Mexico and Spain. World production is composed of 50% orange, 22.8% mandarin and tangerines, 11.7% lemons and limes, and 6.2% grapefruit and shadok. Turkey is the second largest producer country of lemons and limes, with a total production of 4,769,726 tons in the Mediterranean region. The steady increase in demand has resulted in expansion of the areas of cultivation in many countries that have a coast to the Mediterranean region, including Turkey (Faostat, 2017).

The European Union countries is a net importer of citrus (GAIN, 2018). Spain and Italy, the leading EU citrus producers, export mainly to other EU countries, i.e. United Kingdom, Germany, France, Belgium, and The Netherlands. These five countries, with imports totaling around one million tons, are the largest importers and consumers of citrus. Spain produces almost 50% of the orange, mandarin and lemon trade, especially in the Mediterranean basin of Europe, and directs and develops the citrus sector in such a way as to retain their current markets. Turkey has a big advantage for export into the Eastern Europe countries of Romania, Bulgaria, Poland, Hungary, and the Czech Republic, because of its proximity.

	2017 Value ($ dollars)	2018 Value ($ dollars)
Citrus	849,427,996	893,614,965
Fresh Fruit	793,204,109	825,571,089
Fresh Vegetables	563,263,914	593,286,615

Figure 1. Turkish citrus, other fresh fruit and vegetable export volumes in 2017 and 2018 (AKİB, 2018).



	2017 Quantity (tonnes)	2018 Quantity (tonnes)
Lemon	475,115	634,897
Mandarin	697,093	744,418
Orange	368,692	448,059
Grapefruit	131,507	194,660

Figure 2. Export volumes of Turkish citrus fruit by category in 2017 and 2018 (AKİB, 2018).

Citrus production, export, and trade have a very important place between the total fruit and vegetable production of Turkey (Figure 1). The total export quantity as well as market value of citrus are more than the total of other fresh fruit or vegetable exports. Turkey exported an average of 744,418 tons of mandarin, 634,897 tons of lemons, 448,059 tons of oranges and 194,660 tons of grapefruit (Figure 2), resulting in $893,614,965 US income during the 2017-2018 season (AKİB, 2018).

In 2017, the area of citrus production in Turkey increased by 4357 ha compared with the previous year; the total area in the country is 140,000 ha.

Turkey has a semi-subtropical or Mediterranean climate and the citrus production is mostly located on the southern Mediterranean and Aegean coast regions, and there is a very low amount of production in the Rize Province, which is located in the Eastern Black Sea region. The Mediterranean region produces about 85% of the oranges, 85% of tangerines and lemons, and 94-98% of the grapefruit for the country. Cukurova, one of the large production areas on the western Mediterranean coastal, produces 70-75% of Turkey's citrus production with all citrus varieties of oranges, mandarins, lemons and grapefruit (TUİK, 2017).

Lemon has the second highest export value of the citrus categories from Turkey. The export quantity and value of lemon in 2018 increased by 14% from 2017 (GCCA, 2018). The Cukurova region of Mersin, Adana and Hatay-Arsuz Provinces specialize in 'Meyer', 'Interdonato', 'Lamas', and 'Kutdiken' lemons (UTK, 2018). The production and export knowledge, along with a large storage capacity, make lemon a unique export product for Turkey. Lemon harvest starts from September and continues until the end of January by making use of different cultivars. The export season can be extended until the end of May or June.

General overview of lemon storage chain

The harvest date difference between early and late cultivars can be from 2-5 months in some Mediterranean countries. Because of the opposite production seasons between

■ Figure 3. Commercial natural storage warehouse in Kavak-Cappadocia.

countries in the northern and southern hemispheres, sustainability of the product and availability to the consumer can be obtained by using different cultivars and storage.
Lemon has a different consumption demand than other citrus fruits. Lemons are sought after and consumed throughout the year. Therefore, every month a supply of lemons is needed for consumers. Fresh production of lemons occurs during only a few months of the year; storage is required for the other months. Although some early lemon cultivars may appear on the market fresh in late August, the main harvest begins in September and fruit harvest is completed after approximately five months. 'Lamas' and 'Kutdiken' can be stored for up to 6-8 months in low cost unique natural "volcanic Tufa storage" located in Cappadocia or in conventional cold storage rooms around the Adana-Mersin Provinces.
Cappadocia is one of the unique tourism areas in Central Anatolia, where world-renowned soft volcanic rock formations make an amazing landscape. The underground-carved storage warehouses are one of the most important storage facilities in the region (Figure 3). In most cases, no mechanical cooling system is required. They are considered as effective as mechanically cooled warehouses. However, they are still considered "ordinary or natural storage rooms". In this storage system, cold air is supplied from outside at cooler night times and the natural insulation of the rock walls blocks the temperature rise during relatively warmer day periods (Erkan, 2018). These stores are installed with CO_2, O_2, and thermohygrometer sensors as well as an automatic ventilation system that control the desired storage conditions.
The average temperature of these caves changes from 7 to 13°C, with 70-90% RH, during the December-July period (Ozkaya et al., 2005). The average temperature increases gradually, starting from January until the end of August. There are several natural stores with different storage capacity around the Cappadocia region, located at Kavak, Ortahisar and Uchisar areas. The lemon storage facility of these cave warehouses is around 100,000 to 160,000 tonnes per year. This type of warehouse system has huge cost advantages over the mechanically cooled storage technologies. It is able to provide significant contributions to the local and national economy by saving energy and providing employment opportunities in the region (Erkan, 2018). These kind of overlooked natural facilities may soon start to be alternative storage warehouses with different kinds of heating or cooling technology implementations.

Postharvest practices of naturally stored lemons

Disinfection of postharvest pathogens that have accumulated on the fruit surface preharvest and during harvest is a direct factor in preventing decay during storage and shelf life. The use of some fungicides by drenching is the most conventional method to stop the spread of fungal pathogens and extend the storage life of the fruit (Christie, 2016).
Harvested fruit should be carefully placed in small baskets that have two layers of soft fabric. Fruit are then transferred to 20-kg crates at orchards before transporting them to the packinghouses (Figure 4). Drenching the harvested goods with fungicide within the first 24 hours postharvest is crucial for long-term storage. Drenching systems and postharvest fungicide effects are well known for lemons. After drenching, the fruit must dry by evaporating the water from the peel surface. Presorting is done in parallel with packaging lines that specialize in preparing these fruit for long-term storage. Each fruit is individually wrapped with waxed paper infused with additional natural compounds. This method has been used successfully for many years to store lemons in the natural volcanic vaults (Figure 4).
Wax and natural compound impregnated papers are special materials developed during a project supported by the Turkish Promotion Group to ensure that biphenyl-free materials be used for lemon storage. These storage papers are used for decreasing the weight loss and stopping the spread of any fungal development during storage. New wax impregnated and natural compound papers developed with a project supported by the Turkish Promotion Group have

■ Figure 4. Drenching, presorting and packaging lemons for storage.

ensured food security and prevented the use of undesirable biphenyl-impregnated materials. This project was conducted by the Mediterranean Exporters Board and Cukurova University. Results were enacted after several years of research.

Results

Turkish lemons and their production meet high international standards in terms of quality, field practices, and traceability. Lemon harvesting, processing, and storing facilities are improving all the time as new techniques are developed. Extending the lemon export season by developing low-cost storage facilities and maintaining safe edible fruit remain the big challenges for exporters.

Summary

Turkish lemon production is gradually increasing. Turkish exporters, producers, and stakeholders have developed excellent traceability systems meeting the needs of the markets. Moreover, the Turkish Promotion Group (TTG) and Turkish Exporters Assembly (TIM) have been supporting citrus breeding and postharvest projects, such as new slow release materials for lemon storage instead of diphenyl-impregnated papers, for several years. Turkey will soon be ready to supply lemon exports throughout the year, by using new cultivars, low-cost storage facilities and modern postharvest techniques..

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› Strawberry culture and breeding studies in China

Yuntao Zhang, Guixia Wang, Jing Dong and Linlin Chang

Introduction

Strawberry is known as “The Queen of Berries” for its delicious flavor and rich nutrient content, particularly vitamin C and ellagic acid. Both compounds have a significant role in promoting human health. China is one of the most important strawberry producers in the world (Zhang et al., 2014). In China, strawberry villages, strawberry towns, strawberry counties, and strawberry cities have been developed in the last 30 years. Consumers can purchase and use strawberry fruit produced in China at any time of the year. China also produces various types of processed strawberries, such as dried, preserves, jam, canned, nectar, juice, and vinegar. Strawberries are also used in baked goods, ice cream, yogurt and chocolate (Figure 1).

■ Figure 1. Strawberries are processed in many ways: A) dried, B) on cakes, C) canned, D) nectar.

The strawberry originated in the Americas and Europe, and arrived into China from Russia in the early 20th century. This fruit has been cultivated in China for about 100 years. The first cultivar planted in China was *F. × ananassa* ‘Victoria’, which was brought from Russia. From the mid-1910s to the late 1940s, strawberries were only cultivated sporadically. At that time, almost all strawberry cultivars were brought from Europe. Some of these original European heritage cultivars were lost during this stage. However, their offspring were named for the fruit shape or the planting locations. They became breeding stock and were known by the local Chinese names. The early Chinese strawberries tended to have medium-size fruit, high yield, fair quality, but soft flesh. These seedlings of old European cultivars were the basis of the main characteristics of regional Chinese genotypes and now have become recollected and conserved in the National Germplasm Repositories of China. In the early 1950s, strawberries began to be cultivated as a commercial crop particularly near big cities, such as Shanghai, Nanjing, Qingdao, Shenyang.

Although the cultivation of strawberry in China started later than in many other countries, the production area increased rapidly. Strawberry cultivation in China began to increase significantly in the 1980s. According to the data from the National Bureau of Statistics of China, the strawberry production area was about 141,300 ha in 2017, while the total yield was more than 3,753,000 tons (Figure 2). About 2.1% of the production was exported (Table 1). The strawberry export market was 5.7% of the total volume of fruit traded in the world, and the main export product was frozen strawberries. As determined from the China Customs Statistics, Japan (13.14%), Russia (11.63%), Thailand (9.0%) and Germany (8.11%) were the main destination countries for this export. For fresh strawberries, the main destination countries were Russia (80.22%), Vietnam (17.31%) and Macao (1.55%).

In China, strawberries are cultivated widely and nearly all of the provinces can produce strawberries. The chief production provinces are Shandong, Liaoning, Anhui, Jiangsu and Hubei. The cultivation systems

■ Table 1. Statistical data of strawberry imports and exports in China (from China Customs).

Type	Year	Import revenue (1000 US $)	Import volume (t)	Export revenue (1000 US $)	Export volume (t)
Frozen strawberry	2013	15,442	8,076	132,578	97,233
	2014	13,510	7,131	107,593	73,830
	2015	14,702	8,849	92,713	74,720
	2016	20,183	11,506	107,550	90,075
	2017	20,352	11,032	110,103	78,829
Fresh strawberry	2013	-	-	1,296	797
	2014	0.9	0.18	3,222	1,291
	2015	-	-	4,007	1,454
	2016	5.55	0.34	4,508	1,575
	2017	245	48	5,324	2,287

“-” indicates no data.

Figure 2. The area and yield of strawberry production in China (from National Bureau of Statistics of China).

Figure 3. Strawberry production in the solar greenhouse.

in China include protected culture and open field, and the ratio is about 9:1. The area of China is vast but can be divided into three regions according to strawberry cultivation. In the region north of the Yellow River, solar greenhouses are dominant for strawberry production (Figure 3). In some provinces of southern China, such as Sichuan, where the temperature is warm in the winter, the fruit is produced under small- or medium-sized tunnels. In the region between these two regions, strawberries are produced in plastic houses or high tunnels (Figure 4). In some orchards, substrate cultivation is popular (Figure 5). Each region has different climatic conditions, but forcing culture has been achieved all over the country by using many kinds of facilities. June-bearing cultivars are planted for forcing culture in winter, and the harvest season in solar greenhouse begins in December, only three and a half months after the transplantation in August, and lasts until May in the next year. Before 2015, the predominant June-bearing cultivars in China were foreign cultivars, mostly from Japan, Europe or the US. These were: 'Benihoppe', 'Sweet Charlie', 'Toyonoka', 'Akihime', 'Sachinoka' and 'Honeoye'. But beginning in 2018, 'Ningyu', 'White Princess', 'Jingyao', 'Jingyu' and 'Jingzangxiang', bred in China by Chinese breeders, have become very popular for Chinese protected strawberry cultivation. They are now as important as 'Benihoppe', 'Sweet Charlie' or 'Akihime'. 'Honeoye', 'Darselect' together with No.3, No.6, and No.13 (code names) introduced from US, are planted mainly in open fields for processed production. Everbearing strawberry production has been established in the northeast of China, in the northern part of Hebei Province and in Yunnan Province, to extend the production season in summer and autumn. There are about 300 ha of everbearing production grown annually. The everbearing strawberry cultivars include Chinese selections as well as the California day-neutral cultivars, 'Albion' and 'San Andreas'.

In China, pick-your-own (Figure 6) is a popular consumption pattern in strawberry production. The price to consumers for pick-your-own strawberries is higher than in supermarket or retail stores. Therefore, successful sales require the pick-your-own businesses to attract people by appealing to their sense of sight, hearing, and taste, and by preparing a delightful atmosphere for the customer.

Strawberry germplasm conservation in China

Throughout the world there are at least 24 species in the *Fragaria* genus. The natural distribution in China includes 13 species. Wild strawberry populations are distributed extensively in Tianshan Mountains, Changbai Mountains, Qinling Mountains, Daxing'an Mountains, Qingzang Highland and Yungui Highland in China. Some *Fragaria* species, variations and types are endemic only to China. Until 2018, more than 1000 strawberry accessions including over 400 cultivars and 600 wild genotypes (22 species)

Figure 4. Strawberry production in the plastic house and tunnel.

Figure 5. Substrate cultivation. A) Intercropped with mushrooms and vegetables, B) Substrate cultivation using pots, C) Substrate cultivation using hanging grooves, D) Substrate cultivation using pipelines.

were conserved in China, in a field genebank; some were also conserved in vitro. Now, strawberry cultivars are preserved in two National Strawberry Germplasm Repositories established at the Beijing Academy of Agricultural and Forestry Sciences and Jiangsu Academy of Agricultural Sciences (Figure 7). The wild strawberry germplasm is mainly conserved in Shenyang Agricultural University. Strawberry conservation is also carried out in other public and private institutes. Since 2016, expeditions to collect wild strawberries from their native locations were conducted by the Strawberry Section of the Chinese Society for Horticultural Science (Figure 8). In the summer, people harvest the strawberries from the native wild stands for making Chinese pie or for sale (Figure 9).

History of strawberry breeding in China

Research on strawberry breeding began in the 1950s (Deng and Lei, 2005). At first, only a few institutions worked on strawberry breeding. New cultivars or advanced selections were obtained by open pollination or hybridization. For example, the Eastern China Institute of Agriculture Science (now renamed Jiangsu Academy of Agricultural Sciences) released three cultivars from open-pollinated seedlings in 1953. Then, Shenyang Agricultural University released four cultivars in 1959 and 1960.

In the 1980s, the Chinese Ministry of Agriculture established the National Strawberry Germplasm Repositories in Beijing and Nanjing, and funded strawberry breeding projects. Strawberry breeding began to develop quickly during this stage. More cultivars were released in the following 40 years. Five cultivars in the 1980s, 16 cultivars in the 1990s, 16 cultivars in the 2000s, and 64 cultivars within the time span of 2010 through to 2016 were released by 25 breeding institutions of China. In 2012, the VII International Strawberry Symposium, held in Beijing under the aegis of the ISHS, attracted a great amount of attention on strawberry research. It indicated that Chinese strawberry breeding has entered an era of rapid development.

New released strawberry cultivars

The Chinese population tends to prefer Japanese strawberry cultivars because of the sweet taste and intense aroma. Unfortunately, the yield and resistance to diseases of the Japanese cultivars are not as good as that of American or European types. Therefore, Chinese breeders hope to release cultivars with good quality as well as high yield and strong disease resistance (Figure 10). In addition, early flowering and short dormancy are vital for forcing early production. For everbearing types, continuous flowering and fruiting in summer are also crucial characteristics for breeding targets. Whilst there have already been great improvements in the present leading cultivars over older cultivars, breeders also want to develop cultivars adapted to the local climate and the trends of the local strawberry industry.

Until 2016, 108 new strawberry cultivars have been released in China (Chang et al., 2018), including 99 June-bearing cultivars and nine everbearing cultivars. Cultivars were classified according to purpose: fresh, ornamental and fresh, processing and fresh, and processing cultivars. The proportions of the four types were 88.9, 4.6, 4.6 and 1.9%, respective-

Figure 6. Pick-your-own farms.

Figure 7. National Strawberry Germplasm Repositories in Beijing (A) and Nanjing (B).

Figure 8. Collection of strawberries from the wild. A) Collection group and local residents, B) Plants of *F. pentaphylla*, C) Fruit of *F. pentaphylla*.

ly. Among those cultivars, 95 were bred by hybrid breeding, 11 by seedling selection, one by bud sport selection and one by mutation breeding. Some Chinese geneticists are breeding everbearing cultivars. The goal is to develop sweeter cultivars.

The Strawberry Section of the Chinese Society for Horticultural Science hosts annual Chinese strawberry festivals. The members of the Strawberry Section present scientific and technological achievements and exchange the latest production and cultivar information at this meeting. To date, 17 national strawberry festivals have been held in China. The best domestic cultivars are selected at the annual Strawberry Challenge Cup (Figure 11), which is the most important activity at the Chinese strawberry festivals. 'Jingzangxiang', 'Jingtaoxiang', 'Yanli', 'Ningyu', and 'Yuexin' are amongst the cultivars that have achieved top honors in recent years. Among them, the most popular cultivars are as follows (Figure 12):

Figure 9. Sales of wild strawberries in farmer's market.

'Jingzangxiang'

Forcing cultivar bred by Beijing Academy of Agricultural and Forestry Sciences from the cross of 'Earlibrite' × 'Benihoppe'; released in 2013. 'Jingzangxiang' is very promising because of its very early harvest, uniform shape and size, very good taste, high yield, and good adaptability to different climatic and cultivation conditions. The berries are conic, bright red, glossy and moderately firm. It has been planted with satisfactory results in more than 20 Chinese provinces.

'Jingtaoxiang'

Forcing cultivar bred by Beijing Academy of Agricultural and Forestry Sciences from the cross of 'Darselect' × 'Akihime'; released in 2014 (Wang et al., 2018). 'Jingtaoxiang' has medium size and bright red berries with excellent flavor and its intense peach-like aroma has impressed consumers. Plants usually grow in moderate vigor. The yield is medium. It is highly resistant to common diseases in the greenhouse. This cultivar is suitable for pick-your-own farms.

'Pink Princess'

Forcing cultivar bred by Beijing Academy of Agricultural and Forestry Sciences from the cross of 'Akihime' × 'Gaviota'; released in 2014 (Chang et al., 2017). The attractive berries are pink in external color giving customers a special visual impact. The fruit is conic or wedge-shaped with high eating quality. It is good at bearing fruit continuously in winter and suitable for pick-your-own farms.

'Yanli'

Forcing cultivar bred by Shenyang Agricultural University from the cross of 08-A-01 × 'Tochiotome'; released in 2014 (Li et al., 2015). The berries are attractive with regular conic shape, uniform size, bright red and glossy color. The flavor is excellent because of high soluble solids content and good balance of sugar and acid. Fruit is very firm, which means they have good shelf-life and are less damaged from transportation than many other cultivars. Plants are vigorous and resistant to diseases.

'Ningyu'

Forcing cultivar bred by Jiangsu Academy of Agricultural Sciences from the cross of 'Sachinoka' × 'Akihime'; released in 2010 (Zhao et al., 2011). Attractive berries are regularly conic, red and glossy. Pollen germinates easily, resulting in high fruit set. Flavor is excellent with high brix, low acid and pleasant flavor. Plants are semi-erect with strong vigor and have high resistant to anthracnose (*Colletotrichum acutatum*) and powdery mildew (*Podosphaera aphanis*).

Figure 10. Identified strawberry selections in the open field and greenhouse.

Figure 11. Strawberry Challenge Cup.

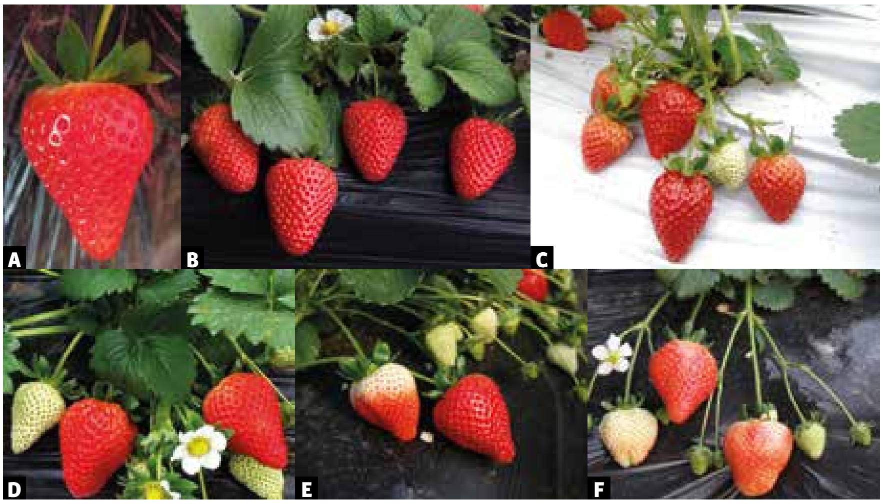

Figure 12. Some new strawberry cultivars released in China. A) 'Jingtaoxiang', B) 'Jingzangxiang', C) 'Ningyu', D) 'Jingyu', E) 'Yanli', F) 'Yongli'.

'Yuexin'

Forcing cultivar bred by Zhejiang Academy of Agricultural Science from the cross of ('Camarosa' × 'Akihime') × 'Sachinoka'; released in 2015 (Zhang et al., 2015). This is an early-season cultivar with a short dormancy requirement. Plants are vigorous, erect and easy to spread runners. Berries are medium-sized, short conic or globose in shape, with light red external and white internal color. The fruit is aromatic and have a sweet taste with a pleasant flavor. It is resistant to anthracnose (*Colletotrichum acutatum*), gray mold (*Botrytis cinerea*) and powdery mildew (*Podosphaera aphanis*).

'Jingyao'

Forcing cultivar bred by Hubei Academy of Agricultural Sciences from the cross of 'Sachinoka' × 'Akihime'; released in 2008 (Zeng et al., 2009). It is an early maturing strawberry cultivar and its dormant period is short. Berries are uniform, conic-shaped and bright red. The fruit has an aromatic, sweet taste, with a pleasant flavor, and are similar to 'Benihoppe'. It has strong resistance to powdery mildew (*Podosphaera aphanis*).

'Jingyu'

Forcing cultivar bred by Hubei Academy of Agricultural Sciences from the cross of 'Sweet Charlie' × 'Jingyao'; released in 2012 (Xiang et al., 2012). It is an early-maturing strawberry cultivar and in Hubei, it ripens in early December in plastic houses. The fruit is long-conic or wedge-shaped and their surface is bright red. Berries are tasty with high brix. It has strong resistance to anthracnose (*Colletotrichum acutatum*) and powdery mildew (*Podosphaera aphanis*).

'Yongli'

Everbearing strawberry cultivar bred by Shenyang Agricultural University from the cross of 'Tochiotome' × 06-J-02; released in 2014 (Li et al., 2016). Plants are medium vigor. Berries are conic or short conic-shaped, bright red with strong glossy and excellent aroma. Fruit flesh is red and core is small with an absent cavity. Berries are less firm than 'Portola', 'Albion' and 'San Andreas'. It is resistant to gray mold (*Botrytis cinerea*) and soil-borne diseases such as anthracnose (*Colletotrichum acutatum*). Berries have medium sensitivity to powdery mildew (*Podosphaera aphanis*). The cultivar is suitable for growing in plastic houses in summer and autumn, and in open fields near Shenyang city. It is also suitable for growing in greenhouses for semi-forcing cultivation.

'Sigongzhu'

Everbearing strawberry cultivar bred by Jilin Academy of Agricultural Sciences from the cross of 'Gongsimei 1' × 'Gorella'; released in 2014 (Zheng et al., 2014). The red berries are conic or wedge-shaped, glossy and aromatic. Berries are tasty with a good balance of sugar and acid when harvested in spring and autumn. The fruit firmness is better in autumn than in other seasons. This cultivar yields continuously from mid- to late-June and lasts for 4 months in the open field in the region near Changchun city. It is suitable for summer-autumn cultivation in northeast China.

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We would like to thank Dr. Kim E. Hummer for editorial assistance and Prof. Jiajun Lei, Prof. Zhihong Zhang and Prof. Mizhen Zhao for supplying strawberry photos and information.

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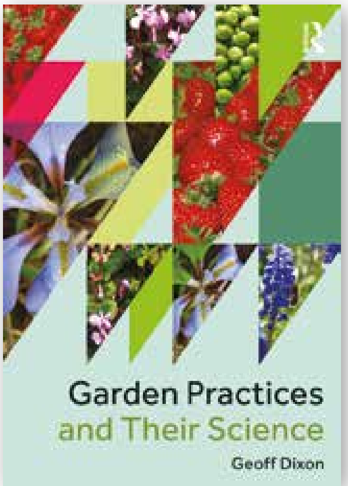
› New books, websites

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



Dixon, G.R. (2019). Garden Practices and Their Science (Routledge), pp.282. ISBN 9781138209060 (paperback) / 9781138485235 (hardback) / 9781315457819 (ebook). £29.99 (paperback) / £110.00 (hardback). www.routledge.com

The author, ISHS Honorary Member Geoff Dixon, is not only an eminent scientist and teacher, but also a keen gardener. These qualities come together in his newest book: Garden Practices and Their Science.

This book, which contains almost 400 full-colour illustrations, starts with a very useful preamble on safety in the garden. Tools, machines and chemicals, as well as the risks they may pose to both the user and the environment, are described. In the subsequent chapters, the reader finds a clever combination of practical advice and scientific information.

The first chapter offers a short course on plant physiology, demonstrating the need for warmth, light, nutrients and substrates, and explains photosynthesis, respiration and transport processes in plants. It contains a number of simple experiments that the reader can do to see the effects of these factors.

The next chapters begin with an elaborate description of garden practices for a certain group of plants, followed by a number of paragraphs on the underpinning scientific knowledge. They end with a number of questions, which the reader can use to check what he or she has understood and learnt.

Thus, the chapter "Understanding soil by growing potatoes and onions" begins with a clear description how to grow these crops, followed by a thorough explanation of what happens in the soil, including the role of micro- and macro-organisms.

The chapter called "Growing legumes from seed and seedlings" not only offers the reader extensive practical advice but also makes him or her acquainted with sexual and asexual reproduction, mitosis and meiosis, inheritance and seed science. "Growing small-seeded vegetables" provides the reader with many details about seeding and transplanting, and offers the scientific background of plant growth and structure, sources and sinks, plus weeds and pathogens.

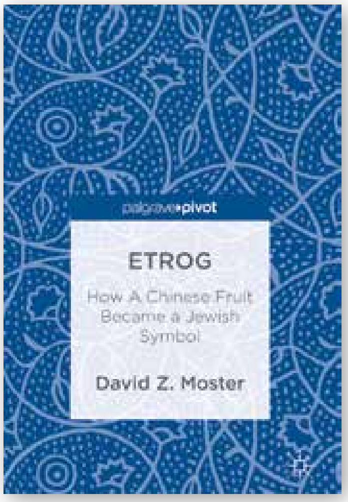
Following this design, the chapter on "Growing soft fruit", in addition to describing the culture of these crops, explains the science behind flower development and pollination; the chapter on "Bulbous plants" informs the reader about the scientific background of bulb structure and development, flower formation and specific pests and diseases.

The chapter on "Flowering plants" gives details on how to grow annual, biennial and perennial herbaceous plants, followed by the science behind flower induction and the way plants react to various kinds of stress. The culture of roses and other woody perennials (shrubs and trees, including fruit trees) is not covered in this chapter or elsewhere in this book. As the author explained, "these plants may be covered in later volumes as they present substantial requirements for practical knowledge and expertise".

The last chapter, "Plant propagation", not only describes different ways to propagate plants but also gives scientific information about the manner in which rooting is regulated.

In conclusion, this is a very useful book that will be a welcome addition to the existing multitude of gardening books. Although intended primarily as a textbook for beginning garden enthusiasts, it also offers a lot for experienced gardeners who want to know more about the science behind their activities. At the same time, this gives the book a kind of hybrid character. On the one hand, the parts "Achievements: have you understood and learnt?" seem to be meant mainly for use at schools and courses for people without a basic knowledge of gardening practice and science. On the other hand, some paragraphs give a level of scientific information that, although formulated in an easily accessible and understandable way, may be more than some readers will find necessary in a gardening book. For most people, however, exactly this combination of practice and science will be one of the great strengths of this unique and remarkable book, which will give the reader a lot of knowledge that he or she can apply immediately in everyday practice.

Reviewed by Robert J. Bogers, ISHS Council Member, The Netherlands



Moster, D.Z. (2018). Etrog: How a Chinese Fruit Became a Jewish Symbol (London and New York: Palgrave Macmillan), pp.144. ISBN 9783319737355 (hardback) / 9783319737362 (eBook). $54.99 (hardback) / $39.99 (eBook). www.palgrave.com

Citron (*Citrus medica* L.), which typically looks like a large lemon with a thick, pebbly rind, has long been the red-headed stepchild of citrus studies. From the standpoint of commercial usefulness that is understandable, since citron is marginally edible – it is primarily the rind that is valued, for fruitcake and Chinese traditional medicine – and so it is little cultivated today.

Historically and culturally, however, citron is fascinating. It is the type species of the genus *Citrus*, and the pollen parent of lemon and lime. It was the first citrus to be cultivated in the Mediterranean region, and it plays a crucial role in Judaism, as one of the "Four Species" used for the Sukkot holiday, originally a harvest festival. Attractive, unblemished citron fruits are particularly prized, and can fetch hundreds or even thousands of dollars per fruit from ultraorthodox Jews.

› 'Ninger Giant' citrons for sale at a stand in Ninger, in Yunnan Province, China. ©David Karp.

› Rabbi Chaim Fekete inspects etrogim for sale at a stand near 48th Street on 13th Avenue in Borough Park, Brooklyn. In the week before Succot, street vendors crowd every block of 13th Avenue from 45th to 55th streets. ©David Karp.

How did this primitive citrus, which originated somewhere in southwestern China, northeastern India, or northern Myanmar, achieve such significance 6,500 km away in ancient Israel? That is the question that David Z. Moster, a research fellow in the Department of Judaic Studies at Brooklyn College, seeks to answer in this monograph.

He calls citron "etrog," which is its name in Hebrew and Yiddish; the plural is "etrogim." This nomenclature perhaps is appropriate for a writer discussing the role of *C. medica* in Jewish culture, but "etrog" really has two layers of meaning. First, it is the Hebrew and Yiddish translation of "citron," referring to all forms of *C. medica*; second, it denotes specifically those cultivars that, because of their morphology and pedigree, are considered suitable for Jewish ritual use.

After a brief introduction Moster describes the journey of the citron from China through India and Persia to Israel. He follows Gmitter and Hu (Gmitter, F.G., and Hu, X. (1990). The possible role of Yunnan, China, in the origin of contemporary *Citrus* species (Rutaceae). Economic Botany, 44 (2), 267–277) in proposing Yunnan, in southwestern China, as the crucial center of origin and diversity for citron. There is no doubt that China is an important center of diversity for citron, but since a comprehensive survey of citron germplasm in Assam and northern Myanmar remains to be done, it is perhaps overstating the case to assert that Yunnan deserves primacy over these adjacent areas.

The biblical text underlying the citron's role in the celebration of Sukkot is Leviticus 23:40, where the American Standard Version reads: "And ye shall take you on the first day the fruit of goodly trees, branches of palm-trees, and boughs of thick trees, and willows of the brook; and ye shall rejoice before Jehovah your God seven days."

The Hebrew phrase *"peri 'eṣ hadar"* (פרי עץ הדר), translated in this version as "the fruit of goodly trees," is ambiguous. Moster reviews no less than 15 potential translations, before arguing that the correct interpretation is "choice tree-fruit" or "beautiful tree-fruit", such as "grapes, figs, dates, olives, and pomegranates." He maintains that originally any of these fruits served for the Sukkot offering. In Chapter 4, the central portion of the book, Moster argues that citron was chosen as the exclusive fruit for the Sukkot offering during the Second Temple Period (530 BCE-70 CE) because it was a rare, exotic plant, grown by the Persian ruling class in paradise gardens. It was exquisitely aromatic, and its marked difference from everyday, native fruits emphasized its specialness for ritual purposes. After the destruction of the Second Temple (70 CE), the etrog became a symbol of Jewish culture, like the menorah; it was particularly suited for this purpose because it was not important to competing sects such as Samaritans or Christians.

Overall Moster's arguments seem plausible, but are not likely to quell the controversies that have long raged among Jewish scholars regarding the citron's path to eminence. Although some of the linguistic discussions will necessarily be difficult to follow for readers who do not know Hebrew, the book is well-written and will be a pleasure to anyone with an interest in the citron's curious conjunction of religion and horticulture. It is worth noting that the many photos and illustrations are in black and white in the print edition, but in color in the eBook.

Reviewed by David Karp, University of California, Riverside, USA

› Courses and meetings

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

IPPS-Western Region Annual Conference, 24-28 September 2019, Santa Cruz, CA, USA. Info: http://wna.ipps.org

Postharvest Technology Course, 8-11 October 2019, Wageningen, The Netherlands. Info: Monique Tulp MSc, Wageningen Academy, The Netherlands, phone: +31 317 48 22 98, e-mail: monique.tulp@wur.nl, web: www.wur.nl/en/show/Postharvest-Technology-Course.htm

2019 IEEE International Workshop on Metrology for Agriculture and Forestry, 24-26 October 2019, Portici (Naples), Italy. Info: Prof. Pasquale Daponte, University of Sannio, Italy, phone: +39 0824 305600, e-mail: daponte@unisannio.it, web: www.metroagrifor.org

› UrbanFarm2019 – International Student Challenge

› Organizing Committee of UrbanFarm2019. From left to right: back line, Giuseppina Pennisi, Mattia Paoletti, Francesco Orsini, Andrea D'Alessandro; front line, Gloria Steffan, Michele D'Ostuni, Denisa Kratocklova and Gianmarco Sabbatini. Photo: Andrea D'Alessandro.

The international competition, UrbanFarm2019, organized by the University of Bologna and the University of Florence, Italy, was initiated with the aim of rethinking the production of food in urban areas in terms of environmental sustainability and welfare creation. Multidisciplinary teams of students from universities, including agriculture, biology, architecture, design, economics, engineering and human studies, were invited to participate in the challenge. They were asked to design innovative systems of urban agriculture that would integrate the best architectural and technological innovations for food production focusing on the three spheres of sustainability (namely social, economic and environmental).

The re-design work carried out by the different teams was focused on three abandoned spaces in the cities of Belluno, Bologna, and Conegliano, Italy, thanks to the collaboration of the local public administrations and scientific societies, such as the International Society for Horticultural Sciences (ISHS) and the Italian Society for Horticultural Sciences (SOI).

The final phase of the competition, launched on 15th October 2018, was held on 13th and 14th February 2019 at the NovelFarm fair, organized by Pordenone Fiere. Each of the 16 teams remaining in the competition was invited to set up a booth inside the fair to present and illustrate their project to visitors. Visitors of the fair were able to express their preferences on the projects presented, which were added to the points collected by the various teams during the different stages of the competition. During the afternoon of 14th February, the teams presented their projects to an international jury, which included Runrid Fox-Kämper (ILS – Research Institute for Regional and Urban Development gGmbH), Joan Rieradevall Pons (Universitat Autònoma de Barcelona), Isabella Righini (Wageningen University & Research) and Augustin Rosenstiehl (SOA Architects). The jury completed the evaluation of the submitted projects by selecting (based on the performances of the pitches by participating teams and the overall score achieved during the previous stages of the competition) the four best teams. These teams were recalled to the stage for the final contest during which they had to answer the questions posed by the jury.

After an animated debate, the jury decided to award the first prize of € 6000 to the PineCUBE team composed of Elisabetta Tonet (University Ca' Foscari), Isabella Dagostin (Polytechnic of Milan), Niccolò Tagliaferri (University of Bologna), Nicola Colucci (University of Pisa),

› PineCUBE team, winner of the first prize. From left to right: Niccolò Tagliaferri, Nicola Colucci, Nicola Dall'Agnol, Elisabetta Tonet and Pamela de Biasi. Photo: Gianmarco Sabbatini.

› The Wanderers team, winner of the second prize. From left to right: Haidy Taki Eldin Adel Ali Mousa, Hadil Tarek Abdelaty Abdelhafez, May Loaay Mohamed Elhadidi and Pietro Tonini. Photo: Gianmarco Sabbatini.

› ReGenius Loci team, winner of the third prize. From left to right: Alessandro Biagetti, Eleonora Marcoccio, Gian Marco Tamborra, Francesco Lombardo and Luca Settanni. Photo: Gianmarco Sabbatini.

› Winners of the ISHS Young Minds Award. From left to right: Pietro Tonini, May Loaay Mohamed Elhadidi, Haidy Taki Eldin Adel Ali Mousa, Hadil Tarek Abdelaty Abdelhafez, ISHS Board representative Silvana Nicola, Nicola Colucci, Niccolò Tagliaferri, Nicola Dall'Agnol, Elisabetta Tonet, Pamela de Biasi and Alan Henrique Santos Silva. Photo: Andrea D'Alessandro.

Nicola Dall'Agnol (University of Padua), and Pamela de Biasi (University of Trento), who focused their project on the former primary school of Orzes in the municipality of Belluno.
The second prize, worth €1000, was awarded to The Wanderers team composed of Haidy Taki Eldin Adel Ali Mousa, Hadil Tarek Abdelaty Abdelhafez, and May Loaay Mohamed Elhadidi (Cairo University), Pietro Tonini, Lorenzo Fellin and Antonella Frongia (University of Bologna), and Virginia Castellucci (University of Trento), who focused their project on the redevelopment of the former Zanussi area in the municipality of Conegliano.
Lastly, the third prize, worth € 500, was awarded to the ReGenius Loci team composed of Francesco Lombardo, Luca Settanni and Gian Marco Tamborra (University of Bologna), Alessandro Biagetti, Eleonora Marcoccio and Marco Falasca (University Tor Vergata) and Lorenzo Scopetti (University of Ferrara), who focused their project on the Fantoni farm in the municipality of Bologna.
Thanks to this competition, promising young students have acquired the ability to work in a multidisciplinary group and deal with people from different sectors and cultures. These requirements are increasingly in demand in the job market.
The ISHS awarded the ISHS Young Minds award to the members of the three projects with the best horticultural approach: the PineCUBE team, the Wanderers team and the Phoenix team. All the team members receive an ISHS award certificate, complementary subscription to the ISHS for the year 2019, an ISHS keyholder and an ISHS pin. The members of the PineCUBE team and Wanderer teams are named above. The members of the Phoenix team were Ricardo Felipe Lima de Souza, Alan Henrique Santos Silva, Stella Aurea Gomes Da Silva, and Helder Enrique Duarde Santos, all from the Universidade Federal Rural do Pernanbuco.
The organizing committee of UrbanFarm2019 would like to express heartfelt thanks to Pordenone Fiere and Studio Comelli for generously supporting the organization of the competition; the companies Flytech, DAKU, Irritec, Coldiretti Treviso and Belluno for their contributions; the municipal administrations of Belluno, Conegliano and Bologna, and the Fondazione Cassa di Risparmio di Faenza for their help; and, of course, all the other sponsors visible on the UrbanFarm2019 website (https://site.unibo.it/urban-farm/en).

Gloria Steffan, Francesco Orsini and Silvana Nicola

› Booth of UrbanFarm2019. Photo: Gianmarco Sabbatini.

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XI International Symposium on Protected Cultivation in Mild Winter Climates and I International Symposium on Nettings and Screens in Horticulture

Division Protected Cultivation and Soilless Culture #ishs_dpro
Division Vine and Berry Fruits #ishs_dvin

Dr. Francesco Orsini (right) presenting the ISHS medal award to the symposium conveners Dr. Avi Sadka (left), Prof. Dr. Juan A. Fernández (second from left), and Dr. Francisco M. del Amor (second from right).

The XI International Symposium on Protected Cultivation in Mild Winter Climates and the first International Symposium on Nettings and Screens in Horticulture were held from 27 to 31 January 2019 in Tenerife, Canary Islands, Spain. The event was organized by the Technical University of Cartagena (UPCT), the Murcian Institute of Research and Agri-food Development (IMIDA) and the Agriculture and Research Organization (ARO). In addition, El Cabildo de Tenerife and the Canarian Institute of Agrarian Research (ICIA) were the local organizers. Almost 80 participants from 19 countries, including students, took part in the symposia, which included 75 contributions (41 lectures and 34 posters). The symposia were structured in six technical sessions dedicated to: Innovative strategies for irrigation, Nutrition and management, Abiotic stresses and environmental impacts, Sustainable systems and pest management, Climate control, and Semi-protected horticulture. In addition, a technical session, Industry perspective of protected and semi-protected agriculture, was held in Spanish for local growers and stakeholders. During the symposia one technical excursion was organized, and the participants had the chance to get to know some of the main protected cultivation areas of the Tenerife Island, visiting several companies that grow pitaya, passion fruit and strawberry under semi-protected conditions.
Protected cultivation is rapidly expanding in many regions all over the world, particularly in those with mild winter climatic conditions. As a result, the greenhouse and the nets/screens industries continually develop new strategies and technologies to solve specific cultivation limitations, to reduce related environmental impacts, and to adjust to new market requirements. Therefore, the main objective of these symposia was to update the scientific knowledge for scientists working in these areas and for R&D teams of the industry.
The opening keynote lecture was presented by Prof. Dimitrios Savvas of the Agricultural University of Athens (Greece). He presented information on innovative strategies for irrigation, nutrition and management of new technologies and developments, focusing mainly on new products and application methods, alternative greenhouse cropping systems, issues related to nutrient and water use efficiency in greenhouses, and environmental sustainability in protected cultivation.

Leonardo Soldatelli Paim, winner of the ISHS Young Minds award for the best oral presentation.

› Dr. Francesco Orsini (right) and Dr. Francesco M. del Amor (center) presenting the ISHS Young Minds award for the best poster to Lidia López-Serrano (left).

Prof. Rod Thompson of the University of Almería (Spain), the second keynote speaker, discussed the reducing nitrate leaching losses from vegetable production in Mediterranean greenhouses. He analysed the current nitrate contamination of aquifers and determined that a major contributing factor to eutrophication of saline waters is nitrate leaching. Also, data of the large nitrate leaching losses from soil- and substrate-grown greenhouse crops were presented, both from research and commercial crops.

The third session, dedicated to sustainable systems and pest management, had two keynote speakers; Prof. Carlo Leifert of the Southern Cross University (Australia), who talked about integrating the use of resistant rootstocks/cultivars, suppressive composts and elicitors to improve yields and quality in protected organic cultivation systems, and Dr. Jan Van der Blom from COEXPHAL (Spain), who suggested that biological control is the only sustainable option for pest management in greenhouse horticulture.

Esteban Baeza of the University of Wageningen (The Netherlands) described the development of smart greenhouse covers, highlighting those covering materials that will allow for the instantaneous modification of the optical properties of the cover, and which are potentially able to serve a large market worldwide.

Netting and photoselective netting were discussed by Dr. Yosepha Shahak from the Institute of Plant Sciences, ARO, The Volcani Center (Israel). Dr. Shakak described the growing impact of netting and photo-selective netting on global agriculture, providing a wide overview on various aspects of the technology, accumulated horticultural knowledge, lessons learned, and future perspectives.

Finally, the business session was dedicated to the industry perspective of protected and semi-protected horticulture. Symposia industrial sponsors, Criado & López, Svensson, Kafrit, Politiv, Agritech and Cotexa, presented their latest R&D innovations.

During the symposia, the Scientific Committee selected two winners to receive the ISHS Young Minds Awards. The award was given to Leonardo Soldatelli Paim, a PhD student from the Federal University of Rio Grande do Sul, Porto Alegre, RS (Brazil), for the best oral presentation entitled “Sequential application of budbreak promoters in ‘Baigent’ apple trees under anti-hail nets in orchards of southern Brazil”, and to Lidia López-Serrano, a PhD student from the Technical University of Valencia (Spain), for the best poster entitled “Can grafting improve crop performance under low calcium supplies in pepper?”.

At the Working Group Business Meeting, the participants decided to merge the two ISHS Working Groups “Nettings in Horticulture” and “Protected Cultivation in Mild Winter Climates” into one, named from now on: “Protected Cultivation, Nettings and Screens for Mild Climates”. The newly elected Chair of the Working Group is Dr. Francisco M. del Amor of IMIDA and the Vice-Chair is Dr. Avi Sadka from ARO. Also, decisions have been made as to the locations and timing of the two following symposia. Dr. Shabtai Cohen and Mr. Itzhak Esquira accepted the task of organizing the next symposium in Tel Aviv (Israel) in May 2021, and Prof. Dimitrios Savvas and Dr. Thomas Bartzanas will host the following one, in Greece in 2023.

Juan A. Fernández, Francisco M. del Amor and Avi Sadka

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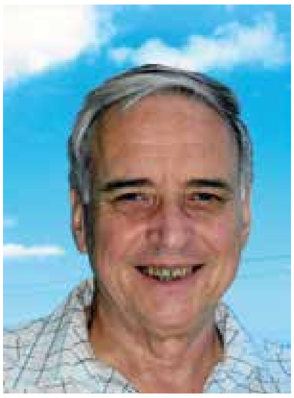
› Dr. Víctor Galán Saúco (Canarian Institute of Agrarian Research) explaining pitaya production in the region.

› Dr. Vanesa Raya (Canarian Institute of Agrarian Research) showing strawberry production techniques in Tenerife.

From the Secretariat

› In memoriam

Bob Martin (1942-2019)



Bob (R.A.) Martin died on Saturday 9 March, 2019 after a long illness. Bob had been Research and Development Manager and Market Access Manager for Zespri and its predecessors, the New Zealand Kiwifruit Authority and the New Zealand Kiwifruit Marketing Board, for many years until his retirement in 2009.

Bob joined the Kiwifruit Authority in 1986, at a time when export volumes of kiwifruit were beginning to increase rapidly, and he was therefore much involved in the transition from a focus on production to a focus on marketing in all aspects of the business. Equally important, it was his responsibility as Market Access Manager to ensure that export production met the quality requirements of markets through the development and effective implementation of quality management systems. His emphasis was on developing market access strategies for all countries, including meeting their phytosanitary, quarantine and pesticide residue requirements. This meant he had to spend much of his time overseas where he soon became known and greatly appreciated for his calm, pragmatic and rational approach to negotiations. He was much involved in developing and obtaining agreement on international standards for trade in kiwifruit. For many years he was a New Zealand representative at IKO (International Kiwifruit Organisation) meetings. His ability to blend his science background with the commercial realities of the international fruit trade was of great benefit to the New Zealand kiwifruit industry.

Another important role was the coordinating of the research contracted by the New Zealand kiwifruit industry from scientists from within New Zealand and from other countries. It required vision, judgement and skilled negotiation to secure research outputs that justified the private sector investments and could deliver a proven return to the industry. A good example was his support of the research that underlay the development of the KiwiGreen programme, which incorporated an integrated pest management (IPM) for orchardists that would lead to reduced and more targeted chemical applications based on careful monitoring. This helped retain market access for the kiwifruit produced in New Zealand.

Bob joined the New Zealand Society for Horticultural Science (NZSHS) in 1990, and served on the Council from June 2001 to July 2004, being President of NZSHS from June 2001 to June 2002, and then President of the newly recombined New Zealand Institute of Agricultural and Horticultural Science (NZIAHS) from June 2002 to June 2003. He next took over the challenging responsibility of chairing the organising committee for kiwi2006, the ISHS VI International Symposium on Kiwifruit, held in Rotorua, New Zealand, in February 2006. The success of this was in large part due to his drive and his meticulous attention to detail. His contributions to New Zealand horticulture were recognised by his being elected a Fellow and then an Honorary Fellow of NZIAHS. Bob was a strong supporter of ISHS and was one of the New Zealand representatives on the ISHS Council for over 12 years starting in 2002.

Bob is survived by his wife, Angela, their daughters Carol and Debbie, and granddaughter Elise.

Ross Ferguson, Plant & Food Research, New Zealand

› New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Albania: Dr. Aida Dervishi; **Australia:** Mr. Bruce French, Mr. Dean Gall, Mr. Ryno Oppermann; **Austria:** Mr. Felix Moser; **Azerbaijan:** Amina Rakida; **Belgium:** Ms. Fien Amery, Dr. Simon Stael, Dr. Joke Vandermaesen; **Botswana:** Dr. Eyassu Seifu; **Brazil:** Ms. Judith Alcalde, Marcela Miranda, Josemar Oliveira Filho, Mr. Guilherme Ribeiro; **Canada:** Dr. Marc Charland, Mr. H. Lee, Ms. Sarah MacCrimmon, Nicolas Watters; **Chile:** Dr. Arturo Calderón-Orellana, Prof. Fernando Fuentes-Peñailillo; **China:** Prof. Dr. XiangNing Chen, Assoc. Prof. Jintao Cheng, Dr. Ke Feng, Dr. Yuge Guan, Dr. Dongliang Guo, Prof. Zhuoyan Hu, Dr. Fengchao Jiang, Assoc. Prof. Yanjie Li, Dr. Yurong Ma, Assoc. Prof. Zhiyu Ma, Mr. Yefan Nian, Prof. Dr. Yonggui Pan, Ms. Liu Pei, Mr. Yong Peng, Dr. Gaowa Saren, Ms. Miaoyu Song, Dr. Jiaxing Tian, Ms. Danfeng Wang, Mr. Wei Wang, Prof. Yong Xu, Dr. Lanhua Yi, Prof. Dr. Qianchun Zeng, Ms. Xuedan Zhang, Minglei Zhao, Ms. Fuhui Zhou, Assist. Prof. Liqin Zhu; **Chinese Taipei:** Mr. Chien-Hua Chen, Ms. Jawrong Chen, Kuo-Hsin Wang; **Czech Republic:** Dr. Aneta Bílková, Mr. Jan Blazek, Dr. Radek Cmejla, Luká Rázl, Mr. Lubor Zeleny; **Egypt:** Mr. Abdullah Talaat; **Finland:** Mr. Nedeljko Basic; **France:** Dr. Ilaria Brunetti, Ms. Caroline Denance, Ms. Vanessa Godfrin, Dr. Vincent Guerin, Ms. Anaïs Jouault, Dr. Eric Kerloc'h, Dr. Séverine Lemaire, Mr. Pascal Poupault, Charlotte Roby, Mr. Alexandre Rouinsard, Prof. Dr. Soulaiman Sakr; **Germany:** Ms. Helena Sophia Domes, Benjamin Göpferich, Olivier Hirschler, Dr. Monika Höfer, Dr. Nicholas Howard, Mr. Marc Juarez, Dr. Maria Martinez, Katja Näthke, Dr. Sylvia Plaschil, Dr. Stefanie Reim, Ulrike Wegener, Dr. Thomas Wöhner; **Guyana:** Mr. Wilmot Garnett; **India:** Dr. Raghavendra Achari, Assist. Prof. Kadarla Chaitanya, Mr. Mayurbhai G Mundhava, Mr. Ramadas Nayak, Mr. Uday Singh, Amarendra Sinha; **Indonesia:** Mr. Muchammad Rofiq; **Ireland:** Ms. Elizabeth Reddin; **Israel:** Prof. Abraham Shaviv, Dr. Helena Vitoshkin; **Italy:**

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› Calendar of ISHS events

For updates and extra information go to www.ishs.org and check out the calendar of events. Alternatively use the "science" option from the website navigation menu for a comprehensive list of meetings for each Division or Working Group.
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 2019

- June 3-7, 2019, Prague (Czech Republic): **XV Eucarpia Symposium on Fruit Breeding and Genetics.** Info: Dr. Jiri Sedlák, Res. &Breeding Inst. of Pomology Holovousy, Holovousy, 50801 Horice, Czech Republic. Phone: (420) 435 692 821, Fax: (420) 435 69 33, E-mail: sedlak@vsuo.cz Web: https://www.eucarpiafruit2019.org/
- June 7-11, 2019, Hanoi (Vietnam): **VI International Symposium on Lychee, Longan and Other Sapindaceae Fruits.** Info: Ms. Thi Ha Le, Fruit and Vegetable Research Institute, Trau Quy town, Gia Lam district, Hanoi, 84 Hanoi, Vietnam. Phone: (84)934347046, Fax: (84)2438276148, E-mail: leharifav2001@yahoo.com E-mail symposium: secretariat@lycheelongan2019.com Web: http://lycheelongan2019.com
- June 9-12, 2019, Molfetta (Italy): **VI International Symposium on Applications of Modelling as an Innovative Technology in the Horticultural Supply Chain - Model-IT 2019.** Info: Dr. Maria Luisa Amodio, Via Napoli 25, 71100 Foggia, Italy. Phone: (39)0881-589105, Fax: (39)0881-589244, E-mail: m.amodio@unifg.it or Prof. Giancarlo Colelli, Dip.SAFE Università di Foggia, Via Napoli 25, 71100 Foggia, Italy. Phone: (39) 320 4394535, E-mail: giancarlo.colelli@unifg.it Web: http://www.unifg.it/modelit2019
- June 16-20, 2019, Angers (France): **Greensys 2019 - International Symposium on Advanced Technologies and Management for Innovative Greenhouses.** Info: Prof. Dr. Pierre-Emmanuel Bournet, Agrocampus Ouest, 2, rue Le Nôtre, 49045 Angers, France. Phone: (33) 2 41 22 55 04, Fax: (33) 2 41 22 55 53, E-mail: pierre-emmanuel.bournet@agrocampus-ouest.fr or Dr. Hicham Fatnassi, INRA 400 Route des Chappes, 06903, Sophia Antipolis, France. Phone: (33)492386400, E-mail: hicham.fatnassi@inra.fr or Eric Brajeul, Centre CTIFL de Carquefou, ZI Belle Etoile Antarès, 35 Allée des Sapins, 44483 Carquefou Cedex, France. Phone: (33)240508165, Fax: (33)240509809, E-mail: brajeul@ctifl.frE-mailsymposium:greensys2019@agrocampus-ouest.fr Web: https://www.greensys2019.org/
- June 17-20, 2019, Matera (Italy): **IX International Symposium on Irrigation of Horticultural Crops.** Info: Prof. Dr. Bartolomeo Dichio, Università degli Studi della Basilicata, DICEM, Via S.Rocco, 75100 Matera, Italy. Phone: (39)08351971422, E-mail: bartolomeo.dichio@unibas.it or Prof. Cristos Xiloyannis, Università degli Studi della Basilicata, DICEM, Via S.Rocco, 75100 Matera, Italy. Phone: (39)08351971416, Fax: (39)0971205378, E-mail: cristos.xiloyannis@unibas.it E-mail symposium: info@irrigationmatera2019.com Web: www.irrigationmatera2019.com
- June 24-28, 2019, Milan (Italy): **III International Symposium on Growing Media, Composting and Substrate Analysis.** Info: Dr. Patrizia Zaccheo, DISAA, University of Milan, Via Celoria 2, 20133 Milano, Italy. Phone: (39)0250316536, E-mail: patrizia.zaccheo@unimi.it or Dr. Costantino Cattivello,

ERSA-FVG, Via Sabbatini 5, 33050 Pozzuolo del Friuli (UD), Italy. Phone: (39)0432529241, Fax: (39)0432529273, E-mail: costantino.cattivello@ersa.fvg.it or Prof. Dr. Francesco Giuffrida, Di3A - Catania University, Via Valdisavoia 5, 95123 Catania, Italy. Phone: (39)095234323, Fax: (39)095234329, E-mail: francesco.giuffrida@unict.it E-mail symposium: susgro2019sci@promoest.com Web: http://www.susgro2019.com

- June 25-28, 2019, Zürich (Switzerland): **XII International Rubus and Ribes Symposium: Innovative Rubus and Ribes Production for High Quality Berries in Changing Environments.** 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 Dr. Erika Krüger, Hochschule Geisenheim University, Dept. of Pomology, Von-Lade-Strasse 1, 65366 Geisenheim, Germany. Phone: (49)6722502561, Fax: (49)6722502560, E-mail: erika.krueger@hs-gm.de or Gunhild Muster, Staatliche Lehr- und Versuchsanstalt, Wein- und Obstbau Weinsberg, Traubenplatz 5, D-74189 Weinsberg, Germany. E-mail: gunhild.muster@lvwo.bwl.de Web: http://www.rubusribes.agroscope.ch
- June 30 - July 4, 2019, Ghent (Belgium): **VI International Symposium on Cucurbits.** Info: Dr. Peter Bleyaert, Landmansstraat 51, Rumbeke 8800, Belgium. Phone: (32)51-273270, Fax: (32)51-240020, E-mail: peter.bleyaert@inagro.be or Prof. Dr. Marie-Christine Van Labeke, Department of Plant Production, University of Gent, Coupure links, 653, 9000 Gent, Belgium. Phone: (32) 9-2646071, Fax: (32) 9-2646225, E-mail: mariechristine.vanlabeke@ugent.be or Mr. Raf De Vis, Stuivenbergvaart 85, 2800 Mechelen, Belgium. E-mail: raf.de.vis@proefstation.be E-mail symposium: info@cucurbits2019.org Web: http://cucurbits2019.org/
- July 1-3, 2019, Angers (France): **Chenin Blanc International Congress.** Info: Ms. Evelyne de Pontbriand, chateau des Vaults, 1 place du Mail, 49170 Savennières, France. Phone: 33241718100, E-mail: academieduchenin@gmail.com or Mr. Patrick Baudouin, Académie du Chenin, 1 Place du mail, 49170 Savennières, France. E-mail: scientifique@cbic2019.com E-mail symposium: contact@cbic2019.com Web: https://www.cbic2019.com
- July 6-10, 2019, Malatya (Turkey): **XVII International Symposium on Apricot Breeding and Culture.** Info: Prof. Dr. Sezai Ercisli, Ataturk University Agricultural Faculty, Department of Horticulture, 25240 Erzurum, Turkey. Phone: (90) 442-2312599, Fax: (90) 442 2360958, E-mail: sercisli@atauni.edu.tr Web: http://www.apricot2019.org
- July 14-18, 2019, Charlotte, NC (United States of America): **II International Symposium on Vegetable Grafting.** Info: Prof. Frank Louws, 2721 Founders Dr; 118 Kilgore Hall, NC State University, Raleigh, NC, 27695-760, Campus Box 7609, Dept Horticultural Science, United States of America. Phone: (1)9195156689, E-mail: frank_louws@ncsu.edu or Dr. Chieri Kubota, The Ohio State University, Department of Horticulture and Crop Science, 330 Howlett Hall, 2001 Fyffe Ct, Columbus, OH 43210-1086, United States of America. Phone: (1)614 292-3175, Fax: (1)614 292-3505, E-mail: kubota.10@osu.edu or Dr. Penelope Perkins-Veazie, NC Research Campus, 600 Laureate Way, Suite 1329, Kannapolis, NC 28081, United States of America. E-mail: pmperkin@ncsu.edu or Dr. Xin Zhao, 1301 Fifield Hall, Horticultural Sciences, University of Florida, Gainesville, FL 32611, United States of America. Phone: (1)352-392-1928, Fax: (1)352-392-5653, E-mail: zxin@ufl.edu Web: https://projects.ncsu.edu/mckimmon/cpe/opd/VGRAFTING/
- August 12-17, 2019, Taian, Shandong (China): **IV International Conference on Fresh-Cut Produce.** Info: Prof. Qingguo Wang, Room 304, No.61 Daizong Street, Taian, 271018, China. Phone: (86)538-8249204, E-mail: wqgyyy@126.com E-mail symposium: freshcut2019@126.com Web: http://www.fresh-cut2019.com
- September 1-4, 2019, Erfurt (Germany): **XXVI International Eucarpia Symposium Section Ornamentals: Editing Novelty.** Info: Prof. Dr. Philipp Franken, Erfurt Research Centre for Horticultural, Crops, University of Applied Sciences, Erfurt, Kühnhäuserstraße 101,, 99090 Erfurt, Germany. E-mail: philipp.franken@fh-erfurt.de Web: https://www.eucarpia-ornamentals2018.org/
- September 2-5, 2019, Rovinj (Croatia): **VI International Symposium on Fig.** 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 or Zeljko Prgomet, Collegium Fluminense Polytechnic of Rijeka, Trpimirova 2/V, HR-52210 Rijeka, Croatia. Phone: (385)98255791, E-mail: skink@pu.t-com.hr E-mail symposium: fig2019@iptpo.hr Web: http://fig2019.iptpo.hr
- September 14-18, 2019, Istanbul (Turkey): **IV Balkan Symposium on Fruit Growing.** Info: Prof. Dr. Sezai Ercisli, Ataturk University Agricultural Faculty, Department of Horticulture, 25240 Erzurum, Turkey. Phone: (90) 442-2312599, Fax: (90) 442 2360958, E-mail: sercisli@atauni.edu.tr Web: http://www.balkanfruit2019.org
- September 30 - October 3, 2019, Guadalajara (Mexico): **IX International Symposium on New Ornamental Crops.** Info: Dr. Rodrigo Barba Gonzalez, CIATEJ a.c., Av. Normalistas # 800, Colinas de la Normal, Guadalajara Jalisco CP 44270, Mexico. Phone: (52)3333455200, Fax: (52)3333455245, E-mail: rbarba@ciatej.mx Web: http://www.newornamentalcrops.com
- October 7-11, 2019, Hyytiälä (Finland): **XI International Workshop on Sap Flow.** Info: Dr. Yann Salmon, P.O.Box 68, Faculty of Science, Department of Physics, FI-00014 University of Helsinki, Finland. E-mail: yann.salmon@helsinki.fi or Prof. Teemu Hölttä, University of Helsinki, Helsinki, Finland. E-mail: teemu.holtta@helsinki.fi Web: http://www.atm.helsinki.fi/sapflow/
- October 7-11, 2019, Palermo (Italy): **International Symposium on Precision Management of Orchards and Vineyards.** Info: Dr. Riccardo Lo Bianco, Università degli Studi di Palermo, Dipartimento SAAF, Viale delle Scienze, Ed 4, 90128 Palermo, Italy. Phone: (39) 09123896097, Fax: (39) 09123860813, E-mail: riccardo.lobianco@unipa.it or Dr. Antonino Pisciotta, viale delle Scienze, 11, 90128 Palermo, Italy. E-mail: antonino.pisciotta@unipa.it or Assist. Prof. Luigi Manfrini, Università di Bologna, 40127 Bologna, Italy. E-mail: luigi.manfrini@unibo.it E-mail symposium: info@pmov2019.it Web: http://www.pmov2019.it
- October 13-15, 2019, Wageningen (Netherlands): **VertiFarm2019: International Workshop on Vertical Farming.** Info: Prof. Dr. Leo F. M. Marcelis, Wageningen University, Horticulture & Product Physiology, Droevendaalsesteeg 1, 6708 PB Wageningen, Netherlands. Phone: (31)317485675, E-mail: leo.marcelis@wur.nl or Dr. Murat Kacira, Dept. of Biosystems Engineering, 1177 East 4th Street, Room 403, Shantz Building, 38, Tucson, AZ 85721-0038, United States of America. Phone: (1) 520-626-4254, Fax: (1) 520-626-1700, E-mail: mkacira@email.arizona.edu or Dr. Francesco Orsini, University of Bologna, Viale fanin, 44, Bologne 40127, Italy. Phone: (39)0512096677, Fax: (39)0512096241, E-mail: f.orsini@unibo.it Web: http://www.wur.eu/vertifarm2019
- November 10-13, 2019, Pretoria (South Africa): **II International Symposium on Moringa.** Info: Ms. Sunette Laurie, ARC - Roodeplaat, Private Bag x293, 0001 Pretoria, South Africa. Phone: (27)128419639, Fax: (27)128080844, E-mail: slaurie@arc.agric.za Web: http://www.ism2019.co.za/
- December 2-4, 2019, Bangkok (Thailand): **I International Symposium on Botanical Gardens and Landscapes.** Info: Dr. Kanchit Thammasiri, Department of Plant Science, Faculty of Science, Mahidol University, Rama VI Road, Phyathai, Bangkok 10400, Thailand. Phone: (66)89-132-7015, Fax: (66)2-354-7172, E-mail: kanchitthammasiri@gmail.com E-mail symposium: bgl2019thailand@gmail.com Web: http://www.sc.mahidol.ac.th/scpl/bgl2019

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