A publication of the International Society for Horticultural Science

Chronica Horticulturae

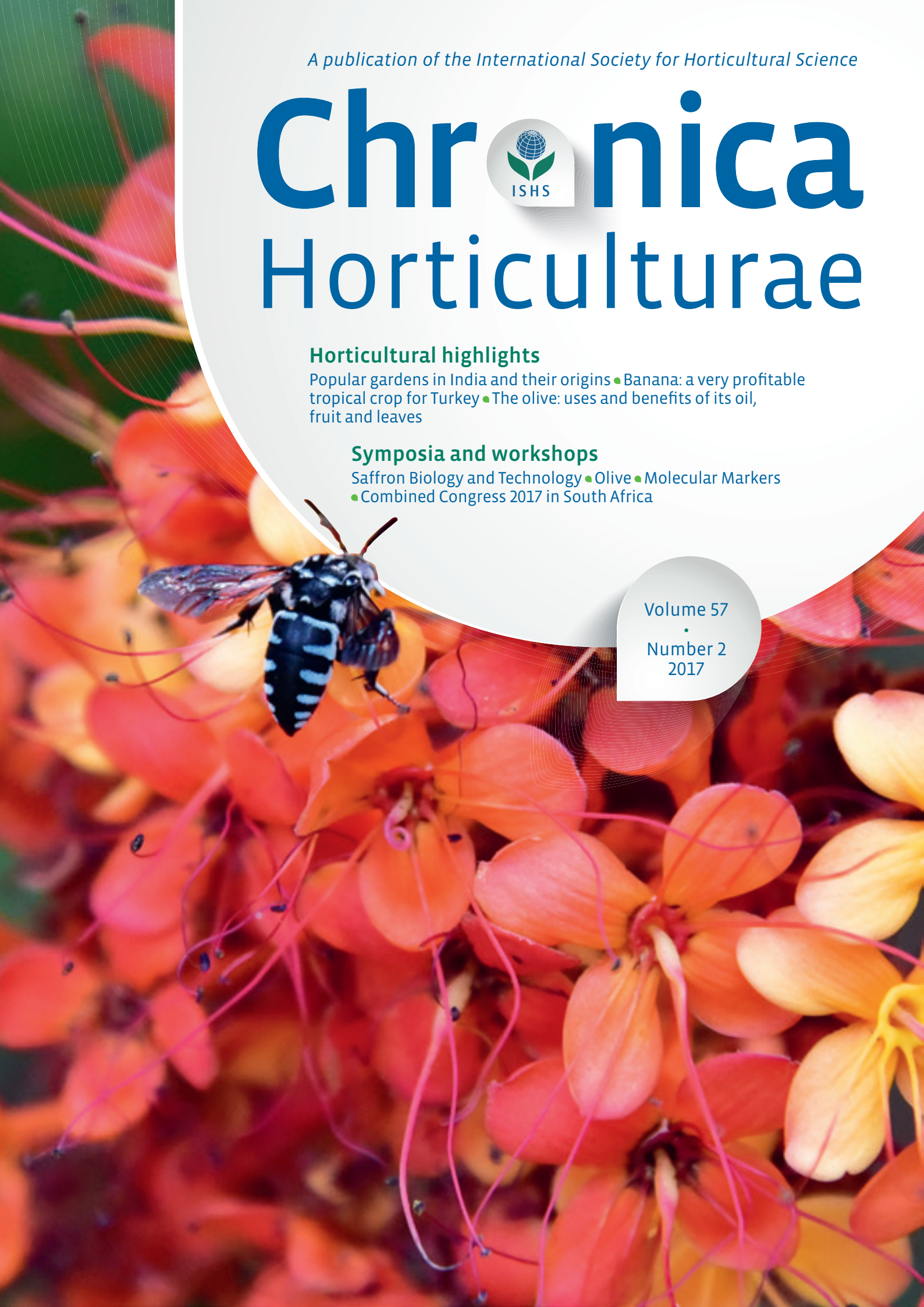
Horticultural highlights

Popular gardens in India and their origins • Banana: a very profitable tropical crop for Turkey • The olive: uses and benefits of its oil, fruit and leaves

Symposia and workshops

Saffron Biology and Technology • Olive • Molecular Markers • Combined Congress 2017 in South Africa

Volume 57 • Number 2 2017



Chronica Horticulturae

**Chronica Horticulturae© Volume 57 – Number 2;
June 2017; ISSN: 0578-039X (print), 2506-9772 (electronic).**
Published quarterly by the International Society for Horticultural Science, Leuven, Belgium. Lay-out and printing by Drukkerij Geers, Gent, Belgium. ISHS© 2017. All rights reserved. No part of this magazine may be reproduced and/or published in any form, photocopy, microfilm or any other means without written permission from the publisher. All previous issues are also available online at **www.ishs.org**. Contact the ISHS Secretariat for details on full colour advertisements (1/1, 1/2, 1/4 page) and/or mailing list options.

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

Membership and orders of *Chronica Horticulturae*
Chronica Horticulturae is provided to the Membership free of charge: Individual Membership is 90 EUR (including VAT) per year (or two years for members in developing countries). Student Membership: 50 EUR per year (including VAT). For details on ISHS membership categories and membership advantages, or to apply for ISHS membership go to **www.ishs.org/members**.

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

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

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

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

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

PubHort – crossroads of horticultural publications
Pubhort is a service of ISHS as part of its mission to promote and to encourage research in all branches of horticulture, and to efficiently transfer knowledge on a global scale. The PubHort platform aims to provide opportunities not only to ISHS publications but also to other important series of related societies and organizations. The ISHS and its partners welcome their members to use this valuable tool and invite others to share their commitment to our profession. The PubHort eLibrary portal contains over 78,000 downloadable full text scientific articles in pdf format, and includes The Horticulture Journal, Journal of the American Pomological Society, Journal of the International Society for Mushroom Science, Proceedings of the International Plant Propagators' Society, Journal of the Interamerican Society for Tropical Horticulture, etc.
Additional information can be viewed on the PubHort website **www.pubhort.org**.

Cover photograph: Ashoka *(Saraca asoca)* was used widely in Indian gardens as far back as 268 to 232 B.C., its name being associated with an Indian emperor of the Maurya Dynasty (Copyright: Ajay Tvm/Shutterstock). See article p. 13.

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

Contents

News & Views from the Board
3 Expanding our activities in Asia and Eastern Europe, *S. Nicola*

Spotlight on Honoured ISHS Members
6 John Possingham

Horticultural Science News
9 ISHS student award winner summaries
12 Horticulturist honoured by Queen and country

History
13 Popular gardens in India and their origins, *N. Deepa Devi*

The World of Horticulture
20 Banana: a very profitable tropical crop for Turkey, *H. Gubbuk, L. Altınkaya and R. Balkıç*
26 The olive: uses and benefits of its oil, fruit and leaves, *V. Sergeeva*
34 New books, websites
36 Courses and meetings

Symposia and Workshops
37 V International Symposium on Saffron Biology and Technology
39 VIII International Olive Symposium
41 IV International Symposium on Molecular Markers in Horticulture
43 Combined Congress 2017 in South Africa

News from the ISHS Secretariat
45 New ISHS members
46 In memoriam
47 Calendar of ISHS events
52 Available issues of *Acta Horticulturae*

Expanding our activities in Asia and Eastern Europe

Silvana Nicola

Silvana Nicola, ISHS Vice-President and Scientific Co-ordinator

Wherever the sun rises, ISHS has a presence, and has done so for some time, including in Asia. The first ISHS symposium held in Asia was in 1969 in India. In the history of the ISHS, this was only the third symposium to be held outside Europe. In 1978 the first ISHS symposium in Japan was held. Not surprisingly, it was about 'Potential Productivity in Protected Cultivation'. Since then, many ISHS events have been held in Japan, including an International Horticultural Congress (IHC) in 1994 in Kyoto. The most recent symposium in Japan was held just this month: the VIII International Cherry Symposium, attended by 245 delegates from 28 countries. The first Asian Horticultural Congress was held in South Korea in 2006. Thailand is another country on the Asian continent that has a long established relationship with the ISHS. Their first symposium was organized in 1988. The first symposium in mainland China was held in 1993, in South Korea in 1994 and in Taiwan in 1995. Many symposia have followed in all of these countries and other Asian countries.

Over the past decades, ISHS has been slowly strengthening our involvement in Asia. We have been involved in the organisation of the Asian Horticultural Congress, which was initiated by the Korean Society for Horticultural Science (KSHS), the Japanese Society for Horticultural Science (JSHS) and the Chinese Society for Horticultural Science (CSHS). The last Congress was held in China in 2016 and the next will be held in Thailand in 2020.

Of course, we have been planning the XXX International Horticultural Congress for some time. It will be held in 2018 in Istanbul, the gateway to Asia. The theme of the 2018 Congress is "Bridging the world through horticulture". IHC2018 will provide a unique platform for scientists, students, engineers, growers, industry, trade, policy makers and consumer organizations working in horticulture from all countries to join in this feria of horticulture. There will be 37 symposia, 2 colloquia and 13 workshops, training sessions and technical tours. You can follow the updates on our web site **www.ihc2018.org**. Because of its location, other new initiatives are in the pipeline for IHC2018.

The East Europe-Central Asia Summit

IHC2018 will not only be the four-yearly meeting point for our members, but will also take advantage of the strategic position of Istanbul and the rich Turkish horticultural history and tradition. We plan to gather horticultural colleagues from the regions nearby to encourage their involvement in our Society so we can in turn support and expand their networking opportunities.

IHC2018 will open a new page in scientific and practical teamwork of horticulturists from Eastern Europe, Kazakhstan and Central Asia. In fact, we will have for the first time at IHC a full-day event specifically organized to interact with interested delegates from these regions. ISHS will present our Society, and regional perspectives from this part of the world (including from Central Asia, East Europe, Russia and FAO) will be showcased through the presentation of case studies. Corporate members of ISHS will present their activities in East Europe and Central Asia. The Board launched this initiative and created a core Organizing Committee consisting of Yüksel Tüzel, Jozef van Assche, and myself as Members of the Board, and Dr. Rina Kamenetsky, an ISHS member working at the Institute of Plant Sciences, ARO, The Volcani Center, Israel, originally born in Kazakhstan and highly knowledgeable about the region. We will be working in the coming months, alongside stakeholders and our corporate members, to make the First East Europe-Central Asia Summit at IHC2018 a starting point for reaching out and creating lasting networks within this region. The Board is hoping to gather as many scientists and practitioners in horticulture as possible from these regions and, with the help of existing ISHS members, to strengthen relationships in this part of the world.

The First Iranian International Conference

In the 1980s, scientists from several universities in Iran decided to establish regular meetings to foster their collaboration. Since 1989, regular meetings have been organized by the universities of Tehran, Shiraz, Esfahan, and Tabriz. The First National Horticultural Science Congress was held at the Seed and Plant Improvement Institute, in Karaj, in 1997. Since then, Iran has been holding the National Horticultural Science Congress of Iran every four years, organized by the Iranian Society for Horticultural Science, and attended by hundreds of participants from all disciplines of horticultural science. This year, from 4-7 September 2017, the meeting will be held in conjunction with the ISHS for the first time, making it the I International Conference & X National Horticultural Science Congress of Iran (IrHC2017). More than 220 abstracts have already been received and attendance is expected to be very high. This will be a great opportunity for scientists around the world to interact with most of the national scientists of Iran working in horticultural science and plan even more future activities with the ISHS. The theme of the Conference is "Productivity of horticultural crops in Iran: potential, production limitations, possible solutions and international collaborations", emphasizing the relationships that can be created at the international level.

The ISHS has held, thus far, a few symposia in Iran: one each year in 2005, 2006, 2010, 2011, 2015, 2016 and 2017. With the First International Conference we are stepping up to a regional symposium which will certainly have great success and provide greater opportunities for future collaborations.

The International Academy of Asparagus Science (IAAS)

In Asia, there is an increasing desire for international exposure and their growing collaboration with the ISHS is gaining attention. Since 2015, we have been working with a steering group in China who are developing an ambitious project to create an International Academy of Asparagus Science (IAAS). In 2016, several meetings took place to create a network of partners and sponsors of the Academy. The China Association for Science and Technology (CAST) has been involved, as well as the China Optimization Society of Capital Construction (COSOCC), an organization member of CAST. The Beijing Municipal Government welcomes the

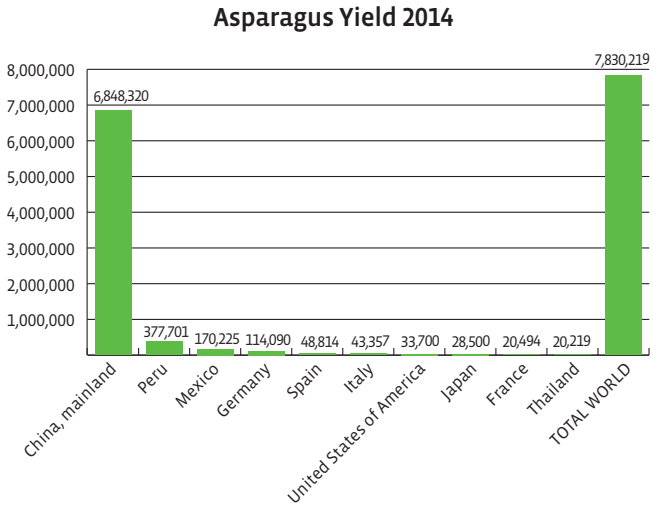


Figure 1. Top ten producers of asparagus in the world (yield in tonnes) (FAO, 2014)

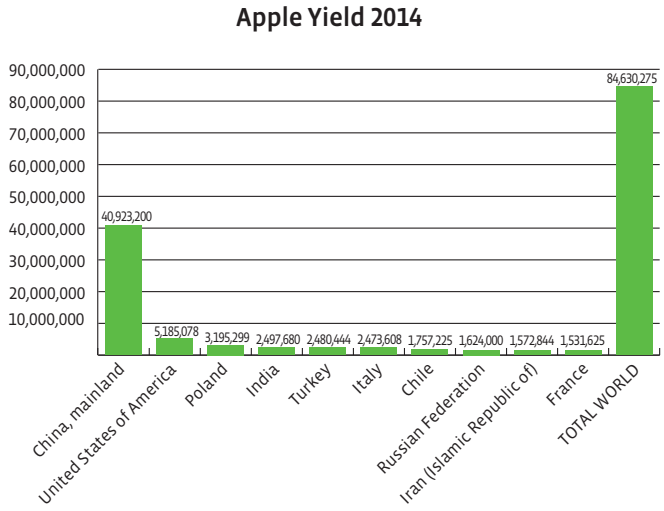


Figure 2. Top ten producers of apple in the world (yield in tonnes) (FAO, 2014).

establishment of IAAS in the capital city as an international connection and innovation centre. The location under scrutiny is in the district of Yanqing, north of Beijing, where preparations are being made to host the International Horticultural Exhibition 2019, one of the Expos organized under the umbrella of the International Association of Horticultural Producers (AIPH).

China is the largest producer of asparagus in the world, producing almost 7 M tonnes of asparagus annually (FAO, 2014). This is about 20 times that of the second largest producer, and represents more than 87% of the world's production (Figure 1).

The IAAS is at the moment designed to become a scientific research institution. An international scientific Board is planned, with members chosen by the ISHS. The academy will organize international events at both an educational and scientific level, such as summer schools, internships and research collaborations. We are regularly in discussions to make the necessary formal steps for the establishment of IAAS and we will keep you informed of progress.

The International Apple Research and Innovation Centre (IARIC)

Another initiative taking place in China is related to a very important horticultural crop: apples. In 2016, the First International Apple Symposium took place in Yangling, Shaanxi Province, China under the aegis of ISHS. The symposium attracted hundreds of scientists from China and from around the world. The province supplies one third of the apples in China. China is the largest producer of apples worldwide, producing more than 48% of the world's apples, an estimated 90 M tonnes (FAO, 2014). In 2016 their estimated production was 8 times that of the second largest producer (Figure 2).

During the First International Apple Symposium, formal talks were initiated by the government of the Shaanxi Province with members of the Board of the ISHS, because Shaanxi Province is dedicating significant resources and focus to apples. The major horticultural university in the region, Northwest A&F University, is heavily involved in research related to apples and is receiving significant international exposure. In March 2017, the full Board met in Xi'an, the capital

Figure 3. The ISHS Board met in Xi'an, Shaanxi Province, China, in March 2017 for a Board meeting. Here they display one of the new apple cultivars developed in Shaanxi Province.

Figure 4. ISHS President Prof. Rod Drew and Dr. Songpol Somsri (Thailand) at Horti-Asia entrance gate.

of Shaanxi Province (Figure 3), and visited the Northwest A&F University, a key national university located in Yangling Agricultural Hi-tech Industries Demonstration Zone, Shaanxi Province. In the same week, several meetings took place in relation to the establishment of an International Apple Research and Innovation Centre, planned to be located in the province. The Centre will conduct research that focuses on problems that are relevant to the apple industry worldwide and includes reciprocal programs and sabbaticals with leading research providers that are working on apple research.

International horticultural exhibition in Thailand and ISHS symposia 2.0

The President and the Executive Director participated recently in Horti-Asia (Figure 4), a relatively new international horticultural exhibition that started in Bangkok in the year 2012. It was an excellent occasion to get in contact with horticulturists from several Asian countries such as Myanmar, Cambodia, Vietnam, Pakistan and others. The ISHS logo appeared on all panels of the exhibition and it was a great way to promote the ISHS to those attending the exhibition. The organizer of Horti-Asia is also organizing the next Asian Horticultural Congress on behalf of the Thailand Society for Horticultural Science. By the time this article has gone to press, the Board will have discussed potential collaboration between the organizer of Horti-Asia and the ISHS, including joint activities during future exhibitions that would include a scientific contribution to conferences held during Horti-Asia, in the spirit of Symposia 2.0 style. We will keep you informed of progress.

Concluding remarks

With the present distribution of the world's population (Table 1), it should not be surprising to see many initiatives occurring in Asia. We feel very positive, therefore, that the International Society for Horticultural Science is involved in initiatives in Central and Eastern Asia, and in Eastern Europe, to co-develop events and strengthen our ties in these parts of the world. We look forward to more to come.

■ Table 1. Regional distribution of the world's population in 2017 (www.worldometers.info).

Region	World population Year 2017	World share (%)
Asia	4,478,315,164	59.59
Africa	1,246,504,865	16.59
Europe	739,207,742	9.84
Latin America and the Caribbean	647,565,336	8.62
Northern America	363,224,006	4.83
Oceania	40,467,040	0.54

› References

FAO. (2014). http://www.fao.org/faostat/en.

Spotlight on Honoured ISHS Members

› John Possingham

› John and his wife Carol observing the degree of colouring of their 'Shiraz' grapevines (1990).

Position or previous position

Chief of the Division of Horticultural Research, CSIRO (retired)
Co-Director of POSSUMS McLaren Vineyards Pty Ltd together with my wife, and Managing Director (imminent retirement)

ISHS honour

Honorary Member

1. Tell us a bit about yourself.

I grew up on a small irrigated horticultural property in South Australia. These farms were referred to as "fruit salad farms" because of the range of different crops grown – grapes, peaches, nectarines and apricots for drying, and a range of different citrus including oranges, grapefruit and mandarins for the fresh fruit market, plus some wine grapes for distillation to brandy. My primary education was in a two-teacher school and my secondary was at the local high school.

My curiosity about further education was kindled by an older student friend who convinced me I should attend university but when it came to enrolling I was one year too young, so I spent a year at Adelaide High School before studying agricultural science at Adelaide University. This I quite enjoyed and stayed on for an honours year in botany. Also, it emerged there wasn't a place for me on the farm as it provided an income for only a single family. I was thus on the labour market.

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

Fortunately, at graduation I was offered a post with Commonwealth Science and Industrial Organisation (CSIRO) in the Division of Plant Industry, Canberra ACT, which I drove to in my Austin 7 tourer, breaking almost every part of the suspension on the way. There I was asked to work on the function and role of the minor nutrient elements in plant growth and metabolism. Because many of the soils of Southern Australia are aged and leached, they are universally deficient in phosphorous and nitrogen and, as well, can lack a range of micronutrients including copper, zinc, manganese and molybdenum. My task, using the recently developed technique of paper chromatography, was to look at concentrations of amino acids present in plants grown under conditions in which the micronutrient elements were deficient. This work turned up some interesting findings, which I submitted back to the Adelaide University for a Master's degree, but more importantly, they enabled me to be awarded a CSIRO Post-Graduate Scholarship to study at the University Of Oxford. There I studied some of the effects of iron deficiency on plant roots and I showed that it reduced cytochrome concentrations, and it interfered with and abruptly stopped cell division. Using radioactive iron, I was able to show that the iron was located in the nuclei of root tips. At the end of my DPhil I was asked to attend, as a member of the British Atomic Weapons Team, the atomic bomb trials held in Australia in 1956, so that in Australia we would have at least one biologist with some knowledge of the fall-out problems arising from these weapons.

On my return to Canberra, I continued my plant nutrition research. Using a manganese isotope, I showed that this element was involved in the oxygen-evolving steps of photosynthesis and in its absence, the anatomy of chloroplasts was altered. This led to a life-long interest in the factors influencing the replication and ultrastructure of chloroplasts. After three years in Canberra, CSIRO asked me to take charge of a small research station at Merbein, Victoria, which they had inherited from local growers when CSIRO was first formed. CSIRO agreed then to build a small horticultural laboratory adjacent to the Waite Agricultural Research Institute and to allow the work of the team to involve wine grapes as well as drying grapes. I guess this was the point at which I became a HORTICULTURIST.

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

As a result of a fleeting visit to the major grapevine research establishments in the USA and Europe through to what was then the USSR, where I visited Moldavian and Crimean vineyards, I came to the conclusion that the only way the Australian grape industries would remain competitive in the modern world of the 1960-70s was to establish a vine improvement program covering both cultivars and rootstocks and to mechanise as many steps in the production cycle as possible.

› Cabernet Sauvignon' vineyard which ascends to 300 m (in 2000).

› John at the ISHS Board meeting in Iceland in 2001 with his wife Carol, Antonio Monteiro, and Jozef van Assche.

This was the period when both Cornell University and the fledging Davis University were involved with developing machines that could shake grape bunches off vines and harvest wine grapes in a form suitable for wine making. I convinced CSIRO to give me money to pursue this opportunity, which initially involved CSIRO bringing the machines that were under development in the USA to Australia for further trials. From there, private enterprise took over the mechanical harvesting of grapevines in Australian vineyards. In CSIRO, we concentrated our efforts on hedging machines to mechanically prune grapevines and in developing a system to dry sultana grapes by severing the fruiting canes and drying the grapes on the vine. A vine-breeding program was set up.

During this period, my personal research was essentially carried out by a series of very talented Post Docs. We developed a sterile leaf disc system that enabled us to study the sequence of events that occurred while newly-formed spinach cells increased in size and increased their chloroplast numbers from 10 to 200 per cell. Using this system, we showed that the initial 10 chloroplasts of young spinach cells came equipped with sufficient copies of their DNA to allow them to form 200 chloroplasts without further DNA synthesis.

As the more practical findings of our viticultural program were increasingly adopted by industry, we were required by CSIRO to allocate some resources to new areas of research. At the laboratory level we expanded our molecular work, developing a method to assist in the identification of grapevine cultivars using the frequency with which a series of different tandem DNA repeats are interspersed between segments of unique DNA in the grapevine genome. Collaborative work was also begun with laboratories in both France and Italy, to learn more about the genome of *Vitis* species. This information is currently being used in conventional grapevine breeding programs but also in gene transfer studies, to develop grape cultivars that are resistant to fungal diseases. These are currently banned from use, but in time the community's attitude to genetically-transformed plants may change.

We also began a small program on tropical crops based in Darwin, where it was clear there was a real prospect of expanding the mango industry. We were fortunate in being able to recruit a senior crop specialist for this work from India and were able to assist with overcoming the problem of irregular cropping generated by variations in the arrival of monsoon rains. Soon after, a mango breeding program was developed between horticulturists in Western Australia, the Northern Territory and Queensland, and some new cultivars have already been released.

Throughout this rather diversified program of horticultural research stretching over 30 years, I was supported by the one employer, CSIRO. In a way, they were benevolent, but never-the-less, it was a constant battle to convince them that the horticultural research I wanted done was both worthwhile and sufficiently good for them to provide the funds for it. These were the days when CSIRO's role in agriculture was to contribute findings to assist in the development of the massive land mass of the Australian continent. We were funded by the Federal Government and were not required to seek external sources of revenue to support our work. CSIRO were generous in their support of my Post Docs and allowed me short overseas trips virtually every year, and as well, gave me short 3-month sabbaticals at Edinburgh, Dusseldorf, Osaki (Japan) and Bangalore (India).

4. What do you consider were your greatest achievements?

I regard my ability to put together small teams to collectively tackle research problems of practical significance as my major contribution to Australian horticulture. For example, our work on mechanising the grapevine industry before others enabled us to grow a range of premium grape cultivars with small bunches, such as 'Chardonnay' and 'Cabernet Sauvignon', which gave our wine industry an advantage. Our work on accessing much of the world's grapevine germplasm and our nematode- and salt-tolerant rootstocks greatly benefitted the raisin industry.

I derived great personal satisfaction from contributing towards our understanding of the role manganese plays in the oxygen-evolving reactions of chloroplasts. This work and my many studies of the ultrastructure and DNA of chloroplasts provided sufficient research

› Becoming a manager after leaving the lab bench.

to be awarded DSc from Oxford University to partner my DPhil. My team leadership work contributed towards my receiving the award of Order of Australia and my election to Fellowships of the Australian Academy of Technological Science, the Institute of Agricultural Science & Technology and the Russian Academy of Sciences. I have published approximately 250 papers in a range of journals but I have not written a book.

My other more practical horticultural achievement was to become a vigneron for the last 20 years of my working life, growing grapevines and making wine. Because I was raised on a farm it was inevitable that someday I would return to my roots. About 10 years before I retired from CSIRO, my wife and I bought a small vineyard in the McLaren Vale area which is less than half an hour's drive from our home in Adelaide. It was quite easy to operate using local area contractors. The 1980s was the beginning of the "wine boom" in Australia and it was easy to add more land. Even more land was added together with a winery when I "retired" and it became quite a large enterprise. We sold wine to a number of overseas countries and my wife and I travelled extensively. I became active in the International Wine Office located in Paris and could also devote more time to ISHS matters and FAO assignments. We expect the sale of our wine business will be completed by the time this article is printed.

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

It is always difficult to think of funny experiences, as often what is funny to one side is not to the other. Mine concerns an anecdote from one of the endless reviews our Division had to suffer from external committees. The occasion was when we were demonstrating to a very learned Professor of Chemistry, how a grape mechanical harvester operates. He thought Merbein was a tropical environment and came dressed

› Looking over the historic buildings of Central London (2014).

in a white safari suit. His folly was, without telling us what he was doing, to look into the rear end of the machine while it was stationary when we were picking very red 'Shiraz' grapes. Disaster struck when it was started up! We are not sure whether his laundry ever managed to clean up that very white suit that became splattered with red juice and bits and pieces of 'Shiraz' grapes! It probably contributed to his report saying that the type of work we were demonstrating did not belong in CSIRO and should be moved to the local Department of Agriculture.

6. 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?

Our Merbein Laboratory was a long time ISHS library member, and we had virtually every publication that ISHS had ever printed. In the early years, this was limited to a few notices of meetings provided by individual countries, together with Actas of variable quality reporting the proceedings of meetings. From these publications I learned a little of the Society and I seriously considered attending the Congress at Maryland, USA. What I do remember was attending the Congress in Tel Aviv, Israel, which made quite an impression on me about how a small number of scientists working in horticulture were managing to do so much. I gave a couple of papers about the work by me and others in my group. Most of the Australian contingent at Israel were preoccupied with trying to host the 1978 Congress. This became largely a State Department of Agriculture activity and did not concern CSIRO. From then on, I attended every ISHS Congress and I think I gave presentations at most of them.

Japan was an important Congress for me as it was when I first joined the ISHS Board and became friends with an outstanding group of colleagues, including Sansavini, Brickell, Zimmerman, Van Assche and Monteiro. It was a time when ISHS had moved away from being an adjunct of the Dutch Ministry of Agriculture who provided office space and limited funds to foster the organisation. However, no money was available to support the meetings of Sections, Commissions and Working Groups. They, as well as Congresses, were required to raise funds for their meetings, usually from local horticultural industries. The organisers of meetings had to not only raise funds to run the meeting, but also raise further amounts to support the printing of the Actas coming from their meeting. This of course all changed with the digital era and I can remember when the Board debated whether we should pay a small Canadian firm with an office in Belgium a few dollars to get ISHS moving into this new-fangled technology. The rest is history. Because of some excellent decision-making and excellent administration, ISHS brought the digital era into our Society. We are now one of the best international societies in the world, providing excellent services to our members and exchanging regularly between continents a massive amount of horticultural science and practical knowledge via our highly respected and profitable *Acta Horticulturae* series.

7. What advice would you give to young people interested in a career in horticulture/horticultural science? What are the most interesting new roles or opportunities you see emerging in the future within horticultural science?

This is a particularly difficult question for me to answer because I changed from a practical agricultural science first degree, and a fairly basic sciences doctorate, to become a horticultural science team manager. I guess my advice is to always go on learning about new knowledge as it becomes available. Currently, areas that must be part of the curriculum are the molecular sciences, which hold the key to all breeding, and of course, the digital sciences that are going to overwhelm us all. These areas also hold the key to the way practical horticulture will advance. It is certain that robotics will play a major role in the horticulture of the future as a way to decrease the hand-labour input to many crops.

› ISHS student award winner summaries

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

Determinants and constraints of fruit and vegetable consumption in Uzbekistan

› A.M. Ergashev

Since 1991, fruit and vegetable production has been expanding in Uzbekistan. Although national supply should be sufficient for the population to receive recommended daily servings, fruit and vegetable intake remains inadequate, with a strong seasonal pattern. The horticultural supply in Uzbekistan is characterized by seasonal fluctuations which impact prices and other factors that then affect decisions on consumption. Detailed analysis of such factors was the focus of this study.

The data in this research came from a food consumption survey conducted in Tashkent province. A total of 931 people were interviewed twice – in summer 2014 and again in winter 2015. High seasonality in individual fruit and vegetable intake was confirmed by the survey data. These fluctuations resulted in variation in the nutrient content of consumed fruit and vegetables. Multiple linear regression analysis examined the relationships between various factors, with intake of horticultural products and derived nutrients examined. Amongst the adult population, regression results showed that income, food knowledge and household size had strong positive effects on fruit and vegetable intake. Across all population groups, the winter season was surprisingly positively associated with consumption, while age and price had strong negative effects. Food knowledge positively influenced nutrient intake for all population groups. Income exhibited a progressive positive effect, i.e. the richer the family, the more nutrients their members consumed by eating fruit and vegetables. Income elasticity was the strongest in infants compared to older children and adult females.

In summary, this paper confirmed the benefits of food and nutrition education among all population groups. State policy measures to combat high horticultural price fluctuations also seemed to be urgent.

A.M. Ergashev won an ISHS student award for the best oral presentation at the I International Symposium on Poverty, Hidden Hunger and Horticulture in Australia in November 2016.

› Contact

A.M. Ergashev, Center for Development Research (ZEF), University of Bonn, 3 Walter-Flex Street, 53113 Bonn, Germany, e-mail: alishergashev@yahoo.com

Effect of light quality on seedling quality characteristics of *Petunia hybrida*

› Behnaz Akbarian

The use of artificial light has become very common as a means to increase production and quality of seedlings. Light-emitting diodes (LEDs) are a new source of economical and spectrally-selective light. The benefits are: versatility in handling and mounting, long life expectancy, wattage use efficiency and lower heat production. We investigated the effects of light quality from different types of LEDs, namely red, blue, combination of 25% blue and 75% red (blue+red light), and fluorescent lamps, each as a sole light source, on seedling emergence and growth of petunia, zinnia, impatiens and verbena. This study indicated that light quality has different effects on the morphological characteristics of different ornamental crops. Pure red light enhanced the emergence of seedlings. Seedlings grown under the blue+red light were generally of higher quality (compact, larger stem caliper, higher root fresh weight and less morphological disorders). However, petunia seedlings showed the highest quality under blue light, which also promoted floral induction. Shoot height of petunia under red light and blue+red LED treatment was significantly shorter than for other light treatments. Mean root length of petunia seedlings grown under blue light, red light or blue+red light was longer than that for seedlings grown under fluorescent light. This therefore suggests that blue light of lower irradiance appears to be sufficient to induce flowering in petunia and that red light may inhibit flower induction.

Behnaz Akbarian won an ISHS student award for the best poster at the International Symposium on Wild Flowers and Native Ornamental Plants in Iran in May 2017.

› Contact

Behnaz Akbarian, Department of Horticulture Science, Faculty of Agriculture, University of Tabriz, 29 Bahman Blvd, 51666 Tabriz, Iran, e-mail: akbarian787@gmail.com

Postharvest UV-C treatment improves health promoting plant compounds and prolongs shelf-life of vegetable amaranth (*Amaranthus cruentus* L.)

› Elisha O. Gogo

Consumption of African leafy vegetables (ALVs) has increased in Kenya, especially within urban and peri-urban areas. ALVs, such as vegetable amaranth (*Amaranthus cruentus* L.), are rich in bioactive compounds, e.g. protein, minerals, vitamins, dietary fiber, carotenoids and phenolic compounds, which play an important role in health promotion. However, ALVs are highly perishable; hence they suffer significant postharvest losses. The use of ultraviolet light C (UV-C) is gaining interest in improving postharvest quality and hygienic status of fruits and vegetables. Currently, only limited studies have been conducted on postharvest UV-C effects on leafy vegetables, especially ALVs. The objective of this study was to evaluate the effects of postharvest applied UV-C irradiation (254 nm) on dry weight, weight loss, main carotenoids (β-carotene, lycopene, and lutein), chlorophylls and protein of vegetable amaranth. Vegetable amaranth 'Madiira' was grown under greenhouse conditions (day/night temperatures ranging between 22-35°C/20-22°C). Eight weeks after sowing, leaves were harvested and immediately subjected to UV-C at 1.7 or 3.4 kJ m^{-2}, while non-treated leaves served as the control. Thereafter, the leaves were stored at 5°C (85% RH) for 14 days or at 20°C (85% RH) for 6 days. Evaluations were done at 0, 2, 6 and 14 days from harvest, although evaluations were terminated early once leaves deteriorated sufficiently to be inedible. Results revealed that postharvest UV-C treatments on vegetable amaranth leaves significantly reduced weight loss compared with the control throughout storage, whereas dry weight was unaffected. UV-C treatments had significantly higher carotenoid, chlorophyll and protein content compared with the control, although it varied depending on storage conditions and applied dosage. The findings of the present study indicate that there is potential for use of UV-C as a postharvest treatment technology which is relatively safe (no residues), affordable and easy to apply. This technique would help in reducing postharvest losses and improving health promoting compounds in ALVs, which might be a promising step in improving living standards, and enhancing food, health and nutrition security in developing countries.

Elisha O. Gogo won an ISHS student award for the best oral presentation at the VI International Symposium on Improving the Performance of Supply Chains in the Transitional Economies in Australia in November 2016.

› Contact

Elisha O. Gogo, Egerton University, Department of Crops, Horticulture and Soils, P.O. Box 536, 20115 Egerton, Kenya, and Humboldt-Universität zu Berlin, Faculty of Life Sciences, Division of Urban Plant Ecophysiology, Lentzeallee 55-57, 14195 Berlin, Germany, e-mail: elishag6@gmail.com

Development of electrospun nano-fibre matrix to extend shelf-life of mango fruit

› R. Shanmugapriya

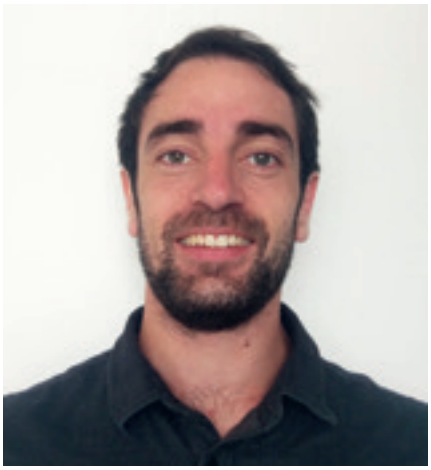
India contributes 69% of global mango production. However, availability of fruit in India meets only 50% of demand. In order to overcome the problems of post-production losses, several strategies, such as the best harvesting and handling practices, are being promoted. However, the recommended practices are not being adopted because of practical difficulties. This situation requires a simple and practical solution to a challenging problem. In this context, a team of scientists from six partnering institutes in India, Canada, Sri Lanka, Kenya, Tanzania and Trinidad & Tobago, are involved in the research program "Enhanced preservation of fruits using nanotechnology", which has been funded jointly by Global Affairs Canada (GAC) and International Development Research Center (IDRC) since 2012. The biomolecule hexanal, which is a plant-derived compound possessing the potential to inhibit degrading enzymes (e.g. phospholipase D) in the skin of fruit, has been identified as having potential to extend the shelf-life of fruit. Exogenous application of hexanal formulation as a preharvest spray or postharvest dip was found to minimize postharvest loss of mango fruit. Although the formulation is effective, the active molecule is highly volatile and quickly evaporates. With a view to encapsulate the compound, an electrospinning technique, which is a versatile technology wherein a polymer is subjected to high intensity voltage to convert the solution into a nano-fibre, has been exploited. The nano-fibre was developed using polyvinyl alcohol and cyclodextrin as a sheath and the hexanal as a core. It has the unique advantage of high surface to mass ratio and regulates the release of hexanal vapour. The nano-matrix (Sticker, measuring 5×5 cm) consists of a nano-fibre that has a surface area of up to 10,000 m^2 that could be stretched out to several kilometers long. Our estimates suggest that it can hold sufficient hexanal to extend the shelf-life of mango fruit by 2 to 3 weeks. The technology is very simple, cost effective and easily adoptable by packaging industries. The team is in the process of making modifications in the matrices to extend the shelf-life of a wide array of tropical fruit for which postharvest losses are huge.

R. Shanmugapriya won an ISHS student award for the best poster at the IV International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions in Sri Lanka in April 2017.

› Contact

R. Shanmugapriya, Department of Nano Science & Technology, Tamil Nadu Agricultural University, Coimbatore 641 003, India, e-mail: priyaagri75@gmail.com

The effects of nitrogen fertiliser application rates on red drupelet disorder (reversion) in 'Ouachita' thornless blackberries grown under tunnels



› Max Edgley

This project investigated the effects that different rates of nitrogen fertigation had on red drupelet disorder expression in commercial blackberries. Red drupelet disorder (sometimes known as red drupelet reversion or reddening) is a postharvest physiological disorder that causes fruit, which is black at harvest, to revert to a red colour following cold storage. This causes a mottled appearance on the fruit that is off-putting to the consumer and can render fruit unmarketable in some cases, causing significant financial loss to producers. In severe cases, the disorder can affect over half the crop. There is currently very little knowledge surrounding causes and contributing factors to the disorder, with no standard management practices available to reduce incidence. One factor that has previously been suggested as a contributor to high rates of the disorder is excess nitrogen fertilisation close to harvest.

Results showed that higher nitrogen fertigation rates prior to and during harvest, to canes grown under high tunnels, significantly increased rates of red drupelet disorder in fruit. The highest nitrogen application rate used in the study resulted in a 56% increase in expression of red drupelet compared with the lowest application rate throughout the course of the harvest season. This effect was highest at the beginning of the harvest season, at which time red drupelet incidence was highest, and declined as the harvest season progressed. Higher nitrogen rates also increased the total yield, but did not affect berry weight, pH, sugar content, or total acidity. This research shows that a link exists between nitrogen fertigation rates and red drupelet disorder expression, although further work is ongoing to investigate the underlying reason for this increase. These findings have the potential to guide industry standards to reduce incidence of the disorder in commercially produced blackberries.

Max Edgley won an ISHS student award for the best oral presentation at the I International Symposium on Protected Cultivation in Tropical and Temperate Climates & X International Symposium on Protected Cultivation in Mild Winter Climates in Australia in November 2016.

› Contact

Max Edgley, Tasmanian Institute of Agriculture, University of Tasmania, College Road, 7005 Hobart, Tasmania, Australia, e-mail: medgley@utas.edu.au

Development of polymorphic simple sequence repeat (SSR) markers from genome re-sequencing of *Carica papaya* L. 'Sunrise Solo' and 'RB2' for marker-assisted breeding

› Usana Nantawan

The purpose of this study was to investigate the use of sequencing technology and *in silico* polymorphism analysis to increase the efficiency of development of polymorphic SSR markers in papaya. We performed whole-genome re-sequencing on two commercial cultivars of papaya, 'Sunrise Solo' (Hawaiian cultivar) and 'RB2' (Australian cultivar), to identify a range of polymorphic sites to facilitate marker-assisted breeding programs for improving fruit quality traits.

In total, 30.2 Gb and 32.4 Gb of genome sequence data were generated using Illumina Hiseq 4000 sequencing technology for 'Sunrise Solo' and 'RB2', respectively. This represented approximately a 80-85x coverage of the papaya genome, which is estimated to be 372 Mb. Subsequently, 236 Mb of 'Sunrise Solo' and 239 Mb of 'RB2' unique sequences were mapped to the papaya reference genome. The initially assembled genomes were compared and analysed for putative polymorphic SSR loci. At the same time, marker-containing coding sequences (CDS) were assigned to gene ontology (GO) terms for providing a set of polymorphic markers putatively associated with functional genes. There were 1,127 polymorphic SSR-containing sequences discovered, of which 478 were associated with GO term. We selected 50 SSRs loci to be assessed for ability to amplify on 'Sunrise Solo' and 'RB2' genotypes. The result showed 100% amplification and 76% yield polymorphic amplicons of predicted sizes.

By combining whole genome sequencing, functional annotation and *in silico* polymorphism analysis, this study significantly increased the efficiency of polymorphic marker development for the target genotypes. The novel polymorphic SSR loci will be applied to the future mapping of QTL harbouring desirable traits, potential candidate gene identification and subsequent marker-assisted breeding strategies using these genotypes. The data will be useful for future genetic analysis, mapping and functional genomics studies in papaya.

Usana Nantawan won an ISHS student award for the best oral presentation at the I International Symposium on Tropical Plant Genomes in Australia in November 2016.

› Contact

Usana Nantawan, School of Natural Sciences, Griffith University, Nathan, Australia, and Environmental Futures Research Institute, Griffith University, Gold Coast, Australia, e-mail: mai.nantawan@griffithuni.edu.au

› Horticulturist honoured by Queen and country

Dr. Dyno Keatinge, former Deputy Director General-Research of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), has received the prestigious award MBE (Member of the Most Excellent Order of the British Empire) for his "services to tropical agriculture and the reduction of both poverty and malnutrition in the developing world".

Dyno served as World Vegetable Center Director General from 2008-2016. He was recommended for the award by the British Foreign Office for his work with the world's foremost research and development institution for the improvement of vegetables and for his services at ICRISAT, the International Institute of Tropical Agriculture (IITA) and the International Center for Agricultural Research in the Dry Areas (ICARDA).

During his tenure, the WorldVeg researchers increased the productivity of tropical tomatoes and other vegetables, developed climate-smart pest- and disease-resistant vegetable cultivars, and distributed home garden seed kits to hundreds of thousands of families across Asia and Africa to enhance the nutritional quality of their diets.

After retirement, Dyno became a Fellow of the International Society for Horticultural Science and chief executive of Tropical Agricultural Development Advisory Services. Commenting on his award, he said: "This came as a complete but pleasant surprise; I have accepted it on behalf of all horticultural scientists who continue to work tirelessly for the alleviation of poverty and malnutrition in the developing world."

Dyno is among 503 people who received MBEs for their work in education, health, economics, science, sports, law, and the arts in the 2017 New Year's honors list. The award was presented personally by Queen Elizabeth II at Buckingham Palace on 5th May 2017.

› Dr. Dyno Keating outside Buckingham Palace, where he received his MBE (Member of the Most Excellent Order of the British Empire) from Queen Elizabeth II.

Popular gardens in India and their origins

N. Deepa Devi

History of gardening in India

(Rana, 2017; Randhawa and Mukhopadhyay, 1986)

The history of systematic gardening in India dates back to the civilization of the Indus valley and to the Harappan culture, which existed between 2500 and 1750 B.C. People were already living in well-planned dwellings during this period. Pots were generally decorated with the design of trees in Harappan. The trees, especially *Ficus religiosa* (pipal) and *F. bengalensis* (banyan), were planted for both worship and shade, and were found in every village (Figure 1).

Aryans arrived in India in 1600 B.C. They were literate and brought with them the four Vedas *viz*. Rig Veda, Sama Veda, Artharva Veda and Yuzur Veda. Vedas (Sanskrit – "knowledge") are a large body of texts originating in ancient India. Composed in Vedic Sanskrit, the texts constituted the oldest layer of Sanskrit literature and the oldest scriptures of Hinduism. Aryans appreciated the beauty of flowering plants, lakes, mountains, and forests, and named their children after flowers like Kamal, Champa, Madhui, Bela, Chameli, and Rukmani. In Ramayana, which is one of the great epics of India written by Valmiki and Tulsidas, a detailed account of the status of gardening at that time was recorded. Ayodhya city, situated adjacent to Faizabad city at the southern end of the Indian state of Uttar Pradesh, was described as having wide streets, large houses, richly decorated temples and gardens. Within these gardens were fruit trees, flowering plants, lakes full of lotuses (*Nelumbo* sp.) and many kinds of birds.

During their exile, Lord Rama and his wife Sita observed a number of trees and were fascinated by beautiful flowers. One such tree was ashoka (*Saraca asoca*), which has beautiful foliage and fragrant flowers, and its name is associated with an Indian emperor (268 to 232 B.C.) of the Maurya Dynasty (see cover photo of this issue).

The saint Vyasa wrote another epic called the "Mahabharat". During the Mahabharat era (313-9 B.C.), pleasure gardens were planted with flowering plants. At this time, one of the most important trees was kadamba (*Nauclea cadamba*), which is associated with the God Krishna (Figure 2). The poet Kalidas described many of the flowering plants of that era in a number of his books. 'Kumar Sambhav' mentioned many plants in his Sanskrit poem, including lilies (*Lilium* spp.), shirish flowers (*Albizia lebbeck*), kalpavriksha (*Cocos nucifera*), Spanish cherry (*Mimusops elengi*), ashoka (*Saraca asoca*), flame of the forest (*Butea monosperma*), parijatham (*Nyctanthes arbor-tristis*) and lotus (*Nelumbo nucifera*). The famous poet Bhana Bhatta, also described a number of flowering plants including the banyan (*Ficus benghalensis*), sal (*Shorea robusta*), champaka (*Magnolia champaca*), flame of the forest (*Butea monosperma*), Spanish cherry (*Mimusops elengi*), kadamba (*Nauclea cadamba*), ashoka (*Saraca asoca*) and Indian coral (*Erythrina variegata*) in his book 'Harsh Charita'.

Figure 1. *Ficus bengalensis* trees were planted in Indian villages during the Harappan culture (between 2500 and 1750 B.C.) and used for worship and shade. They are often found in Indian villages today (Copyright: Ajay Tvm/Shutterstock).

Figure 2. During the Mahabharat era (313-319 B.C.), one of the most important trees was kadamba (*Nauclea cadamba*) because it was associated with the God, Krishna (Copyright: chetan mahapatra/Shutterstock).

Gardening during Mughal era (1526-1857)

(Rana, 2017; Randhawa and Mukhopadhyay, 1986; Villiers-Stuart, 1913)

Babur (1526-1530) was the first of the Mughal emperors. He was very interested in gardens and had gardens built at Panipat and Agra (Figure 3). The Archeological Department of the state is still maintaining the garden of Aram Bagh at Agra. Mughal gardens are very formal, of which square and rectangular flower beds are special features. The introduction of exotic plants, like cypress, rose, carnation, narcissus, daffodils, lilies, and tulips, were an important contribution of this era to Indian gardens.

The famous gardens established by the Mughal rulers include those listed in Table 1.

Gardening during the British era (1858-1947)

(Rana, 2017; Randhawa and Mukhopadhyay, 1986)

During the British era, British and Indian kings had a significant influence on gardening in India. A particular contribution of the British was the use of herbaceous borders and lawns. Specifically, they influenced gardening in three important ways: (i) introduction of exotic plants from England and other countries, (ii) establishment of Royal Agri-Horticulture societies and botanical gardens, and (iii) compilation of local flora of different regions. Annual plants, like phlox, verbena, larkspur, dahlia, pansy, aster, and antirrhinum, were also introduced. Many botanical gardens were established in different parts of the country. Plants were established in these botanical gardens in family groupings and were labeled.

Some of the most prominent gardens in India are described below.

Government Botanic Gardens, Ootacamund (Tamil Nadu)

(Nilgiris District Administration, 2017; Rana, 2017; Randhawa and Mukhopadhyay, 1986)

The Government Botanical Garden was established in 1847-48 in Udhagamandalam, near Coimbatore (Ooty), Tamil Nadu. This garden is situated at an altitude of 2,175-2,280 m above sea level in the Nilgiris Hills. The garden, divided into several terraced sections, covers an area of around 22 ha, and lies on the lower slopes of Doddabetta peak. It is maintained by the Tamil Nadu Horticulture Department. The garden has six major sections:

- The lower gardens, including the main entrance, the lower lawns and the new gardens
- The Bandstand
- The conservatory, the Bog Garden and the Tennis Court Gardens
- The terrace with fountains and picnic spots
- The new Bandstand and its surroundings
- The nursery area.

The garden is located in a temperate climate, with an average rainfall of 1400 mm, which is mostly received during the monsoon, and it has frosty nights from November to February. The maximum and minimum temperatures are 28 and 0°C, respectively. Vegetables, such as potato, cabbage, cauliflower, carrot, and beetroot, and many fruits were introduced to the gardens. It is also known for introducing to this region a range of *Cinchona* species, which are native to Andean forests, and different species of *Eucalyptus*. Many essential oil yielding plants were introduced to the garden, including scented geranium.

Figure 3. Babur, the first of the Mughal emperors (Emperor from 1526-1530), supervising the laying out of the Garden of Fidelity. This painting is from an illustrated copy of the Baburnama (or "Memoirs of Babur") prepared for the author's grandson, the Mughal Emperor Akbar (Copyright: Painters of Babur/Wikimedia Commons).

Table 1. Some of the famous gardens established during the Mughal era (1526-1857).

Emperor	Gardens established
Akbar (1556-1605)	Fatehpur Garden, Sikri (Agra) Tomb Garden, Sikandra (Agra)
Jahangir (1605-1627)	Shalimar, Acbhalbal, Varinag (Kashmir) Itmad-ud-Daulah (Agra) Dilkusha Garden (Lahore)
Shan Jahan (1627-1658)	Shalimar (Lahore) Tai Mahal, Red Fort (Agra) Red Fort (New Delhi)
Fadai Khan (1658-1707)	Pinjore Garden (Pinjore)

Bryant Park, Kodaikanal (Tamil Nadu)

(Rana, 2017)

Bryant Park is situated on the eastern side of Kodaikanal Lake in Kodaikanal, in the Dindigul district of Tamil Nadu. A British army officer, Glenn Bryant, conceived and landscaped the park in 1908, which has a total area of 10 ha. A large section includes nearly 740 cultivars of rose. In total, more than 325 species of trees, shrubs and cacti are found in the park. A major attraction is a *Eucalyptus* tree planted in 1857, but the park is also known for the incredible range of flower colours. A flower and vegetable show is organized every year at the park during May. The park has terrace gardens, lawns, a children's park, a glasshouse and a sunken garden. The park is a centre for supplying ornamental plants to the province.

Figure 4. Lalbagh Gardens, Bangalore, India, are probably most famous for their glasshouse, which hosts two flower shows annually, as well as being used for holding meetings, conferences and receiving dignitaries.

Sim's Park, Coonoor (Tamil Nadu)

(Rana, 2017; Randhawa and Mukhopadhyay, 1986)

Sim's Park is located in Coonoor, The Nilgiris, Tamil Nadu, and is 1780 m above sea level. It was developed by J.D. Sims and Major Murray in 1874. It is an important tourist destination in Coonoor. The park, which is also considered to be a botanic garden, covers an area of 12 ha. It has seven sections or terraces, which range from formal to informal designs. Whilst many of the terraces have been planted with flower beds, lawns and rockeries, there are some naturally occurring trees, shrubs, and creepers. In addition, many unusual species of plants have been introduced from around the world. The garden has some rare economic trees, such as Rudraksh (bead tree) from the genus *Elaeocarpus*; *Cinnamomum*, a genus of aromatic trees and shrubs from the *Lauraceae* family; and Queensland karri pine (*Eucalyptus diversicolor*). There is a glasshouse and a rose garden. This park has more than 1,000 species from 255 genera belonging to 85 families. The garden is laid out in the English landscape style. The park is located in a saucer-shaped deep valley and a stream bisects it and leads to a pond at the lower part of the park. Original patches of native trees on the higher slopes were selectively retained and incorporated into the design. A mild mountain climate, rainfall occurring over the whole year, and high relative humidity, result in flowering of different plants throughout the year. Flowering and foliage shrubs are used as hedges along the boundaries of the park, along contours, footpaths and around the lake.

Lalbagh, Bangalore (Karnataka)

(Lalbagh gardens, 2017; Randhawa and Mukhopadhyay, 1986)

Lalbagh or Lalbagh Botanical Gardens, meaning *The Red Garden* in English, is a well known botanical garden in Southern Bangalore, Tamil Nadu, and covers 97 ha. The gardens are located at an altitude of about 900 m, have a mild climate and are therefore suitable for growing a wide range of plants. The garden was originally commissioned by Hyder Ali in 1760, the ruler of Mysore, and later finished by his son Tipu Sultan. The garden is currently the seat of the Directorate of Horticulture of the State. The garden is probably best known for its famous glasshouse, which hosts two annual flower shows (26 January and 15 August), and is also used for holding meetings, conferences and for receiving important dignitaries (Figure 4). Lalbagh houses India's largest collection of tropical plants, has a lake, and is one of the main tourist attractions in Bangalore. There are also many bird species seen within the park, including myna, parakeets, crows, brahminy kite, pond heron, common egret, and purple moor hen. The garden has over 1,000 species of plants and has many trees that are over 100 years old.

Brindavan Gardens, Mysore (Karnataka)

(Karnataka State Tourism, 2017; Rana, 2017; Randhawa and Mukhopadhyay, 1986)

This garden is one of the most important tourist attractions in India. It covers about 24 ha and was established between 1927 and 1932. The gardens were the initiative of Sir Mirza Ismail, the Dewan of the State of Mysore at the time, and were modelled on the Shalimar Gardens of Kashmir in a similar Mughal design. The garden is famous mainly for its illuminated fountains and running water, decorated with coloured lights (Figure 5). In the evening, the fountains and running water are illumi-

nated with lights that change colour and are often synchronized to music. Apart from the fountains and lights, the gardens have open spaces under lawn, illuminated flower beds and other ornamental plantings. The garden is laid out in three terraces, which contain water fountains, *Ficus* trees, foliage plants such as *Duranta plumaria* and *Euphorbia*, and flowering plants such as celosia, marigold and bougainvillea. The river Cauvery, below a giant dam, divides the garden into two parts and visitors can go boating on the lake.

The Mughal Garden, Pinjore (Haryana)

(Rana, 2017; Villiers-Stuart, 1913)

This garden was designed by Fidai Khan, for his foster-brother, the Mughal emperor Aurangzeb, during his reign in the 17th century. The original name of the gardens, Panchapura or Panjpur, has association with the five Pandavas (sons of Pandu) from the Sanskrit poem, Mahabharata. It is one of the better preserved gardens in northern India. The garden covers 25 ha and is divided into several terraces. The main gate is at the highest terrace and there is a central water channel, so water falls from one terrace to the next. The garden is situated at the foothills of the Himalayas at an altitude of about 600 m.

Figure 5. The fountains at Brindavan Gardens, Mysore, India, are illuminated with lights that change colour and are often synchronized to music (Copyright: saiko3p/Shutterstock).

Figure 6. The Taj Mahal, Agra, India, is placed at the end of one of its gardens, rather than the centre as found in other Mughal tombs.

Zakir Hussain Rose Garden (Chandigarh)

(Rana, 2017; Randhawa and Mukhopadhyay, 1986)

The rose garden in Chandigarh, India, is the largest of its kind in Asia, covering almost 11 ha. This garden was established in 1967 with the support of Chandigarh's first Chief Commissioner, the late Dr. M.S. Randhawa, and was named after India's former President, Zakir Hussain. It contains more than 17,000 plants, including almost 1,600 rose cultivars. The Zakir Hussain Rose Garden contains trees of medicinal value, as well as a wide range of roses. Some of the medicinal plants that can be seen include bel, bahera, harar, camphor and yellow gulmohar. The gardens hold an annual rose festival, which is a major cultural event for the city.

Taj Mahal Gardens, Agra (Uttar Pradesh)

(Azmee et al., 2015; Begley, 1979; Rana, 2017)
The Taj Mahal, meaning "Crown of the Palace", is a marble mausoleum on the south bank of the Yamuna River, Agra. It was supposedly built in 1632 by the Mughal emperor, Shah Jahan, for his wife, Mumtaz Mahal, who died in childbirth. However, others have suggested it represents one of the mansions promised to the faithful in "Paradise". The tomb is located in the centre of 17 ha of formal gardens, in which a mosque and guest house are also situated, and the garden is surrounded on three sides by a crenellated wall. The Taj Mahal was designated as a UNESCO World Heritage Site in 1983. The complex is set around a large 300 m^2 Persian (charbagh or chahar bagh) or Mughal garden. The charbagh garden design was introduced to India by Babur, the first Mughal emperor. It uses raised pathways that divide each of the four quarters of the garden into 16 sunken flowerbeds. In the centre of the garden, between the mausoleum and the gate, is a raised marble water tank, which has a pool aligned north-south to reflect the mausoleum. Unlike other Mughal tombs, the Taj Mahal is placed at the end of one of its gardens, rather than the centre, so in this respect is quite unusual (Figure 6). The raised marble water tank is called al Hawd al-Kawthar, in reference to the "Tank of Abundance" promised to Muhammad. Elsewhere, the garden is laid out with avenues of trees and fountains. The charbagh design incorporates the four flowing rivers of Jannah (Paradise) and reflects the Paradise garden derived from the Persian paridaeza, meaning "walled garden". In Islamic texts of the Mughal period, "Paradise" is described as "an ideal garden of abundance with four rivers flowing from a central spring or mountain, separating the garden into north, west, south and east" (Azmee et al., 2015).

Rashtrapati Bhavan Garden, New Delhi

(Indian Government, 2017; Rana, 2017; Randhawa and Mukhopadhyay, 1986)
Rashtrapathi Bhavan Gardens are part of the official residence of the President of India, formerly known as Viceroy's House (Figure 7). The palace and gardens were designed by Sir Edwin Lutyens in 1917, but the gardens were not planted until 1928-29. The gardens are spread over 6 ha, and follow the pattern of Mughal gardens, with a conventional arrangement of squares, terraces, and water channels. The main garden area is roughly 134 m^2 and is bound from all sides by a paved red stone path. Two canals, each of 5.4 m width, run from north to south and two similar canals intersect these to form a 60 m^2 island in the centre. This island is the venue for most of the receptions held at Rashtrapati Bhavan. There is a sunken, circular garden, which is known for its flower display. The garden is famous for quantity and quality of seasonal flowers. There are good collections of bougainvilleas, exotic bulbous plants, and various flowering trees, ensuring there are colourful flowers present throughout the year. There is also a collection of over 150 cultivars of rose. Other important features include greenhouses, pergolas and trees, especially cypress (*Cupressus*), which are clipped in the topiary style. The garden remains open for about a month for general visitors during winter, when the seasonal flowers are in full bloom.

Mughal Gardens of Kashmir

(Rana, 2017; Randhawa and Mukhopadhyay, 1986; UNESCO, 2017)
Three Mughal rulers are credited with the creation and development of the Mughal gardens in Kashmir: Emperor Akbar, who was the first Mughal ruler to visit Kashmir in 1588, Jahingir (Jehangir) and Queen Nur Jahan in the late 1500s, and Shah Jahan in 1633. Although the design didn't deviate drastically from the original form or concept of Mughal gardens, the greatest challenge in Kashmir was to maximise the potential of the site and the abundance of water. The sites tended to be

Figure 7. The Rashtrapathi Bhavan Gardens, New Delhi, India, are part of the official residence of the President of India.

at the foot of a mountain, particularly where there was a source of water such as a stream or spring. This feature eventually resulted in the typical terraced garden layout. Although the mountainous terrain offered challenges in developing the gardens, the Mughal engineering skills and aesthetics managed to excel in developing beautiful garden layouts. The gardens have a series of descending terraces, following the tradition of Mughal style, to facilitate the flow of water, which is another main characteristic of Mughal gardens. The gardens on the bank of the Dal Lake, Shalimar, Nishat Bagh and Chasma-e-Shahi, are well preserved and are those mostly frequented by visitors. Some other popular gardens are at Achabal, Verinag and Bijbehara.

Figure 8. A stone pavilion, located in Shalimar Garden, Srinagar, India, is surrounded by a reservoir containing 140 large fountains. It is a Mughal garden developed in 1619 (Copyright: Gritsana P/Shutterstock).

Shalimar Garden (Jammu and Kashmir)

(Rana, 2017; Randhawa and Mukhopadhyay, 1986; UNESCO, 2017; Villiers-Stuart, 1913)

Shalimar Garden is a Mughal garden located in Srinagar, Jammu and Kashmir. It is also known as Shalimar Bagh, Farah Baksh and Faiz Baksh. Jahangir started to develop the garden in 1619 and it was extended in 1630 by Zafar Khan, the Governor of Kashmir at the time, under the instructions of Emperor Shah Jahan. The word "Shalimar" in Sanskrit means abode of love. The garden is linked to Dal Lake through a canal of about 1.6 km in length and 11 m in width. The garden was laid out with trellised walkways lined by avenues of aspen trees. The garden covers an area of more than 12 ha. The garden has three terraces incorporating fountains and lined with chinar trees. The Shahnahar is the main feeder channel to all the terraces. On the first terrace was a baradari, the Diwan-e-Am, which is a pavilion with 12 doors designed to allow free flow of air. On the second terrace was the Diwan-e-Khas, which is commonly called the Hall of Public Audience. Unfortunately, only the stone bases of both these buildings are left today, surrounded by fountains. Along the centre of the garden are a series of water reservoirs inter-connected by a wide canal. The canals and the reservoirs are paved with polished limestone. The source of running water is a stream, which flows through these reservoirs and canals and sometimes through beautiful chutes of various design. A magnificent black stone pavilion, located on the third terrace, was meant for entertaining the ladies. The pavilion is surrounded by a reservoir containing 140 large fountains (Figure 8).

Nishat Bagh (Jammu and Kashmir)

(Randhawa and Mukhopadhyay, 1986; UNESCO, 2017)

The literary meaning of Nishat is "pleasure". This pleasure garden was built by a Persian, Asaf Jah, who was the brother of Nur Jahan, in 1633. Nishat Bagh is amongst the most prominent gardens that the Mughals developed in the Hindustan region (Figure 9). This garden is located along the bank of Dal Lake, with the lowest terrace directly connecting to the lake and with views from the terraces and pavilions to the lake. The garden stretches out over a rectangular area of approximately 47 ha. The garden has twelve terraces, each representing a sign of the Zodiac. The garden is well known for its beautifully designed flower beds and avenue of chenar trees.

Chasma-e-Shahi, Srinagar (Kashmir)

(Randhawa and Mukhopadhyay, 1986; UNESCO, 2017)

Chasma-e-Shahi was constructed by Ali Mardan Khan, the Governor of Kashmir, under the instructions of Emperor Shah Jahan in 1632. The garden is situated about 8 km away from Srinagar and is the smallest among the three gardens in the valley, being about 0.7 ha. The main feature of the garden is the spring that feeds the central aqueduct, water tanks, waterfalls, and fountains. The garden consists of three terraces, and there are two baradaris in the garden, both of recent origin, although the plinth was provided by the Mughal designer. The garden provides a panoramic view of the Dal Lake.

Verinag (Jammu and Kashmir)

(Archnet, 2017; UNESCO, 2017; Verinag, 2017; Villiers-Stuart, 1913)

This garden was constructed by Mirza Haider, an engineer of the Mughal Court, under the orders of the Mughal Emperor, Jahangir. The date of construction of the garden is unclear, but was somewhere between 1607 and 1620. The garden was enlarged further between 1626 and 1627, during Emperor Shah Jahan's reign and was renamed Shahabad.

The garden is 460 m by 110 m in size. The main attraction of this garden is the Verinag Spring, the water of which is exceedingly clear. The spring is enclosed within an octagonal pool and surrounded by a wide stone walkway. The garden is located on a slope, so the traditional charbagh garden of four symmetrical gardens had to be modified, with the water source at one end. The pool is connected to a very long central water channel (3.7 m wide and 305 m long) that discharges into the Jehlum River. The garden includes manicured lawns, flowering plants and trees, and is surrounded by densely forested hills.

Achabal (Kashmir)

(UNESCO, 2017)

Achabal Garden (or Achabal Bagh) is about 8 km from Anantnag, Kashmir, and is about 10 ha in size in the shape of a trapezoid. It was originally developed as an orchard garden surrounding a spring, even before the arrival of the Mughals, during the time of the Sultans of Kashmir in the 15th century. The current Mughal garden design was built by Empress Nur Jahan in 1620. The garden consists of four terraces, based on the charbagh theme. The main feature of the garden is a central canal, which has branch canals, and six vertical waterfalls. There are also several buildings, including a ruin of *hammam* (Turkish bath), platforms and baradaris. The garden has many plants, including different fruit trees and avenues of chenars.

Bijbehara gardens (Kashmir)

(Villiers-Stuart, 1913)

These gardens are also known by the name of their creator, Dara Shikoh (or Dara Shukoh), the eldest son of Shah Jahan, and were

Figure 9. The garden of Nishat Bagh, close to Srinagar, India, illustrates the Mughal garden design with a central canal and multiple terraces (Copyright: McKay Savage/Wikimedia Commons).

constructed in 1640. They are situated about 48 km from Srinagar and are over 17 ha in size. The gardens are designed in the typical Mughal style, and include a pool and water channel. They are divided into two parts, which are connected by a stone bridge, however, only the ruins of this remain today. A particular feature of this garden is the spectacular display of chinar trees; the girth of one of the trees measures about 16.2 m.

Conclusion

Gardening was an art and science in earlier days, and now it has emerged as a huge industry in India. The concept of landscaping and gardening is growing rapidly with the importance of improving and conserving the environment. Fortunately, the value in preserving these historical gardens has been recognized, so that the local people and tourists alike will be able to enjoy them into the future.

References

Archnet. (2017). Vernag gardens. https://archnet.org/sites/6340 (accessed May 2017).

Azmee, N., Yazid, M., Yunos, M., Mydin, A.O.M., Ismail, S., Ariffin, N.F.M., Isa, N.K.M., and Latiff, Z.A. (2016). Analyzing the features of Mughal garden design: case of Taj Mahal, Agra, India. Jurnal Teknologi *78* (*5*), 165–168.

Begley, W.E. (1979). The myth of the Taj Mahal and a new theory of its symbolic meaning. The Art Bulletin *61* (*1*), 7–37.

Karnataka State Tourism. (2017). Brindavan Gardens. http://horticulture.kar.nic.in/brindavan.htm (accessed May 2017).

Indian Government. (2017). The Mughal and other gardens: circuit 3. http://rashtrapatisachivalaya.gov.in/rbtour/circuit-3/mughal-gardens (accessed May 2017).

Lalbagh gardens. (2017). Lalbagh Botanical Gardens. http://www.horticulture.kar.nic.in/Design_final/lalbagh/index.html (accessed May 2017).

Nilgiris District Administration. (2017). Government Botanical Garden. https://web.archive.org/web/20110114053740/http://www.nilgiris.tn.gov.in/ooty.htm (accessed May 2017).

Rana, A. (2017). Ornamental Horticulture. Lecture notes for Veer Chandra Singh Garhwali (VCSG) College of Horticulture, Bharsar, India. http://k8449r.weebly.com/uploads/3/0/7/3/30731055/ornamental_horticulture___2_1.pdf (accessed May 2017).

Randhawa, G.S., and Mukhopadhyay, A. (1986). Floriculture in India (New Delhi, India: Allied Publishers Pvt Ltd).

UNESCO. (2017). Mughal gardens in Kashmir. http://whc.unesco.org/en/tentativelists/5580/ (accessed May 2017).

Verinag. (2017). Verinag Kashmir: Natural spring and garden. http://www.verinag.com/ (accessed May 2017).

Villiers-Stuart, C.M. (1913). Gardens of the great Mughals (London: Adam and Charles Black), http://dx.doi.org/10.5962/bhl.title.55753.

› N. Deepa Devi

About the author

N. Deepa Devi is a Post Doctoral Fellow (UGC - India) at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore-Tamil Nadu, India. E-mail: natesandeepa@gmail.com

The world
of Horticulture

IHC2018
XXX. INTERNATIONAL
HORTICULTURAL CONGRESS
12-16 AUGUST 2018
ISTANBUL / TURKEY
www.ihc2018.org

Banana: a very profitable tropical crop for Turkey

Hamide Gubbuk, Lokman Altınkaya and Recep Balkıç

Introduction

Banana growing areas of the world are situated mainly in tropical regions, between the equator and latitudes 20°N and 20°S. Climatic conditions in these areas are tropical, with relatively small temperature fluctuations from day to night and from summer to winter (Robinson, 1996). In addition, bananas are also grown in subtropical areas such as Western Australia, South Queensland, South Africa, Israel, Taiwan, Spain (The Canary Islands), Egypt, Morocco and parts of Brazil and Turkey (Galán Saúco et al., 2004), many of which are situated between the latitudes 20 and 30°N (Stover and Simmonds, 1987). Although the banana-growing areas in Turkey are located further north than the subtropical zone (36°N), bananas have been grown economically in Turkey for over a century. Turkey has seven geographical regions. The main crops for each region are different. Banana production is found only in the coastal Mediterranean region, where the northern areas are protected by the high altitude Taurus Mountains. Alanya and Gazipaşa, a district of Antalya province, and Anamur and Bozyazı, districts of Mersin province, are the most important banana growing locations in Turkey (Figure 1). In recent years, banana growing has expanded towards other towns in the coastal regions including Antalya (Kumluca, Finike and Manavgat districts), Mersin (Erdemli), Adana (Yumurtalık) and Hatay (İskenderun) provinces (Figure 1).

Banana growing areas and total production figures in Turkey have continued to increase over the past 10 years (Table 1) (TUIK, 2016). The total banana growing area in Turkey increased to 6,225 ha by 2016, with 305,926 t total production. In the last six years, the majority of the increase in banana production, in terms of both area and production quantity, was in protected cultivation: 252,077 t of bananas was produced from 4,078 ha of protected cultivation (Table 2). Turkish domestic banana consumption is over 521,000 t. As a result, Turkey imports nearly 217,000 t of bananas. Furthermore, banana consumption per capita has reached nearly 6 kg annum^{-1} and is expected to increase in the future.

Banana is considered a very profitable crop for farmers in Turkey. Local importers pay very high import taxes (over 140%) to bring bananas into the country. As a result, banana

Figure 1. Banana growing areas in Turkey (Antalya and Mersin are the major cities in this region).

Table 1. Changes in the growing area and total production of bananas in Turkey over the past 15 years.

Years	Production areas (ha)	Production (t)
1991	1,309	35,000
1995	1,150	31,000
2000	1,725	64,000
2005	3,600	150,000
2010	4,428	210,178
2015	5,838	270,500
2016	6,225	305,926

Table 2. Banana growing areas and production quantities in Turkey between 2011 and 2016 according to cultivation system.

Year	Production areas (ha)		Production (t)	
	Protected cultivation	Open-field	Protected cultivation	Open-field
2011	2,686	1,821	161,875	44,626
2012	2,679	1,813	161,511	46,216
2013	2,852	1,819	172,006	43,988
2014	2,976	2,373	180,081	71,913
2015	3,298	2,540	200,244	70,256
2016	4,078	2,146	252,077	53,849

Figure 2. General view of both open-field and protected cultivation of banana in Turkey.

Figure 3. General view of protected cultivation areas of banana in Mersin districts of Turkey (picture provided by Anamur-Mersin Food, Agriculture and Livestock Directorate Office).

Figure 4. General view of protected cultivation areas of banana in the Bozyazı district of Mersin, Turkey.

retail prices remain high, which makes local banana production a very profitable enterprise. Additional reasons for bananas being a highly desirable crop include: fruit can be harvested in the same year as planting, less labour costs than that of protected vegetable production, and stable pricing because of a lack of overproduction. If the expansion in banana production under protected cultivation continues as it is, Turkey will be self-sufficient and will be able to stop importing bananas for domestic consumption within five years.

Cultivation systems

As indicated above, banana growing areas in Turkey are located in the Mediterranean coastal strip. The northern borders of plantations are mountainous, which provides protection from wind and frost damage. Both open-field and protected cultivation (plastic greenhouse) are used for production (Figure 2). The Anamur and Bozyazı districts in Mersin province are the main protected cultivation areas for banana (Figure 3 and 4), whereas bananas are grown in both open-field and protected cultivation in the Alanya and Gazipasa districts of Antalya. Some of the banana plantations are established on steep-sloped areas and some of them are on flat land (Figures 5 and 6), which has enabled protected cultivation of banana to develop in the districts of Erdemli (Mersin), Finike and Kumluca (Antalya), İskenderun (Hatay) and Yumurtalık (Adana).

In Turkey, greenhouse structures are made of round galvanized poles, are 7.5-8 m high at the peak and 5-6 m high below the gutters, and are covered with plastic (Figure 7). Generally, greenhouses are not heated in any of the current growing locations. Currently, greenhouses cost approximately €12-16 m^{-2}, including the plastic cover and the irrigation system. However, banana plants bear fruit in the same year as planting and the production cost outlays are recovered within a few years.

Mean yearly minimum/maximum/average temperatures in open-field cultivation and under protected cultivation are 16/26/20°C and 15/33/23°C, respectively, in the Alanya district of Antalya. Yearly minimum/maximum/average relative humidity values in open-field cultivation and under protected cultivation are 47/82/66% and 54/88/75%, respectively (Gubbuk et al., in press). Temperature and relative humidity (minimum, maximum and average) over the year for both open-field and protected cultivation are shown in Figures 8 and 9. Shading powder is applied onto the plastic covers during the summer season to protect plants and fruit from sunburn damage under protected cultivation.

The main differences between the two cultivation systems are the number of days from shooting to harvest and the yield. While one crop per year is produced in open-field conditions, either one or two crops per year are obtained under protected cultivation. The number of days from shooting to harvest is shorter (between 90 and 120 days) in protected cultivation. Thus, bunches are harvested earlier in protected cultivation than in open-field cultivation (Figures 10 and 11). The shorter interval is a great advantage in subtropical regions, especially if there is a risk of frost damage. After mid-November, the temperature begins to drop in the cooler subtropical climate. Frost damage can be seen from time to time in open-field plantations, however, it is rarely seen under protected cultivation. Average yield is between 25-30 t ha^{-1} in open-field and 50-70 t ha^{-1} under protected cultivation. Therefore, income is doubled using protected cultivation. Gubbuk and Pekmezci (2004) compared yield and quality of 'Dwarf Cavendish' banana (*Musa* spp. AAA), cultivated in open fields and in protected (plastic greenhouse) cultivation. Protected cultivation was found to be better than open-field cultivation in terms of total production, expressed as the number of hands and fingers per bunch and bunch weight (Figures 12 and 13). Average annual yield in plastic greenhouses was 53% higher than in the open field (65.5 t ha^{-1} compared with 42.8 t ha^{-1}). Gubbuk et al. (in press) also found that some of the yield and fruit quality components were superior in the greenhouse production system compared to those observed in the open-field production system, and no wind damage was observed in protected cultivation. Average bunch weight obtained was 40 kg in greenhouse-produced bananas versus 27 kg in bananas produced under open-field conditions.

There are many advantages in protected cultivation compared with open-field cultivation in subtropical conditions, including: (a) reduction of time from planting to harvest; (b) reduction in water consumption; (c) extended duration of temperatures above 20°C; (d) higher rate of photosynthesis; (e) protection against wind and other harsh weather conditions (e.g. sunburn and hail); and (f) increased bunch and finger weight (Galán Saúco et al., 1998). No heating systems are used in protected cultivation in Turkey. Therefore, significant temperature fluctuations between day and night in winter can sometimes affect plants negatively in a similar way to that observed in open-field production. The main constraints of banana growing in Turkey, as in other cooler subtropics, are high diurnal temperature fluctuations, low night temperatures, insufficient rainfall and wind damage. Furthermore, win-

Figure 5. General view of banana plantations on sloping areas along the Mediterranean coast, Turkey.

Figure 6. General view of banana plantation on flat areas along the Mediterranean coast, Turkey.

Figure 7. General view of banana greenhouses, Turkey.

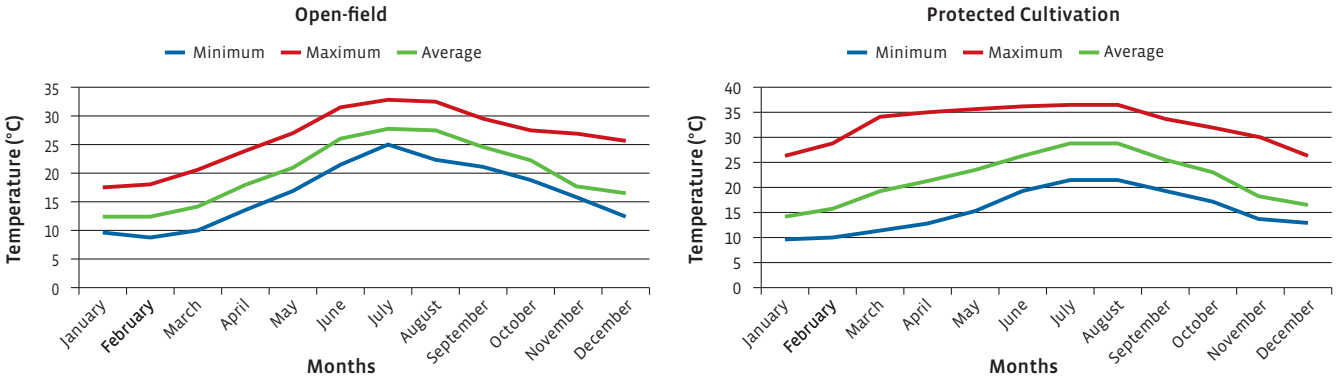


Figure 8. Temperatures (minimum, maximum and average) averaged for each month for both open-field and protected cultivation of banana in the Alanya district of Antalya, Turkey.

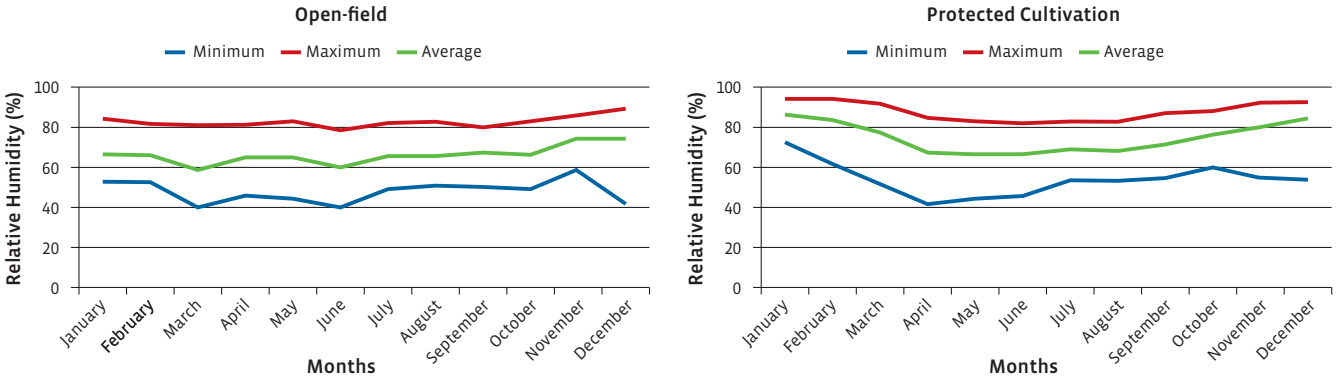


Figure 9. Relative humidity (minimum, maximum and average) averaged for each month for both open-field and protected cultivation of banana in the Alanya district of Antalya, Turkey.

ter leaf sunburn, under-peel discoloration and growth cessations are typical physiological problems associated with banana production in the subtropics (Robinson, 1996).

Cultivars

'Dwarf Cavendish' is the most common cultivar for open-field, and 'Grande Nain' and 'Azman' (local cultivars) are the most widely planted cultivars for greenhouse conditions. An evaluation of 'Cavendish' cultivars under open-field and protected cultivation was undertaken. The cultivars 'Grand Nain', 'Petit Nain', 'Poyo', 'Williams', 'Basrai' and 'Dwarf Cavendish' were compared under open-field and greenhouse conditions in terms of yield and quality characteristics (Gubbuk et al., 2004). Cultivars 'Williams' and 'Grand Nain' were superior to 'Dwarf Cavendish' in greenhouse cultivation, while these two cultivars and 'Petit Nain' and 'Basrai' were superior to 'Dwarf Cavendish' in open-field cultivation. 'Poyo' was not suitable for greenhouse cultivation because of its excessive height nor for open-field cultivation because of its sensitivity to wind damage. Greenhouse cultivation of bananas was superior to open-field cultivation for all cultivars, with yield increases of 19 to 28% according to the cultivar. Güven and Gübbük (2014) evaluated agronomic performance of four new banana cultivars ('Williams', 'MA 13', 'Jobo' and 'CV 902') under plastic greenhouses. Cultivar 'Dwarf Cavendish' was used as a control. The results showed that all tested cultivars were superior to 'Dwarf Cavendish' under an unheated plastic greenhouse.

Cultural practices

Plants are planted in March for open-field cultivation. However, there are two planting times for protected cultivation, early spring (February-March) and fall (September). The first ratoon crop (crop from the suckers) is not very productive under open-field conditions while this is not the case for protected cultivation. While suckers are used for open-field cultivation, virus-free tissue culture plants are mainly used for protected cultivation. Plant spacing is 2.5×2 m (2000 plants ha^{-1}) in open-field conditions, and 3×1.8 m (1850 plants ha^{-1}) in protected cultivation (Gubbuk and Pekmezci, 2004). Single row planting is preferred over double rows. However, after the second ratoon crop, plant density is increased to 2100 or 2200 plants ha^{-1} in both cultivation systems. The important soil properties are: pH 7.6, 8.3% lime content, loamy texture and less than 3% organic matter (Gubbuk et al., in press). Organic manure (goat manure) is applied at about 20 to 40 kg $annum^{-1}$ $plant^{-1}$. Fertilizers are applied either by hand around the plant or via irrigation. The main fertilizers are NPK, which are applied at the rate of 250-270, 400, and 1000 g $plant^{-1}$ $cycle^{-1}$, respectively. A drip irrigation system is used in both cultivation systems. An extra fine droplet sprinkler irrigation system (like fogging) is mounted in greenhouses to increase air humidity. There are no bacterial or viral issues as found in the tropics. While the most common pest is nematode, spider mite (*Tetranychus lambi*) can also affect bananas grown in protected cultivation.

Storage and ripening

Harvest time for open-field and protected cultivation is different. The harvesting period for open-field production is from November to March, while it is October to January in

Figure 10. General view of banana plants grown in open-field conditions in Turkey.

Figure 11. General view of banana plants grown in protected cultivation in Turkey.

protected cultivation. However, some farmers are able to produce year-round in protected cultivation, as is done in the tropics. The number of days between shooting to harvesting time varies according to shooting time, and is between 90 and 120 days in protected cultivation and between 140 and 160 days in open-field cultivation. There is generally no need for storage of harvested bananas in Turkey. They are treated with ethylene and marketed within 3-4 days of harvest. Almost all bananas produced in Turkey are consumed in the domestic market. Interestingly, all banana imports occur during the peak harvesting season (winter) of domestic production. Importation decreases in the spring and summer seasons because of an increase in the range and quantity of alternative fruit choices.

Marketing

Farmers sell bananas through formal wholesale produce markets, there being at least one for each town, or through banana maturation facilities located in production regions. As in other parts of the world, wholesalers market bananas to retailers on behalf of the farmers, whereas banana maturation facilities buy from farmers and sell to retailers. Retailing bananas to consumers is generally through fresh produce markets, market places, greengrocers or mobile retailers (less common). Pricing is commonly affected by the following guidelines: the influence of farmer associations and banana maturation facilities, the volume of bananas imported, the availability of bananas in the market and consumer demand at any given time. However, the most influential driver is the quantity of bananas available in the market for consumers. For example, the highest volume of bananas in the market is found in the winter months when prices are the lowest, whereas prices increase after the month of March when domestic production declines. Typical wholesale prices in winter are €0.60-0.80 kg^{-1}, while it is above €1.00 in spring months. Similarly, retail prices are around €1.00 in winter and €1.50-2.00 in spring months. While the price of bananas produced in protected cultivation is higher compared to the price of open-field produced bananas, prices of exported bananas are also higher than domestic prices. The rules for importing bananas into other countries are very strict, though, and the export market from Turkey is almost non-existent. Bananas are marketed at a stage earlier than eating maturity stage.

Farmer incentives

Governmental support, e.g. as subsidies and incentives, are available for growers. These may include:

- Money support for planting material;
- 50% subsidy for pressurized irrigation systems (drip, sprinkler);
- Subsidy for fertilizer;
- Subsidy for gasoline;
- Incentive for biological pest control (€1,220 ha^{-1});
- Money support for agricultural advisory service through agricultural chambers and farmer cooperations;
- Support for Good Agricultural Practices (GAP) applications;
- 50% subsidy for insurance;
- €7500 grant for young (18-40 years old) entrepreneurs;
- 50% cost support for cold storage and/or packing houses established within rural development programs;
- 50% cost support for greenhouse and/or solar energy system establishment;
- Loan and/or interest support for greenhouse establishment and/or modernization.

Ongoing and future studies

There are studies already completed on selection breeding and in vitro propagation of selected types, supported by the Turkish Scientific and Technological Research Council – TUBITAK. There have also been studies conducted on irrigation, yield and quality comparison of bananas produced in greenhouses. Other completed studies include: effects of production systems on biochemical parameters of fruits, taste and aroma components, and research on cultural practices, fruit storage and maturity conditions. In addition to these, there are completed graduate studies on cultivar adaptations and effects of cover types on quality parameters. Currently, there are ongoing studies on banana residue management, irrigation management and water use efficiency, improvement of cultural practices and GAP practices.

Problems

As in other subtropical regions, low temperatures are the primary problem of banana production in Turkey. Also, strong winds and hail can create big problems for plants in both open fields and protected plantations. There are problems with cultivation practices, determination of harvest time and postharvest practices, however, solutions are being developed. Fortunately, there are no devastating diseases as found in tropical conditions.

Conclusion

Although its production area stretches far beyond the tropical and subtropical banana

production zones of the world, banana is the only tropical species produced on a commercial scale in open-field and protected conditions in Turkey. Popularity of banana production in Turkey is the result of: fruiting in the same year as planting, lower labour costs compared with many other alternative species, low pest and disease pressure, governmental incentives for banana farmers, no over-production pressure and ease of marketing with stable pricing. Currently, banana production in Turkey does not meet the domestic demand. However, if the increase in protected cultivation continues at its current pace, it is highly likely that within a few years production will be sufficient to meet this demand. In conclusion, banana production remains quite a profitable agricultural activity for farmers, as well as providing agricultural employment in Turkey.

Figure 12. Banana bunch from open-field grown plant in Turkey.

Figure 13. Banana bunch from greenhouse grown plant in Turkey.

References

Galán Saúco, V., Ait-Oubahou, A., and Abdelhaq, H. (2004). Greenhouse cultivation of bananas. Chronica Hortic. *44* (*2*), 35–37.

Galán Saúco, V., Cabrera Cabrera, J., Hernández Delgado, P.M., and Rodríguez Pastor, M.C. (1998). Comparison of protected and open-air cultivation of Grande Naine and Dwarf Cavendish bananas. Acta Hortic. *490*, 247–259. https://doi.org/10.17660/ActaHortic.1998.490.25.

Gubbuk, H., and Pekmezci, M. (2004). Comparison of open-field and protected cultivation of banana (*Musa* spp. AAA) in the coastal area of Turkey. New Zealand Journal of Crop and Horticultural Science *32*, 375–378.

Gubbuk, H., Pekmezci, M., and Erkan, M. (2004). Production potential of Cavendish cultivars (*Musa* spp. AAA) under greenhouse and field conditions in subtropical areas of Turkey. Acta Agriculturae Scandinavica, Section B - Plant Soil Science *54* (*4*), 249–253.

Gubbuk, H., Gunes, E., and Guven, D. Comparison of open-field and protected banana cultivation for some morphological and yield features under subtropical conditions. Acta Hortic. (in press).

Güven, D., and Gübbük, H. (2014). Agronomic performance of several Cavendish cultivars (*Musa* spp. AAA) under plastic greenhouse. Lucrari Ştiintifice, Seria Horticultura *57* (*1*), 111–116.

Robinson, J.C. (1996). Bananas and Plantains (Wallingford: CAB International), pp.238.

Stover, R.H., and Simmonds, N.W. (1987). Bananas, 3rd edn (UK: Longman Group Ltd), pp.468.

TUIK. (2016). https://www.tuik.org

› Hamide Gubbuk

› Lokman Altınkaya

› Recep Balkıç

About the authors

Dr. Hamide Gubbuk received her PhD from the Horticultural Sciences Department at the University of Akdeniz, Turkey, in 1999. She is currently full time Professor of the Department of Horticulture at the University of Akdeniz, Antalya, Turkey. She is engaged in teaching tropical and subtropical fruit growing and breeding courses, conducting research, and supervising MSc and PhD students in these areas. Dr. Gubbuk conducts research on tropical and subtropical fruit production, mainly on banana, carob, papaya, avocados, pitaya and passiflora cultivation. She has published more than 100 research papers in these areas. She was one of the conveners of the International Symposium on Banana at the 28th International Horticultural Congress in Lisbon in 2010. She is one of the conveners of the International Symposium on Banana and the International Symposium on Carob at the 30th International Horticultural Congress, to be held in Istanbul in 2018. She is a member of the International Society for Horticultural Science (ISHS). E-mail: gubbuk@akdeniz.edu.tr

Lokman Altınkaya has been working in consultation with Prof. Dr. Hamide Gubbuk in the Faculty of Agricultural and Department of Horticulture, Akdeniz University, since 2013. His specialty is tropical fruits. He was also an assistant researcher for other research projects such as “Investigations on Propagation and Seedling Growing of Passiflora (*Passiflora edulis* Sims.)” and “Net Cover System Under Banana Cultivation Facilities” in 2015-2016. E-mail: lokmanaltinkaya@hotmail.com

Recep Balkıç is an agriculture engineer (MSc). He has been working in consultation with Prof. Dr. Hamide Gubbuk in the Faculty of Agricultural and Department of Horticulture, Akdeniz University, since 2011. He is currently a PhD student. His specialty is tropical and subtropical fruits. E-mail: recepbalkic@hotmail.com

› The olive: uses and benefits of its oil, fruit and leaves

Vera Sergeeva

› Harvesting machines moving through the olive plantations of Cobram Estate, Boundary Bend in the Murray Valley, Australia (photo credit: Cobram Estate).

› Olive plantations of Cobram Estate, Victoria, Australia, cover over 6500 ha (photo credit: Cobram Estate).

Olive trees (*Olea europaea* L.) are among the oldest historically important fruit trees. References to olives within the western civilized world date back to Biblical and Roman times and to Greek mythology. Extra virgin olive oil proved itself indispensable in the ancient world, and was called "liquid gold" by Homer and "the great healer" by Hippocrates, placing olive oil at the top of the food and medicine list (Clodoveo et al., 2014). Kings were anointed with olive oil as a sign that they were chosen by God to rule (1 Samuel 16:1). Olive oil was considered by the Egyptian and Minoan civilizations to be of vital importance, and it was sometimes used as a form of currency (Arte Legno, 2016). The oil, fruit, and leaves of the olive tree have an ancient history of nutritional, medicinal, and traditional uses. Olives and olive leaves are the first botanicals prominently noted in the Bible, in Ezekiel 47:12, "The fruit thereof shall be for meat, and the leaf thereof for medicine" – thus its nickname, "Tree of Life." The Spartans rubbed olive oil on their bodies as a moisturizer and to emphasize their physique, while Greek athletes received olive-oil massages. Early Roman emperors gave olive oil as gifts during celebrations. The Romans developed the screw press to extract the oil, a technology that is still used today. In the Eastern world, the first Japanese known to have eaten olive fruits was Toyotomi Hideyoshi, an Imperial Regent of Japan. He received a barrel of salted olives from Spanish King Felipe II in 1594. In the early 1860s, the shogun's physician, Hayashi Doukai, who studied Dutch medicine in Nagasaki, developed the first trial orchard in Japan to produce olive oil for medical use (Takeuchi and Shibata, 2012).

Olive tree culture was an important agricultural activity and a symbol of wealth and security in ancient civilizations (Rick, 2016). "The olive tree is surely the richest gift of heaven" said Thomas Jefferson (Firenze, 2011).

History of olive cultivation and use

The use of olives has been recorded on ancient tablets and in ancient documents, and signs of olives have been found during archeological digs and within tombs (International Olive Council, 2016; The Big Olive, 2016; Vossen, 2007). These have provided evidence of the history of the use of olives and the spread of olive cultivation to different locations.

Taking the area that extends from the southern Caucasus to the Iranian plateau and the Mediterranean coasts of Syria and Palestine (Acerbo) to be the original home of the olive tree, its cultivation developed considerably in these last two regions, spreading from there to Cyprus and from Crete towards Egypt.

8,000 -6,000 BC. Olive was first domesticated in the eastern Mediterranean region.

6,000-3,000 BC. Olives were being grown and used in southern Turkey, Syria, Israel, Lebanon, Cyprus, Greece and North Africa.

2,000 BC. The value of olive oil was five times that of wine. Oil was used for food, lamp fuel and for anointing people in the temples.

1,700 BC. The olive tree was introduced to Egypt around this time. Tutankhamen wore a garland of olive branches.

1,500 BC. Olive oil became a major commodity in the trade of Crete. Many artifacts, such as milling stones, storage vessels and frescos showing the use of olives were found in Greece, Egypt and western Turkey archeological sites.
1,000 BC. Olive tree cultivation moved westward over this period, including to Italy, France, Spain, Portugal, Morocco, Algeria and Tunisia. The expansion of the Roman Empire contributed to the spread of olive cultivation and olive oil production across the Mediterranean region.
400 BC. The Greeks, Spanish and Portuguese were major exporters of olive oil to other Mediterranean countries including Italy, France, England and Germany.
100 AD. The Romans were expert at producing processed olives and many different types of olive oil.
325 AD. Constantine the Great established the Byzantine Empire, and the many uses of olive oil continued to increase.
400-1000 AD. Olive tree plantings increased significantly during the Middle Ages, particularly in Spain, Italy and Greece, to supply the growing urban populations, and its economic importance continued.
1503-1600 AD. Spanish explorers brought olives to South America. Olive trees were grown in Chile, Peru, Argentina and Mexico.
1800-1900 AD. Olives were planted in Australia, New Zealand, California and Japan. The development of low-cost extraction of oil from seeds, and the development of other sources of oil, caused a drop in demand for olive oil. This resulted in a glut in the world market, and a focus on higher production rather than quality.
1946-1947. Olive plantations were established in Azerbaijan.
1958. The International Olive Oil Council was established in Madrid, Spain, under the auspices of the United Nations, to create standards for the different types of olive oil so that fraud could be reduced.
1978-1987. The FAO played a significant role in sponsoring an olive development project in China.
1990s. There was a major increase in interest and investment in olives as an industry by new (World) producers, such as those in Australia, New Zealand, United States, South Africa, Argentina, Brazil, Chile, Uruguay, Peru, and Japan.
1995-1996. The potential for using olive leaves for medicinal purposes began to be explored by a chemist, William Fredrickson. He patented his extraction technique in 2000.
2006. The International Olive Oil Council changed its name to the International Olive Council (IOC), to encompass sustainable growing of olive trees for all forms of use.
2007. Olive plantations were established in India.
2010. UNESCO recognized the Mediterranean diet as an Intangible Cultural Heritage of Humanity, in which extra virgin olive oil has a key role.

› Bulk storage of table olives going through the curing process, at Treetops Plantation, New South Wales, Australia.

2016. The IOC celebrated the olive tree, the "universal symbol of peace and harmony", which is now growing on five continents and contributes to sustainable economic and social development.

World olive production

In 2014, olive trees were cultivated on approximately 10 million ha across the world. Between 2014 and 2016, the land occupied by olive trees increased by 10%, to 11 million ha, of which more than 8 million ha were not irrigated. During the 25 years between the 1990/91 and 2015/16 seasons, world consumption of table olives increased 2.8 times. In 2015/16, the world's top ten consumer countries were Egypt, Turkey, Algeria, the United States, Spain, Syria, Italy, Brazil, Iran, France and Russia (International Olive Council, 2016). Spain is the world's leading producer and exporter of olive oil and table olives.
In 2014, the ten largest producing countries were located in the Mediterranean region and produced around 15 million t of olives, representing around 98% of the world's crop (Figure 1) (FAO, 2016). The best olive growing climate lies between latitudes 30 and 45° north and south of the equator, including the Mediterranean region. Olives also grow well in California, Central Chile, Western Cape of South Africa, and in Western and Southern Australia. The top ten virgin olive oil exporters include not only Mediterranean basin countries, but also Argentina, Chile and the United States, while the top ten preserved olive exporters include similar Mediterranean basin countries, but also Argentina, Peru and Belgium (Figure 2). Some countries that export olive products do not grow the fruit, but manufacture products after importation of raw materials, e.g. Belgium.
Australia is an exporter and also an importer of both olive oil and processed olives. Olive trees have been grown in Australia since European settlement. There has been a renaissance in the Australian olive industry since the early 1900s, primarily due to the increased popularity of Mediterranean cuisine and the opportunity to replace imported olive products (Sergeeva, 2012). Australia is one of the smaller olive producing countries, although it is in the top 20 for cultivated area, production quantity, and virgin olive oil exported (Figures 1 and 2). The current area planted covers more than 43,000 ha (FAO, 2016), extending over more than 2000 plantations (Ravetti and Edwards, 2014). Compared with Aus-

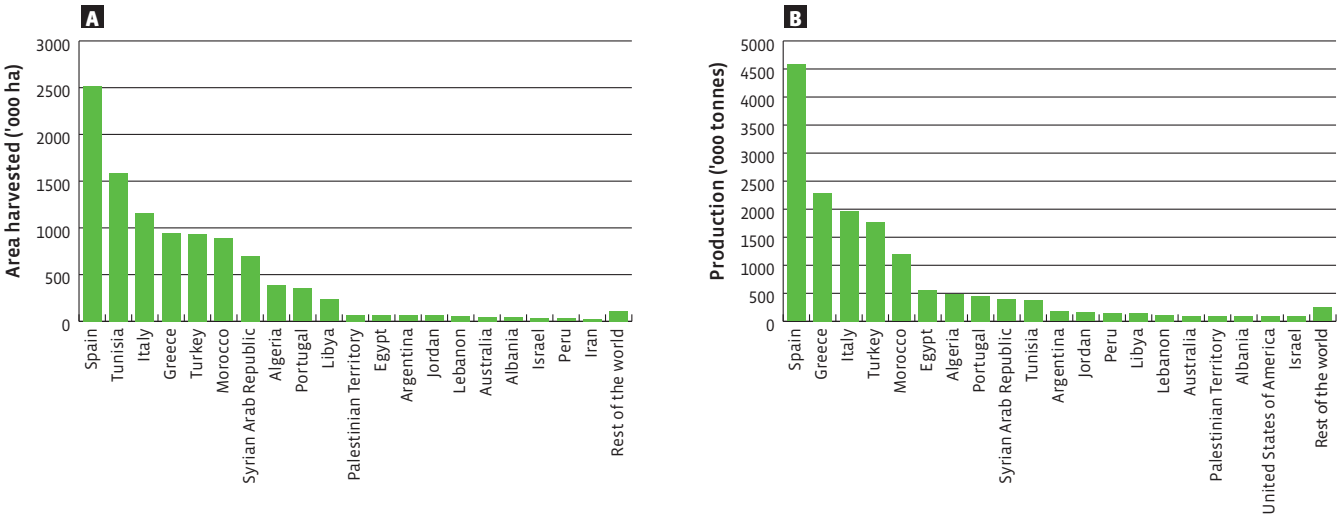


Figure 1. The top twenty countries in 2014 for A) the area of olive trees grown and B) the production of olives harvested (FAO, 2016).

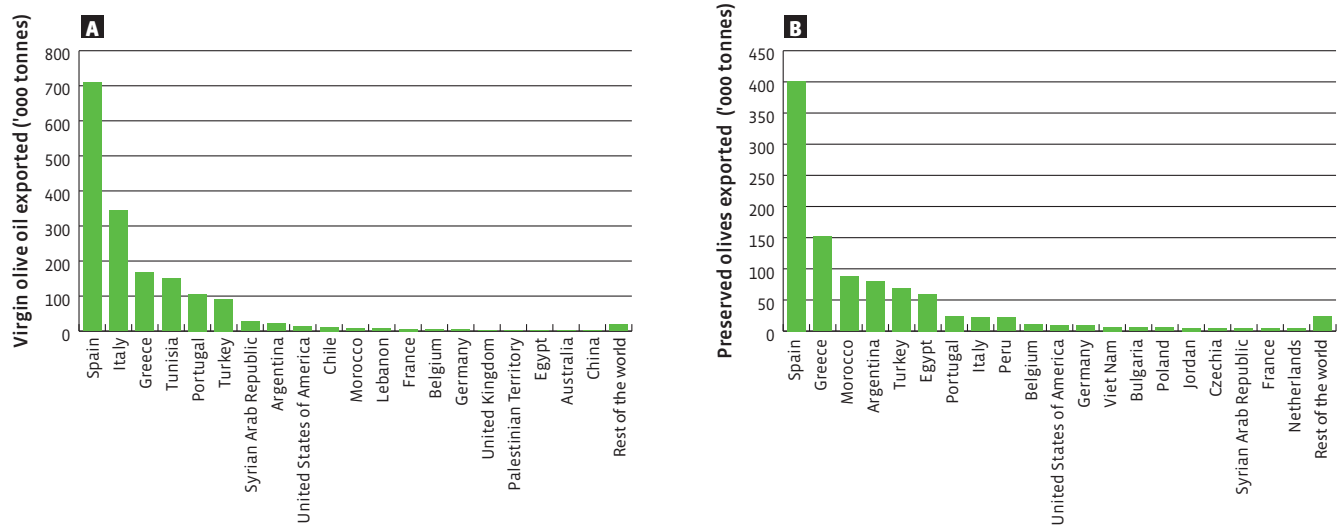


Figure 2. The top twenty countries in 2013 from which A) the quantity of virgin olive was exported and B) the quantity of preserved olives was exported (FAO, 2016).

tralia's 20,000 t production, Spain produces approximately 1.1 million t of olive oil per annum (225,000 t exported), Italy 623,000 t (208,000 t exported) and Greece 261,000 t (10,000 t exported). Total world production is approximately 3 million t (International Olive Council, 2016).

According to the Australian Olive Association (AOA), between April 2015 and March 2016, Australia exported 6,686 t of olive products to Spain, Italy, China, New Zealand and the United States (AOA, 2017). Victoria was the leading export state, accounting for 74% of export volume. Olive exports from Western Australia lifted from 30 t in July-March 2015 to 565 t in July-March 2016. Western Australia now accounts for 11% of national exports by volume. There are more than 100 known cultivars of olives in Australia, both classic Mediterranean cultivars and recent hybrids. Italy is one of the richest countries in terms of olive cultivars, with more than 600 cultivars, including 'Frantoio', 'Leccino', 'Pendolino', 'Carolea', 'Coratina' and 'Moraiolo'. Major Spanish cultivars include 'Picual', 'Alberquina', 'Hojiblanca', 'Cornicabra', 'Manzanilla de Sevilla' and 'Manzanilla de Jaén'. In Greece, cultivars include 'Kalamata', 'Koroneiki' and 'Consevolia'; in Tunisia, 'Chetoui', 'Meski' and 'Chemlali Sfax'; in France, 'Picholine'; in California, 'Mission'; and in Portugal, 'Galega'.

Olive oil

Olive oil has long been used in Mediterranean cuisine but it has become globally popular in recent years because consumers have become more aware of its health benefits (Alemán et al., 2016; Sofi et al., 2014). The health benefits of olive oil are extensive, with new positive attributes continuing to be discovered. Extra virgin olive oil is traditionally used in the Mediterranean cuisine, a diet that promotes good health and longevity. Olives and olive oil are good sources of monounsaturated fat. Extra virgin olive oil has more than 70% monounsaturated fat, the highest percentage of any edible oil. It contains high concentrations of antioxidants, anti-inflammatory substances, and fat-soluble vitamins, E, A, D, and K. Research has shown that the compounds found in extra virgin olive oil have positive effects in preventing many diseases, such as cancer, diabetes, atherosclerosis, heart disease, oxidative stress, blood pressure, obesity, rheumatoid arthritis, osteoporosis, and Alzheimer's (Covas et al., 2006; Alonso et al., 2006; Martínez-González et al., 2008; Salas-Salvadó et al., 2011).

Extra virgin and virgin olive oils have aroma and flavor characteristics that vary depending on the country of origin, soil conditions, rainfall, climate, cultivar, ripeness, and processing methods (Vossen, 2007). For example, oil from the Catalan cultivar 'Arbequina' is typically very aromatic with a fresh, herbal olive flavor, and a very light pungency and bitterness. In contrast, 'Frantoio' grown in Tuscany, is harvested fairly green and has a strong aromatic, grassy and fruity flavor with a strong pungency, whereas in Umbria the olives tend to be harvested a bit later and 'Frantoio' is blended with olives from other cultivars, resulting in an oil that has a riper fruitiness flavour, medium bitterness

› A “sea” of olive plantations in Andalucia, Spain.

and medium pungency. The color of extra virgin olive oil varies from light gold to rich green but it is not an indication of quality. Perhaps the most important factor determining the color of olive oil is the time of harvesting of the olives, which affects the amount of chlorophyll and carotenoids present in the fruit. Olive oil, especially extra virgin, contains tyrosol phenolic compounds such as oleuropein and oleocanthal. These compounds are responsible for its bitter and pungent taste and are antioxidants.

Olive oil is produced by the pressing or crushing of olive fruit. For high quality olive oil to be produced, the olives must have unbroken skin. The process to produce oil must be started within 24 h of harvest. First, olives are washed and the leaves are removed. Then the olives are crushed using a mill, which was traditionally made of stone. More modern methods use a hammer mill made of steel. This lyses the cells of the olive fruit and releases the oil. The next step is called malaxation, which involves mixing the olive slurry into a paste to prepare for separation of the oil. The paste is stirred for 30 to 60 min at a temperature between 26.6 and 30°C. Preferably oxygen is not present. Finally, the oil is extracted from the solids and the fruit-water. Traditionally, this is done using a press, however, it can also be performed using a selective filtration process or by using a vertical centrifuge. After processing, the oil is left to settle at 7 to 18°C for up to 3 months to allow for any further separation before bottling.

The trade standards for different types of olive oil have been defined by the International Olive Council (2016). The main differences between the different oil classifications are the acidity percentages and the production methods. The details are as follows.

The acidity concentrations for the different classifications are: extra virgin olive oil 0.8% (0.8 g 100 g^{-1}), virgin olive oil 2%, and ordinary virgin olive oil, which is virgin olive oil that has no more than 3.3% acidity.

Extra virgin is the highest quality and most expensive olive oil classification. It should have no defects and a flavor of fresh olives. Extra virgin olive oil is made using a process called “first cold-pressed.” The word “first” refers to the olives being pressed on the first round of extraction. “Cold” refers to the olives being kept at a temperature no higher than 27.7°C, and “pressed” refers to the method of extraction. This method indicates that no heat or chemical additives were used to extract the oil from the olives, which can alter and destroy the flavors and aromas of the olive oil. Without adding heat to the processing, the olive oil also retains its full nutritional value.

Virgin olive oil production involves producing oils from the olive fruit by physical means under conditions that do not lead to alterations within the oil. Virgin olive oil is produced from the first and second pressings of the olive fruit by the cold-pressing method (where no chemicals and only a small amount of heat are applied).

Table olives

The most common cultivars of processed olives are ‘Kalamata’, ‘Manzanillo’, ‘Mission’, ‘Green Spanish Queen’, ‘Jumbo Green Kalamata’, and ‘Leccino’. Green olives, which are picked before they mature completely, tend to be higher in polyphenols. Black olives, which are allowed to mature on the tree, generally have higher oil content and lower concentrations of bitter compounds than green olives. All table olives are a good source of iron, copper, and vitamin E.

Raw olives are hard and very bitter when eaten straight off the tree as they contain very high quantities of oleuropein. They are not usually eaten fresh, but are fermented or cured with lye, brine or packed in salt to remove the oleuropein. However, there are a few cultivars that don’t need processing and can be consumed when fully ripe. The method of “curing” the olives affects the flavour and texture of the finished product.

Methods of curing table olives

Olives are harvested at different stages of ripeness: green-ripe, turning color, and naturally black ripe. The most common curing processes use brine, water, lye treatments or dry salt. During these curing processes, the water-soluble compound, oleuropein, is leached out of the olive flesh.

Water curing. To prepare olives for water curing, each olive is first individually cut or cracked, so that the bitter oleuropein can more easily leach out. Water cured olives are soaked in fresh water (i.e. no salt added) for a month. The water is changed daily. Water curing doesn't change the taste of the olive as much as other methods such as brining, but the olives won't store for as long afterwards. Water-cured olives typically remain slightly bitter because water-curing removes less oleuropein from the olives than other curing methods. After curing, the olives are placed in a brine, which is a vinegar-salt solution, containing garlic and herbs that add the characteristic flavors.

Brine-curing. Olives can be cured by placing them directly into brine (a concentrated salt solution) where they undergo a natural fermentation. As the olives ferment, they create lactic acid, which results in a typical sour taste. The olives end up with shiny, smooth surfaces. The brining not only removes bitterness but seasons the olives as well. The process takes at least three months and may take six months, depending on the cultivar and maturity, as well as the temperature, salt concentration, and acidity (pH level) of the brine. Green-ripe olives take longer to cure in brine than naturally black ripe olives.

Lye-curing. "Artificial ripening" is applied to green and semi-ripe olives. Olives are soaked in lye from 2 to 3.5% sodium hydroxide solution, depending on the ripeness of the olives, cultivar, temperature and water quality. The fermentation process produces lactic acid, which lowers the acidity of the brine and therefore stabilizes the product. The olives remain in this solution until the lye has penetrated two thirds of the way through the flesh. The lye is then replaced by water, which removes any remaining residue and the process is repeated. Once olives are fermented, fully oxidised or "become black", they are placed in fresh brine and packed in bottles. Green olives are processed in two principal ways: with fermentation (Spanish type) and without fermentation (Picholine or American type).

Dry-salt curing. Dry-salt cured olives are prepared from fully ripe, mature fruit that are dark red to black. Once picked, the olives are washed thoroughly and packed in alternating layers with salt. The olives are cured in layers of salt for up to four to six weeks. The high concentrations of salt remove the moisture from the olives, dehydrating and shrivelling them. Once cured, they are sold without adding any preservatives. Dry-salt cured olives can be stored for up to six months in a refrigerator, or they can be frozen for longer storage.

› Four popular olive cultivars: A. 'Barnea', B. 'Manzanillo', C. 'Koroneiki', D. 'Nevadillo Blanco'.

Oil curing. Salt-cured ripe olives are plunged briefly into boiling water to remove the salt, then dried and stored in olive oil. The oil is sometimes flavored with spices and herbs, which add other layers of flavor. These olives come out salty and are chewier and meatier than other olives. Dry-cured olives retain more of their bitterness than brine cured olives. Though these olives still have a telltale prune-like exterior that comes from salt-curing, the oil rehydrates them, making them slightly plumper and meatier.

Smoked

To get the olives ready for the smoker, the brine is drained, then the olives are placed in a disposable pan. The smoker is set at 95-105°C, and the olives are smoked for 1-2 h. The longer they are smoked, the more pronounced the smoky flavor will be. A small quantity of virgin olive oil, infused with rosemary and basil or other herbs, is poured onto the olives. Poached sliced garlic cloves are often added to the pan and all the ingredients are tossed together.

Olive wood

Olive wood has a dense grain giving a long burning time and creating a smokey flavour, which is light and aromatic but punchy enough for red meats without overpowering fish and poultry. Since ancient Greek times, grill masters in the Mediterranean have used the fragrant wood of the olive tree for grilling lamb, pork, poultry and seafood.

Difference between olive oil, olives, and leaves

Olive oil, fruit and leaves have been used as medicine throughout recorded history. The olive tree produces oleuropein abundantly in its leaves as well as in the olive fruit itself, and special processing techniques now allow for the extraction of a stable, standardized form of oleuropein from leaves.

There are several significant differences between the nutritional composition of olive oil and whole olives. Olive oil is 100% fat, while whole olives are only about 20% fat. A tablespoon of olive oil contains 120 calories, while olive fruit (about 10 medium) have only 40 calories. Olives, which have to be cured or pickled to be edible, usually contain a lot of sodium, while olive oil is sodium-free. The curing process removes a lot of the polyphenols in olives, whereas these are largely preserved in extra virgin olive oil. Polyphenols, such as oleuropein, are phytonutrients, which play an important role in maintaining human health and wellness. The concentration of phenols in extra virgin olive oil varies from 50 to 800 mg kg^{-1}. The phenol concentration in olive oil depends on cultivar, climate, region, latitude, and ripeness of the olive.

Olive fruit provide some fiber, whereas olive oil does not. Some olives are processed with natural fermentation, meaning that they would be a source of beneficial bacteria, but olive oil is not. Unfortunately, the different processing methods of olives have, as their main goal, to reduce the very bitter oleuropein. The final flavour of the olive depends on the cultivar, fermentation, processing solution and the final soaking solution (that is, salt, vinegar, marinades, herbs and spices).

Oleuropein content correlates well with the pungency of oil and fruit-based olive products, although leaf extracts tend to be quantitatively standardized for oleuropein and have more powerful antioxidant activity.

Olive leaves are available throughout the year. Olive leaves can be ingested in the human diet as an extract – liquid concentrate, herbal tea (fresh or dried leaf), powder, or in capsules. Olive leaf products can also be used as an ingredient in some food dishes. Olive leaf powder can be added in smoothies, pastas, pancake, salad, ice-cream and other products.

› Olive oil and table olives are an important part of the healthy Mediterranean diet.

Health benefits of olive oil and olive leaves

The three most powerful phytochemicals in olive oil and olive leaf are oleuropein, oleocanthal, and hydroxytyrosol (Bulotta et al., 2014; Abaza et al., 2015). Oleuropein, one of the best known active constituents of olive leaf, has been endowed with many health promoting properties. Furthermore, this herbal extract is a potent antioxidant. Researchers determined that olive leaf extract has twice the antioxidant capacity of green tea and 400% the antioxidant capacity of vitamin C. Besides its antioxidant effect, oleuropein can also stimulate the immune system and promote fat-burning (Poudyal et al., 2010).

Research suggests that the immune system can reduce the effect of viruses, such as the ones responsible for common cold and influenza, by this process (Walker, 1997; Fredrickson, 2000). Olive leaf extract has been shown to increase recovery from the influenza virus. Additional anti-inflammatory and antioxidant properties offer promise in fighting liver, colon, prostate, breast and skin cancers, atherosclerosis, arthritis and neurodegenerative disease (Visioli et al., 2002; Menendez et al., 2008; Goulas et al., 2009; Barbaro et al., 2014). A study showed that a Mediterranean style diet rich in olive oil reduced the risk of type II diabetes by almost 50% compared to a low fat diet (Paravantes, 2011; Guasch-Ferre et al., 2015). Olive oil and leaf extracts and their oleuropein constituents are best known for their blood pressure-lowering effects, preventing the clogging of blood vessels and reducing the risk of stroke, and it can help maintain the blood-brain barrier (Alonso et al., 2006; Perrinjaquet-Moccetti et al., 2008; Bowden, 2009).

Olive leaves are traditionally used in herbal medicine for the relief of coughs, colds, flu, and sore throats, to help reduce fevers (Walker, 1997; Bowden, 2009; Barbaro et al., 2014) and to treat gout in Mediterranean regions.

Benefits of extra virgin olive oil and leaves for skin

Extra virgin olive oil is being used externally for the skin, hair, and face in cosmetics or as a natural remedy (Rodrigues et al., 2015). There are suggestions olive oil may be helpful in healing burned skin lesions based on trials with rats (Hangan et al., 2016), and in lowering the risk of dermatitis in premature babies (Kiechl-Kohlendorfer et al., 2008). It is also being used as a substitute for shaving cream, shampoo, soap, hand and body cream, lip balm, and as make-up remover. Olive leaf extract also provides some unique medicinal benefits in the treatment of many problem skin conditions such as eczema, acne, psoriasis and shingles. Olive leaf extract can protect the skin by its antioxidant, antimicrobial and anti-inflammatory effects (Ancora et al., 2004). Oleuropein extract of olive leaf reduced reddening of the skin, dehydration, and blood flow to the skin better than vitamin E (Bowden, 2009). Kimura and Sumiyoshi (2009) suggested that olive leaf extracts and oleuropein have preventative effects on chronic UVB-induced skin damage. Wounds heal faster with olive leaf extract, according to Koca et al. (2011). Olive leaf extract is a common ingredient in botanical soaps and creams.

Conclusion

The Mediterranean diet has consistently been demonstrated to have a beneficial influence on human health and longevity. The benefit is due to its constituent foods, amongst which virgin olive oil, especially extra virgin, is considered to be the most important. Its benefits include its antioxidant, anti-inflammatory, anti-atherogenic and lipid-lowering capacity, which are chiefly a result of its chemical composition, particularly its high content of oleic acid, polyphenols, sterols, and tocopherols, which sets it apart from other oils. Studies on extra virgin olive oil and olive leaf extracts have been published in scientific journals such as Phytomedicine, Sci Pham, Phytother Res, Nutr Biochem, Clin Chem, Clin Nutr, Med Food, J Ethnopharmacol, Int J Antimicrob Agents, Int J Cancer, Cancer Res Clin Oncol, Int J Cosmet Sci, Plant Foods Hum Nutr, Agric Food Chem, Mol Nutr Food Res, Diabetes Care, Plant Foods Hum Nutr and other journals. Abundant published medical studies have shown that the olive tree is an important medicinal plant, with health benefits used for the treatment of many diseases and skin problems (Poudyal et al., 2010; Visioli et al., 2002; Menendez et al., 2008; Goulas et al., 2009; Barbaro et al., 2014; Bowden, 2009; Ancora et al., 2004; Kiechl-Kohlendorfer et al., 2008). Extra virgin olive oil is a major component and the "gold elixir" of the Mediterranean diet.

Acknowledgments

This was adapted from a presentation entitled 'Olive oil, fruits and leaves use and benefits – a review', which was presented at the VIII International Olive Symposium, held in Split, Croatia in October 2016.

References

Abaza, L., Taamalli, A., Nsir, H., and Zarrouk, M. (2015). Olive tree (*Olea europeae* L.) leaves: importance and advances in the analysis of phenolic compounds. Antioxidants (Basel). *4* (*4*), 682–698.

Alemán, J.A., Rentero, M.P.Z., Montoro-Garcia, S., Mulero, J., Garrido, A.P., Leal, M., Guerrero, L., Ramos, E., and Ruilope, L.M. (2016). Adherence to the "Mediterranean diet" in Spain and its relationship with cardiovascular risk (DIMERICA study). Nutrients *8*, 680 https://doi.org/10.3390/nu8110680.

Alonso, A., Ruiz-Gutierrez, V., and Martínez-González, M.A. (2006). Monounsaturated fatty acids, olive oil and blood pressure: epidemiological, clinical and experimental evidence. Public Health Nutr. 9, 251–257.

Ancora, C., Roma, C., and Vettor, M. (2004). Evaluation of cosmetic efficacy of oleoeuropein. Paper presented at: Symposium on the New Frontiers of Dermo-cosmetology: Efficacy, Stability and Safety (Rome, Italy).

AOA. (2017). Australian Olive Association. http://www.australianolives.com.au/ (accessed May 2017).

Arte Legno. (2016). The legendary olive tree and the oil extracted from its fruit have accompanied the history of mankind. http://www.artelegnospello.com/en/company.php (accessed December 2016).

Barbaro, B., Toietta, G., Maggio, R., Arciello, M., Tarocchi, M., Galli, A., and Balsano, C. (2014). Effects of the olive-derived polyphenol oleuropein on human health. Int. J. Mol. Sci. *15* (*10*), 18508-18524.

Bowden, J. (2009). Unleash the Amazingly Potent Anti-Aging, Antioxidant Pro-Immune System Health Benefits of the Olive Leaf (Topanga, CA, USA: Freedom Press), ISBN: 978-1893910-68-3.

Bulotta, S., Celano M., Lepore, S.M., Montalcini, T., Pujia, A., and Russo, D. (2014). Beneficial effects of the olive oil phenolic components oleuropein and hydroxytyrosol: focus on protection against cardiovascular and metabolic diseases. J Transl Med.*12*, 219 https://doi.org/10.1186/s12967-014-0219-9.

Clodoveo, M.L., Camposeo, S., De Gennaro, B., Pascuzzi, S., and Roselli, L. (2014). In the ancient world, virgin olive oil was called "liquid gold" by Homer and "the great healer" by Hippocrates. Why has this mythic image been forgotten? Food Research International *62*, 1062–1068.

Covas, M.-I., Ruiz-Gutiérrez, V., de la Torre, R., Kafatos, A., Lamuela-Raventós, R.M., Osada, J., Owen, R.W., and Visioli, F. (2006). Minor components of olive oil: evidence to date of health benefits in humans. Nutr Rev. *64*, 20–30.

FAO. (2016). http://www.fao.org/faostat/en.

Firenze, C. (2011). Thomas Jefferson and olive oil – our first foodie president. https://www.oliveoilsource.com/article/thomas-jefferson-and-olive-oil-our-first-foodie-president.

Fredrickson, W.R. (2000). Patent - olive leaf extract = Method and composition for antiviral therapy (US Patent # 6,117,844).

Goulas, V., Exarchou, V., Troganis, A.N., Psomiadou, E., Fotsis, T., Briasoulis, E., and Gerothanassis, I.P. (2009). Phytochemicals in olive-leaf extracts and their antiproliferative activity against cancer and endothelial cells. Mol Nutr Food Res. *53* (*5*), 600–608.

Guasch-Ferre, M., Hruby, A., Salas-Salvado, J., Martinez-Gonzalez, M.A., Sun, Q., Willett, W.C., and Hu, F.B. (2015). Olive oil consumption and risk of type 2 diabetes in US women. The American Journal of Clinical Nutrition *102* (*2*), 479–486 https://doi.org/10.3945/ajcn.115.112029.

Hangan, L.T., Carabineanu, A., Badiu, D., Crainiceanu, Z., Cumpanas, A., Bardan, R., Ciurlea, S., Oancea, A., and Navolan, D.B. (2016). The benefits of olive oil compounds in healing burned skin lesions. Revista de Chimie *67* (*9*), 1793–1796.

International Olive Council. (2016). http://www.internationaloliveoil.org (accessed December 2016).

Kiechl-Kohlendorfer, U., Berger, C., and Inzinger, R. (2008). The effect of daily treatment with an olive oil/lanolin emollient on skin integrity in preterm infants: a randomized controlled trial. Pediatric Dermatology *25* (*2*), 174–178.

Kimura, Y., and Sumiyoshi, M. (2009). Olive leaf extract and its main component oleuropein prevent chronic ultraviolet B radiation-induced skin damage and carcinogenesis in hairless mice. J Nutr. *139* (*11*), 2079–2086 https://doi.org/10.3945/jn.109.104992.

Koca, U., Suntar, I., Akkol, E.K., Yilmazer, D., and Alper, M. (2011). Wound repair potential of *Olea europaea* L. leaf extracts revealed by in vivo experimental models and comparative evaluation of the extracts' antioxidant activity. J. Med Food *14* (*1-2*), 140–146 https://doi.org/10.1089/jmf.2010.0039.

Martínez-González, M.Á., de la Fuente-Arrillaga, C., Nunez-Cordoba, J.M., Basterra-Gortari, F.J., Beunza, J.J., Vazquez, Z., Benito, S., Tortosa, A., and Bes-Rastrollo, M. (2008). Adherence to Mediterranean diet and risk of developing diabetes: prospective cohort study. BMJ *336*, 1348–1351.

Menendez, J.A., Vazquez-Martin, A., Oliveras-Ferraros, C., Garcia-Villalba, R., Carrasco-Pancorbo, A., Fernandez-Gutierrez, A., and Segura-Carretero, A. (2008). Analyzing effects of extra-virgin olive oil polyphenols on breast cancer-associated fatty acid synthase protein expression using reverse-phase protein microarrays. Int J Mol Med. *22* (*4*), 433–439.

Paravantes, E. (2011). Olive Oil Diet Reduces Risk of Type 2 Diabetes. Olive Oil Times. https://www.oliveoiltimes.com/olive-oil-health-news/olive-oil-diet-reduces-diabetes-risk/15948.

Perrinjaquet-Moccetti, T., Busjahn, A., Schmidlin, C., Schmidt, A., Bradl, B., and Aydogan, C. (2008). Food supplementation with an olive (*Olea europaea* L.) leaf extract reduces blood pressure in borderline hypertensive monozygotic twins. Phytother. Res. 22 (9), 1239–1242.

Poudyal, H., Campbell, F., and Brown, L. (2010). Olive leaf extract attenuates cardiac, hepatic, and metabolic changes in high carbohydrate-, high fat-fed rats. J Nutr. *140* (*5*), 946–953.

Ravetti, L., and Edwards, M. (2014). Olive oils from Australia and New Zealand. In Olive Oil Sensory Science, E. Monteleone, and S. Langstaff, eds. (John Wiley & Sons, ltd), p.313–336.

Rick, P. (2016). History of olive trees. https://www.tytyga.com/History-of-Olive-Trees-a/453.htm (accessed December 2016).

Rodrigues, F., Pimentel, F.B., and Oliveira, M.B.P.P. (2015). Olive by-products: challenge application in cosmetic industry. Industrial Crops and Products *70*, 116–124.

Salas-Salvadó, J., Bulló, M., Babio, N., Martínez-González, M.Á., Ibarrola-Jurado, N., Basora, J., Estruch, R., Covas, M.I., Corella, D., Arós, F., Ruiz-Gutiérrez, V., and Ros, E. (2011). Reduction in the incidence of type 2 diabetes with the Mediterranean diet, results of the PREDIMED-Reus nutrition intervention randomized trial. Diabetes Care *34*, 14–19.

Sergeeva, V. (2012). Following olive footprints in Australia. In Following Olive Footprints (*Olea europaea* L): Cultivation and Culture, Folklore and History, Traditions and Uses, Scripta Horticulturae 13, M. El-Kholy, D. Avanzato, J.M. Caballero, K.S. Chartzoulakis, F. Vita Serman, and E. Perri, eds. (Córdoba, Spain: AARINENA, IOC and ISHS), p.32–47.

Sofi, F., Macchi, C., Abbate, R., Gensini, G.F., and Casini, A. (2014). Mediterranean diet and health status: an updated meta-analysis and a proposal for a literature-based adherence score. Public Health Nutr. *17*, 2769–2782.

Takeuchi, S., and Shibata, H. (2012). Following olive footprints in Japan. In Following Olive Footprints (*Olea europaea* L): Cultivation and Culture, Folklore and History, Traditions and Uses, Scripta Horticulturae 13, M. El-Kholy, D. Avanzato, J.M. Caballero, K.S. Chartzoulakis, F. Vita Serman, and E. Perri, eds. (Córdoba, Spain: AARINENA, IOC and ISHS), p.192–197.

The Big Olive. (2016). About our olive oil: history. http://www.bigolive.com.au/about-our-olive-oil/history/ (accessed December 2016).

Visioli, F., Poli, A., and Galli, C. (2002). Antioxidant and other biological activities of phenols from olives and olive oil. Med Res Rev. *22*, 65–75. http://doi.org/10.1002/med.1028.

Vossen, P. (2007). Olive oil: history, production, and characteristics of the world's classic oils. HortScience *42*, 1093–1100.

Walker, M. (1997). Nature's Antibiotic: Olive Leaf Extract (New York: Kensington Books).

› Vera Sergeeva

› About the author

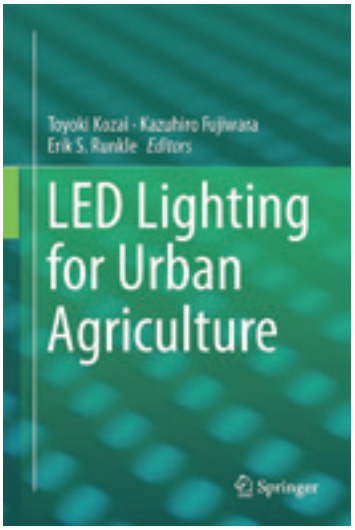
Dr. Vera Sergeeva is a Director of Ulivita, and she is based in Sydney, Australia. She helps educate producers in the growing of olives and the marketing of olive oil and olive tree products. Dr. Sergeeva is a certified olive oil taster and has been invited to be a judge at the Sydney Fine Food Show. She is an international consultant in plant pathology and operates her own consultancy company, OliVera in Australia, and promotes the Mediterranean diet. She is well known in the Australian olive industry as an authority on pests and diseases of olive. She has collaborated in a number of research projects at Western Sydney University. Her research interests include biological and non-chemical plant protection, and more environmentally friendly processes to grow olives. She was a convener of the Symposium on Plants, as Factories of Natural Substances, Edible and Essential Oils, organized by IHC2014 and WOCMAP, chairperson at the Olivebioteq 2014, 13th Congress of the Mediterranean Phytopathological Union and IOBC/wprs working group on integrated protection of olive crop conferences. She contributed two chapters to 'Following Olive Footprints (*Olea europaea* L.) - Cultivation and Culture, Folklore and History, Tradition and Uses' (*Scripta Horticulturae* 13).
E-mail: sergeeva@tpg.com.au

New Books
Websites

› New books, websites

Book reviews

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



Kozai, T., Fujiwara, K., and Runkle, E.S., eds. (2016). LED Lighting for Urban Agriculture (Springer Singapore), pp.454. ISBN 978-981-10-1846-6 (hardcover) / 978-981-10-1848-0 (eBook). $179.00 (hardcover) / $139.00 (eBook). http://www.springer.com/la/book/9789811018466

Book titles pull you in or push you away. *LED Lighting for Urban Agriculture*, edited by Kozai, Fujiwara, and Runkle, pulls you in if one is interested in LED lighting or urban agriculture. If one is interested in other topics related to the effects of light on plant growth and development, then the title may not attract so much. And this is a shame because this book has much more information and value than LED lighting or urban agriculture by themselves. In fact, there is so much more information in this book that the term "urban agriculture" does not even occur in 26 of the 32 chapters. Remove all the chapters directly related to urban agriculture and one still has an excellent text book related to the effects of light quantity, quality, and duration on plant growth and development.

The 32 book chapters are broken into seven sections: Part I - Perspective and significance of LED lighting for urban agriculture, Part II - Plant growth and development as affected by light, Part III - Optical and physiological characteristics of a plant leaf and a canopy, Part IV - Greenhouse crop production with supplemental LED lighting, Part V - Light quality effects on plant physiology and morphology, Part VI - Current status of commercial plant factories with LED lighting, and Part VII - Basics of LEDs and LED lighting systems for plant cultivation.

Part I introduces urban agriculture to include "atrium, potted plants and plant stands to create green interiors with or without supplemental artificial light, and plant factories with artificial lighting (PFALs)". With this introduction, the book focuses on urban agriculture in terms of the use of electric light, especially from LEDs, in PFAL.

Part II starts a long section through to Part V on plant responses to light from any source, including phototropism, photomorphogenesis, photoperiodism, and photosynthesis. These chapters are well written, well referenced, and easily provide reference text to anyone wishing to understand the genetics, biophysics, biochemistry, and management of light for plant growth and development control.

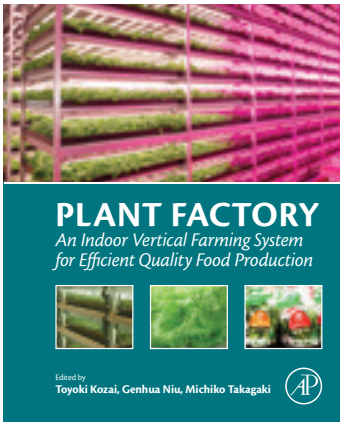
Part VI focuses on business models for plant factories using LED lighting, as well as consumer perceptions of products produced in plant factories.

Part VII starts a series of chapters on the fundamentals of light, light measurement and units, and LED design including energy balances. Further, an excellent cautionary chapter on health effects of occupational exposure to LED light is provided.

Two additional topics would have added value to the book. Authors tended to be "optimistic" about food production in plant factories without providing cost and caloric analysis of the foods produced in plant factories compared to income of people throughout the world and their daily calorie requirements. Additionally, production of plants in factories requires electricity, which is primarily fossil-fuel generated. Given the concern over climate change associated with the rise in atmospheric carbon dioxide concentration, an analysis of the carbon footprint from food produced in plant factories versus that with sunlight would have been interesting (although this subject is discussed in other books edited by Kozai).

In conclusion, this book is a gold mine of information for anyone wishing to gain a current understanding of light and plants as well as plant factory production systems. It is highly recommended.

Reviewed by Royal Heins, Michigan State University, USA



Kozai, T., Niu, G., and Takagaki, M., eds. (2016). Plant Factory: an Indoor Vertical Farming System for Efficient Quality Food Production (London, UK: Academic Press), pp.432. ISBN 978-0-12-801775-3 / ISBN 978-0-12-801848-4 (eBook). US$ 99.95 (paperback) / US$ 79.95 (eBook).

This book opens by highlighting the need for more efficient food production due to the rapid growth in world population, and an even faster growth in urban population. The authors explore the potential of a new form of agricultural cultivation: indoor vertical farming using a plant factory system with artificial lighting (PFAL). They point out that "PFALs are not a replacement for conventional greenhouses or open-field production". Indeed, vertical farming is not suitable for staple crops like rice, wheat, corn or potatoes. PFAL is also called Closed Plant Production System (CPPS) and is one option for controlled environment agriculture (CEA). Many potential advantages of PFAL are mentioned, e.g. no solar light nor soil is needed, year-round and very high productivity, constant high-quality produce and high water use efficiency. The criticisms of PFALs, e.g. high energy use, are addressed with realism and by providing actual data.

Prof. Toyoki Kozai is a well-known leading scientist and expert on PFAL, and he is co-author of many of the 28 chapters in this book. Other contributors are mainly from Japan, but contributions are also included from authors in Canada, China, South Korea, Taiwan, UK, USA and Vietnam. The chapters fall into one of the following four sections: (1) Overview and concept of PFAL, (2) Basics of physics and physiology – environments and their effects; (3) System design, construction, cultivation and management (about one third of the book); and (4) PFALs in operation.

This book provides valuable information, especially on the technology of PFAL (lighting systems, hydroponics, systems design) and the physics of climate (e.g. psychrometric chart). Plant processes such as photosynthesis, respiration, growth and development, also receive the necessary attention, although discussions are more general and less specifically focused on the new options provided by a PFAL. I would have appreciated more detail on how specific lighting strategies (different wavelengths), only possible in PFAL, can improve product quality (e.g. anti-oxidant content). However, I realize that in this field much more research is still needed, and functional components in leafy vegetables, medicinal herbs and production of pharmaceuticals in PFAL receive attention in Chapters 13, 14 and 15. Chapter 24 is called 'Life Cycle Assessment (LCA)' and applies the general concepts of LCA to a PFAL, however, only with a schematic presentation; no data are provided.

I highly recommend this book to students and researchers interested in indoor vertical farming. It is easy to read, and provides many references to scientific papers. Readers need only a general biology and physics background to comprehend most of the book. This also makes it useful for a more general readership. The book provides information on the number and profitability of PFAL businesses in Japan and several other countries. It includes detailed information of some example PFALs and analyzes why 25% of Japanese PFALs are losing money. This is highly relevant information for commercial parties. The book contains interesting tables, graphs, colorful pictures and schemes that (university) teachers will find useful for illustrating lectures on PFALs.

Reviewed by Ep Heuvelink, Wageningen University & Research, Wageningen, The Netherlands

Taiz, Lincoln, and Taiz, Lee. (2017). Flora Unveiled: The Discovery and Denial of Sex in Plants (Oxford, UK: Oxford University Press), pp.528. ISBN 978-0-19-049026-3 (hardback). $69.95 / £45.99. global.oup.com

Flora Unveiled: The Discovery and Denial of Sex in Plants is a tour de force written by the eminent plant physiologist Lincoln Taiz and his wife Lee, a biologist. It is destined to be a classic. The authors review the knowledge of sex in plants in a sweep of history; a remarkable story that connects science, mythology, religion, agriculture, literature, and art. It is scholarly, yet a fascinating read, and I highly recommend it.

Sexual reproduction in plants has long been misunderstood and still remains mysterious. It remained for the experimental work of Rudolf Jacob Camerarius in the late 17th century to prove the connection between pollination and seed production. He expanded the observation

of Marcelo Malpighi and Nehemiah Grew of the presence of pollen in stamens, but who failed to make the leap to elucidate its role. Yet, surprisingly, the ancient Assyrians had a general understanding of plant sex as a result of date cultivation, a dioecious species composed of staminate and pistillate plants. They observed that fruit-bearing plants grown *en masse* would be barren without the presence of staminate plants. Collecting and applying the "dust" of the staminate inflorescence to the pistillate inflorescence would become a traditional horticultural practice with religious overtones. It was included in the Code of Hammurabi, with rewards to the gardener who performed the task and penalties if neglected. Similarly, the importance of the wild caprifig, the host of the wasp pollinator, was understood as essential to fig production, although the details of pollination were difficult to completely understand. Theophrastus, the Greek father of botany (ca. 371-287 BCE) used the term "male" to refer to the pollen-bearing date trees and "female" to the fruit-bearing ones, but assumed the pollen only promoted fruit growth. Pliny, the first century Roman historian of natural history, came very close to understanding the process. Even Mohammed, skeptical of pollination of date palms, admitted his error, demonstrating perhaps for the first time, the distinction between religious belief and scientific fact.

Somehow, all this knowledge was lost in Medieval times, perhaps because dioecious fruit crops were not common in Europe. Experimental science declined while the Church regarded sex in general as sinful. Flowers, somehow, were transformed into symbols of purity, despite the fact that the inflorescence enclosed their sex organs. It was believed that flowers were created to satisfy human desire for beauty rather than as attractants for pollinators. The general consensus, long held, was that plants were female entities, emblems of chastity, and considered as religious symbols. The rosary is based on the connection attributed between the rose and the Virgin Mary.

All this came to an end in the 19th century when the intricacies of sex in plants were unraveled. The details continue to be explored. This is discussed in the last chapter, *Flora's Secret Gardens*, which explains the evolutionary details of plant sex. The intricacies of sex in plants still bedevil freshmen exposed to botany and horticulture for the first time. It is complex and weird. If you do not believe me, try to explain alternation of generations, megasporogenesis, nucellar embryony, apomixes, double fertilization, and endosperm to laymen.

Reviewed by Jules Janick, Purdue University, USA

› New titles

Colla, G., Pérez-Alfocea, F., and Schwarz, D., eds. (2017). Vegetable Grafting: Principles and Practices (Wallingford, Oxfordshire, UK: CABI Publishing), pp.308. ISBN 9781780648972 (hardback). £76.50 / €99.00 / $126.00. www.cabi.org
A 20% discount will be received by entering the code "CCVG25" when ordering through http://www.cabi.org/bookshop/book/9781780648972

Garcia, J.Q., Lezzoni, A., Pulawska, J., and Lang, G., eds. (2017). Cherries: Botany, Production and Uses (Wallingford, Oxfordshire, UK: CABI Publishing), pp.480. ISBN 9781780648378 (hardback). £125.00 / €165.00 / $205.00. www.cabi.org
A 20% discount will be received by entering the code "CCLC20" when ordering through http://www.cabi.org/bookshop/book/9781780648378

Husaini, A.M., and Neri, D., eds. (2016). Strawberry: Growth, Development and Diseases (Wallingford, Oxfordshire, UK: CABI Publishing), pp.348. 9781780646633 (hardback). £105.00 / €140.00 / $175.00. www.cabi.org
A 20% discount will be received by entering the code "CCSCH20" when ordering through http://www.cabi.org/bookshop/book/9781780646633

Mumtaz Khan, M., Al-Yahyai, R., and Al-Said, F., eds. (2017). The Lime: Botany, Production and Uses (Wallingford, Oxfordshire, UK: CABI Publishing), pp.368. 9781780647845 (hardback). £95.00 / €125.00 / $160.00. www.cabi.org
A 20% discount will be received by entering the code "CCLC20" when ordering through http://www.cabi.org/bookshop/book/9781780647845

› Courses and meetings

The following are non-ISHS events. Make 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

CIHEAM – International Master on Horticultural Genetics and Biotechnology, 2017-2018, Chania, Greece. Info: Dr. Panagiotis Kalaitzis, Studies/Research Coordinator, Dept. Horticultural Genetics & Biotechnology, Mediterranean Agronomic Institute of Chania, Alsyllio Agrokepion, P.O. Box 85, Chania 73100, Crete, Greece, Phone: +30 28210 35030, Fax: +30 28210 35001, E-mail: panagiot@maich.gr, Web: www.maich.gr/hort/

International Conference on Emerging Trends in Integrated Pest and Disease Management for Quality Food Production, 25-27 July 2017, Kuching, Malaysia. Info: V Sivaram Research Foundation, No. 132, 2nd Main Rd, R R Nagar, Nagadevanahalli, Jnana bharathi, Bangalore - 560056, India, Phone: +91(080)-28484729, Fax: +91 (080) 23181443, E-mail: ipmfp2017@indiattitude.com, Web: www.ipm2017.com

International Workshop on Production, Value Addition and Marketing of Jackfruit, 9-14 August 2017, Wayanad, India. Info: Dr. Rajendran Pangath, Associate Director of Research, Kerala Agricultural University, Regional Agricultural Research Station, Ambalavayal, Wayanad, Kerala, 673 593, India, Phone: (91)4936260421, E-mail: adramb@kau.in, Web: http://techmeets.kau.in/jackfruit

AMI's AGRICULTURAL FILM 2017 International conference on plastic film technologies used in agriculture, silage, mulch, greenhouse and tunnel films, 26-28 September 2017, Barcelona, Spain. Info: Rocio Martinez, Senior Conference Organiser, Phone: +44 (0) 117 314 8111, E-mail: rmm@amiplastics.com, Web: https://www.amiplastics.com/events/event?Code=C827

Advanced Course on Advances in Breeding and Agronomy for Improving Sustainability and Quality of Grain Legume Crops, 16-20 October 2017, Zaragoza, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida de Montañana 1005, 50059 Zaragoza, Spain, Phone: +34 976 716000, Fax: +34 976 716001, E-mail: iamz@iamz.ciheam.org, Web: www.iamz.ciheam.org

V International Symposium on Saffron Biology and Technology

Section Medicinal and Aromatic Plants #ishs_seme

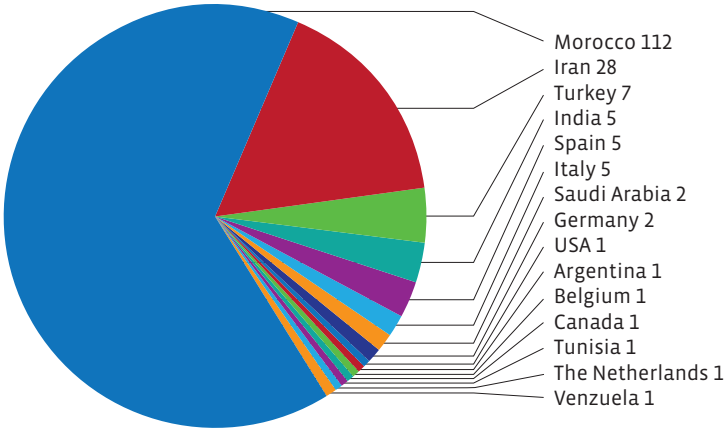
› Participants of the symposium.

From 23-26 November 2016, the V International Symposium on Saffron Biology and Technology (VISSBT2016) was convened in the city of Agadir, Morocco. This event was hosted by the National Institute of Agronomic Research of Morocco (INRA) under the auspices of the International Society for Horticultural Science (ISHS). Participants came from 15 countries interested in saffron production (Figure 1).

The opening session of the symposium was led by Prof. Mohamed Badraoui, Symposium Convener, Mrs. Zineb Al Adaoui, Governor of Souss-Massa region, and Prof. Brahim Hafidi, President of the Regional Council of Souss-Massa region and Director of the National Agency for the Development of the Oasis Areas and the Argan Tree. The government policy on saffron production in Morocco was presented.

After Prof. Badraoui welcomed the participants, Prof. A. Koocheki, ISHS representative, gave an inaugural presentation entitled "Global situation of saffron in the world: challenges and opportunities", followed by a presentation on the ISHS.

Prof. M. Polissiou gave a plenary presentation on "SaffronOMICS: the international dimension and impact of the scientific achievements of a European COST ACTION project" on behalf of Prof. Maria Tsimidou, chair of the action and Professor at Aristotle University of Thessaloniki, Greece, who was unable to attend the symposium.



■ Figure 1. Number of participants from each country attending the V International Symposium on Saffron Biology and Technology.

During the symposium, five sessions were held: Saffron history and saffron market; Physiology and biology of saffron; Genetics and biotechnology; Production of spices and seed-corms; and Saffron quality. Each session began with a keynote presentation.

In Session 1, Prof. Alireza Karbasi from Ferdowsi University of Mashhad, Iran, gave a keynote presentation on "Adding value and market of saffron", which was followed by five other presentations.

In Session 2, a keynote lecture on "Saffron crocin biosynthesis: a tale of three compartments" was presented by Dr. Giovani Guiliano from the Italian National Agency for new technologies, energy and sustainable economic development, Rome, Italy, followed by seven other presentations.

Session 3 started with keynote presentations on "Advance in saffron research for integrated development of saffron in Kashmir-India" by Prof. F.A. Nehvi from Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, India, and on "Strategy for promoting the con-

servation and sustainable use of saffron (*Crocus sativus* L.) genetic resources: case of saffron Morocco" by Dr. Amri Ahmed from ICARDA, Morocco, followed by eight presentations.

In Session 4, Prof. Alireza Koocheki from the Faculty of Agriculture, Ferdowsi University of Mashhad, Iran, gave a keynote presentation on "Saffron corm: science and technology", which was followed by nine other presentations.

In Session 5, a keynote lecture on "Saffron's quality and adulteration control by rapid and non-destructive spectroscopic techniques" was presented by Prof. M. Polissiou from the Agricultural University of Athens, Greece, followed by eight other presentations.

During the symposium, a field trip was organized to the main saffron zone and a meeting was organized between farmers and scientists to discuss saffron problems and probable solutions.

› Question and answer session.

› ISHS student awards presented to A) Ms. Sakina Sokrate for the best student oral presentation, and B) Ms. Helia Bidad for best student poster presentation.

Major recommendations on saffron from the symposium

There is a need to:

- Update saffron statistics in different countries;
- Exchange information, expertise and possibly germplasm under specific terms and conditions;
- Establish extension centers targeting farmers and other key stakeholders, for smooth and efficient technology transfer;
- Promote both ex situ and in situ conservation of saffron genetic resources including wild species, and strengthen research on saffron breeding;
- Investigate intercropping, which is useful for sustainability of saffron cropping systems. However, there is a need for optimizing and identifying suitable new crops;
- Carry out more research on non-destructive techniques for quality analysis and adulteration;
- Carry out more participatory research on postharvest, crop management and integrated pest management;
- Continue to use and develop new statistical approaches for experimental designs and data analysis;
- Identify the best fertilizer use and analysis of rhizosphere;
- Carry out more research on water use efficiency in relation to climate change;
- Promote diversification of the use of saffron and its by-products.

› A. Field trip to the main zone of saffron production in Morocco. B. Technical visit to a cooperative in the south of Morocco.

Outcomes of the business meeting

During the ISHS business meeting Symposium Convener Prof. Mohamed Badraoui was elected Chairman of the ISHS Working Group Saffron Biology and Biotechnology. It was suggested that the saffron symposium be held every two years: the 6th symposium in 2018 in Iran and the following one in 2020 in Turkey.

Given the great development of the saffron value-chain worldwide, the idea of establishing a "saffron scientific society, SSS" was suggested by the participants. Details will be discussed with the ISHS during 2017.

Closing session

During the closing session, Prof. Badraoui proposed that the focus during the VI International Symposium on Saffron Biology and Technology in Iran be "saffron and health" issues.

ISHS student awards were given to Miss Sakina Sokrate, PhD student at the National Institute of Agronomic Research, Rabat, Morocco, for the best student oral presentation entitled "Boosting saffron (*Crocus sativus* L.) micro-propagation through vitro corm production", and to Miss Helia Bidad, PhD student at the University of California, Berkeley, USA, for the best student poster presentation entitled: "The resilience of saffron production to climate change in the Khorasan Province of Iran".

Mohammed Badraoui

› Contact

Prof. Mohammed Badraoui, Institut National de Recherche Agronomique, Avenue Ennasr, BP 415, Rabat, Morocco, e-mail: mohamedbadraoui@gmail.com

› VIII International Olive Symposium

Section Nuts and Mediterranean Climate Fruits Commission Molecular Biology and In Vitro Culture

#ishs_senu ishs_cmmv

The VIII International Olive Symposium was held in Split, Croatia, from October 10-14, 2016. The symposium was organised by the International Society for Horticultural Science (ISHS) Working Group Olive Culture, and the Institute for Adriatic Crops and Karst Reclamation Split (IAC), in cooperation with the International Olive Council, University of Zagreb (Faculty of Agriculture), University of Dubrovnik, Institute of Agriculture and Tourism Poreč, University Josip Juraj Strossmayer of Osijek (Faculty of Agriculture) and University of Zadar under the auspices of the President of the Republic of Croatia, Kolinda Grabar Kitarović, and the Ministry of Agriculture of the Republic of Croatia. Slavko Perica, Director of IAC, convened the symposium.

› Opening ceremony.

› Organizing committee of the symposium.

The symposium brought together 187 scientists from 30 different countries all over the world. Four days were devoted to scientific oral and poster presentations. A wide range of topics were divided into five sessions: Germplasm, genomics and breeding; Biology and physiology; Nursery, orchard management and use of by-products; Table olives, oil technology, quality and health promoting properties; and Economy and marketing. The theme of the symposium was olive cultivation in marginal olive growing areas. Altogether, 87 oral presentations and 104 posters were presented, including 9 invited lectures. One day was devoted to a technical tour where participants visited some traditional extensive and some modern intensive orchards and facilities in the area of Split-Dalmatia County, Šibenik-Knin County and Zadar County, where they became more familiar with the characteristics of Croatian olives and the olive oil sector.

Slavko Perica, Convener of the symposium, welcomed everyone and extended his thanks and gratitude to the participants and to the members of the Scientific and Organizing Committees during the opening ceremony. A representative of the Croatian Ministry of Agriculture, the Governor of the Split-Dalmatia County and the Deputy Mayor of the City of Split, also greeted the participants. Prof. Tiziano Caruso welcomed participants on behalf of ISHS and gave a short reflection in memory of Shimon Lavee, one of the initiators of autonomous olive symposia, who passed away a few months earlier.

The session on "Germplasm, genomics and breeding" started with an invited lecture by Luciana Baldoni, Italy. Twelve more oral presentations and 12 posters were also presented in this session, mostly dealing with new insights into olive origins and characteristics of olive cultivars in different ecological environments around the globe.

The session on "Biology and physiology" was dedicated to Shimon Lavee, because this area covered his primary scientific interest. It started with the invited lecture "Abiotic stress in olive: physiological and molecular mechanisms" by Luca Sebastiani, Italy. Stress related issues, whether caused by drought or temperature, dominated this session, however, there were also presentations about problems in cultivation during different olive phenophases. In total, 18 oral presentations and 19 posters were presented.

The session on "Nursery, orchard management and use of by-products" was the largest session of the symposium and covered a wide range of topics. Three invited lectures were

presented: “Trends in olive nutrition” by Ricardo Fernandez Escobar, Spain; “New approaches for precise irrigation in olive” by José Enrique Fernández Luque, Spain; and “Alternative technologies for olive mill wastewater (OMW) management with emphasis on land application” by Kostas Chartzoulakis, Greece. Problems associated with *Xyllela fastidiosa* were recognised as a very important issue, and in the frame of this session, a workshop on “Pest management and *Xyllela fastidiosa*” was organised. Giovanni Paolo Martelli from Italy presented an invited lecture: “*Xylella fastidiosa* emergence: a new phytosanitary threat for the olive crops” during the workshop. A wide range of agricultural aspects of olive cultivation were covered during this session, which included 25 oral presentations and 43 posters.

› Slavko Perica (left) and Gabriela Vuletin Selak (second from right) presenting the ISHS student awards to Sara Oulbi (second from left) for the best oral presentation and to Barbara Ferronato (right) for the best poster.

› A. Visit to the old olive tree in Kaštel Novi. B. Visit to the olive orchard in Polača.

The session on “Table olives, oil technology, quality and health promoting properties” also covered many topics of scientific interest and was introduced with two invited lectures: “Extra virgin olive oil and its co-products: technologies for facing new sector challenges” by Agnese Taticchi, Italy, and “Virgin olive oil: genetic variability for the senses and health” by Gabriel Beltrán, Spain. Besides these two lectures, there were another 18 oral presentations and 24 posters, mostly dealing with different aspects of olive oil quality, but also some covering table olive production.

The invited lecture for the session on “Economy and marketing” was “World olive oil market” by International Olive Council representative, Jaime Lillo, Spain. Another 10 oral presentations and 6 posters also contributed to this session which addressed economic aspects of different areas of olive and olive-related production.

Activities of the “Biology and physiology”, “Nursery, orchard management and use of by-products” and “Table olives, oil technology, quality and health promoting properties” sessions, as well as the technical tour, were funded with a grant from the International Olive Council. This included a “Workshop on

environmental footprint in olive growing – current state and future challenges".
At the business meeting, it was decided that the host of the IX International Olive Symposium will be Montpellier (France) in 2020. ISHS student awards were given to Sara Oulbi from Morocco for the best student oral presentation entitled "Somatic embryogenesis expression from mature explants of Moroccan olive cultivar (*Olea europaea* L.), 'Moroccan Picholine'", and to Barbara Ferronato from Uruguay for the best student poster entitled "Olive oil quality of 'Arbequina' and 'Coratina' cultivars produced in Uruguay".

Jakša Rošin and Gabriela Vuletin Selak

› Contact

Jakša Rošin and Gabriela Vuletin Selak, Institute for Adriatic Crops and Karst Reclamation, Put Duilova 11, Split, Croatia, E-mail: jaksa.rosin@krs.hr and gabriela.vuletin.selak@krs.hr

› IV International Symposium on Molecular Markers in Horticulture

Commission Molecular Biology and In Vitro Culture #ishs_cmmv
Commission Plant Genetic Resources #ishs_cmgr

› Participants of the symposium.

The IV International Symposium on Molecular Markers in Horticulture was convened in Napier, New Zealand, by Dr. Vincent Bus from 7-10 March 2017. The technical portion of the symposium covered five major themes: Selection Strategies and Application; Markers for Biotic and Abiotic Stress, and Traits; Germplasm and Genetic Diversity; Molecular Genetics; and Molecular Technologies, and was distributed over 10 sessions. The last afternoon of the 3-day meeting was dedicated to a field trip. About 90 delegates from 18 countries attended the meeting, with about one-third coming from each of Oceania, Asia and the rest of the world. Thirty-five delegates presented oral papers, some of whom presented posters as well, together with 19 delegates presenting a poster only.
As one can expect of a technology-based symposium, the presentations covered over 30 crops, mostly fruit, but also some vegetables and a few flowers. This was specifically extended to non-horticultural crops, too, with the first keynote address presented by Richard Spelman from the Livestock Improvement Corporation, New Zealand, being notable in several aspects. His topic was genomic selection in the breeding of dairy cows in New Zealand, which began in 2008 following the sequencing of the bovine genome and the development of genotyping platforms. Overcoming the next bottleneck of improving statistical techniques has meant that genomic predictions now are accurate enough to be commercially acceptable. However, the cost of genotyping, through SNP arrays or increasingly through genotyping-by-sequencing, will limit its application to well-funded breeding programmes for the time being.
The second keynote speaker, Professor Jacqueline Batley, Australia, demonstrated how detailed genomic information can assist plant breeding programmes. She presented the example of how allelic variation contributes to phenotypic variation in blackleg resistance in canola, and noted that important sources of disease resistance, such as copy number variants, are not always identified in genome sequences.

Considering that the early development of marker-assisted selection was largely focused on disease resistance, few papers were presented on this topic, however, this was balanced by more papers on consumer traits. The highly diverse range of traits, some of which were examined across several crops, ranged from flat fruit in peach to orange cauliflower, and sugar accumulation in papaya to flesh firmness in watermelon. In other crops, genomic resources are being developed in preparation for marker-assisted selection, in some cases for a set of economically important traits at the same time, taking the functional genomics approach, e.g. in cacao, but more commonly now through the sequencing of accessions to identify allelic variation through single nucleotide polymorphisms (SNPs). Whatever the scale of genomic analyses, they have their challenges for data management, which was the topic of several presenta-

› Symposium Convener Dr. Vincent Bus receiving the ISHS medal award from ISHS representative Dr. Susan Gardiner.

› ISHS representative Dr. Susan Gardiner (left) and Student Awards committee chair Dr. David Chagné (right) presenting the ISHS student awards for the best oral presentation to Siqi Zhang (second from right) and for the best poster presentation to Soon Li Teh (second from left).

› During the field trip, crop supply agronomist Tim Agnew of Heinz Wattie's explains the traits required of new processing cultivars for canning.

› Ms. Emma Taylor of Vineyard Plants giving a tour at their grape plant nursery during the field trip.

tions. Genetic characterisation of germplasm is at the basis of every breeding programme, in order to understand the diversity of a crop, hence the potential for genetic improvement for both specific/unique and generic traits. However, presentations on marker-assisted breeding were few at the symposium, perhaps reflecting the major step that is required to achieve implementation, as it comes with its own challenges in establishing high-throughput pipelines. Examples were the pyramiding of genes coding for bioactive compounds to improve the nutritional quality of tomato; the parent and seedling selection for powdery mildew and phylloxera resistance; flower sex and seedlessness in grape; production of polyploid lines in citrus; and the matching of breeding parents in apple based on their self-incompatibility alleles.

The ISHS student awards were presented to Siqi Zhang (Huazhong Agricultural University, China) for her oral presentation on the genetic analysis of polyembryony in citrus, and to Soon Li Teh (University of Minnesota, USA) for his poster on the QTL mapping of foliar phylloxera resistance in grape.

A main topic of the business meeting was the merging of the Molecular Markers and Biotechnology of Horticultural Species Working Groups and symposia. One of the drivers for this was that both symposia were relatively poorly attended. Drawing from a larger pool would ensure that the symposia remain financially viable. As both are in the Commission Molecular Biology and In Vitro Culture, it was thought that they had a natural fit and the motion was unanimously carried. The next combined meeting was proposed to proceed under the heading of 'International Symposium on Biotechnology and Molecular Breeding in Horticultural Species'. A collective of universities chaired by Professor Jun Wu of Nanjing Agricultural University will host the symposium in China in October 2020.

Vincent Bus

› Contact

Dr. Vincent Bus, Plant and Food Research, Private Bag 1401, Havelock North 4157, New Zealand, e-mail: vincent.bus@plantandfood.co.nz

› Combined Congress 2017 in South Africa

The Combined Congress is held annually, and in 2017, was convened by the South African Society for Crop Production with the Organising Committee comprising members from the four professional societies involved. The venue was Klein Kariba, a self-contained holiday resort in Bela-Bela, an agricultural community situated north of Johannesburg. The societies taking part in the Combined Congress included the South African Society for Horticultural Sciences (SASHS), the South African Society for Crop Production, the South African Soil Science Society and the South African Weed Science Society. Parallel sessions co-ordinated by each society proday. This proved to be extremely successful. Keynote speakers included Mr. Ivo Brants from Monsanto (South Africa), Prof. Dr. Rod Drew, Griffith University (Australia) and President of the International Society for Horticultural Science (ISHS), and Dr. Adriana Marais, University of KwaZulu-Natal (South Africa) and one of the short-listed Mars One Project volunteers. Mr. Ivo Brants' keynote presentation entitled "Facts and myths of glyphosate" focussed on the facts and myths of the use of glyphosate. Glyphosate is used widely, globally, as a tool for the management of invasive weeds and he highlighted the environmental fate, safety and benefits of glyphosate, as well as the versity of KwaZulu-Natal, with her presentation entitled "Watch this space: expanding our imaginations and our world", had the audience captivated with the latest preparations for the Mars One Project, including how the volunteers would be involved in the establishment of a sustainable settlement with a decreasing dependence on Earth. One of their aims is to investigate the ability to produce food on Mars and several trials are underway on Earth and are planned for Mars itself!

Each society organised a technical field trip, which focussed on projects or points of interest in the region in which the Combined Congress was held. The SASHS field trip

› Keynote speakers: A) Mr. Ivo Brants, Monsanto; B) Prof. Dr. Rod Drew, Griffith University and ISHS President; C) Dr. Adriana Marais, University of KwaZulu-Natal.

moted synergy between members of the different societies and provided a platform for delegates to attend any presentation of any of the societies. With the theme "Adaptability of agriculture in a changing world", 160 oral presentations and 113 posters were presented at the Congress, with the SASHS having the greatest number of presentations. Furthermore, there was an extremely high number of postgraduate students attending and presenting their research results. The SASHS in particular seeks to promote young scientists in diverse fields of horticultural science and the future certainly looks bright for horticulture in South Africa!

Apart from the parallel sessions for each society, this year the Combined Congress featured plenary sessions at the start of each morning session instead of a single session on the first

critics and myths related to the use of glyphosate. Prof. Drew, with his presentation entitled "There has never been a more important era to work in horticulture", inspired delegates with the potential impact of horticulture and horticultural science on alleviating poverty and malnutrition in a world where the global population is expected to reach 9 billion by 2050. Prof. Drew highlighted the contribution of horticultural crops in providing a range of nutrients, vitamins, anti-oxidants, medicines and income, as there is an enormous need to increase food production, consumption of nutrient-rich foods, and access to a balanced diet. He touched on aspects related to new technologies, as well as novel approaches to greening cities and revolutionising supply chains for horticultural products. Dr. Adriana Marais, a quantum biologist based at the Uni-

visited two farms close to Bela-Bela, which produce export quality peaches and apples, respectively. What made the visit even more interesting was the fact that the relatively warm Limpopo Province is not traditionally a deciduous fruit production area. The growers make use of low-chill cultivars of both peaches and apples. However, deciduous fruit horticultural practises are well-established in the cooler Mediterranean climates of the Western Cape of South Africa but must be adapted to the warm production areas to ensure optimum yield and quality. The growers also provided feedback on pest and disease control and it was very interesting to note that they prefer to implement 'green technologies' for pest and disease control.

The Combined Congress was wrapped up with a gala dinner where old and new friends

› Mr. Mark Penter (SASHS President, left), Dr. Nhlanhla Mathaba (SASHS Secretary, second from left) and Prof. Dr. Rod Drew (right) handing out A) the best MSc presentation award and B) the student travel award to Ms. L. Muchena; C) the best PhD presentation award to Mr. F. Zirebwa; the best poster presentation award to Ms. Nikki Combrink (D) and Dr. Riana Kleynhans (E); and F) the award for the best paper published in an international journal to Dr. Karin Hannweg.

enjoyed the evening together before heading home. The societies conferred a number of awards for excellence at the dinner and the SASHS was no exception. The SASHS conferred several awards, including the best MSc presentation for students studying towards a Masters degree in Science, the best PhD presentation for students studying towards a Doctoral degree in Science, the best poster presented at the Combined Congress, the best paper published in the South African Journal of Plant and Soil (SAJPS), as well as an award for the best paper published in a peer-reviewed international journal. A prestigious student travel award for the overall best student oral presentation at the Combined Congress was also conferred and was specifically for the attendance at an ISHS symposium of the student's choice.

The winners of this year's awards were:

- Best MSc presentation: Ms. L. Muchena – "Improved growth of hydroponically grown rough lemon (*Citrus jambhiri* lush) seedlings treated with kelp and organic extracts"
- Best PhD presentation: Mr. F. Zirebwa – "Use of continuous stem and fruit growth measurements for detecting water stress in apple orchards"
- Best posters: Ms. N. Combrink – "Evaluation of five Valencia cultivars at ARC-TSC ADDO" and Dr. R. Kleynhans – "Preliminary investigation of in vivo vegetative propagation methods for *Ornithogalum* bulbs"
- Best SAJPS paper: Dr. S. Laurie – "Agronomic performance of new cream to yellow-orange sweet potato cultivars in diverse environments across South Africa", South African Journal of Plant and Soil *32*, 147–155.
- Best international paper: Dr. K. Hannweg – "In vitro-induced tetraploids of *Plectranthus esculentus* are nematode-tolerant and have enhanced nutritional value", Euphytica *207*, 343–351.
- Student travel award: Ms. L. Muchena

The Society was extremely honoured that Prof. Dr. Rod Drew not only delivered the keynote address, but also participated in the Congress on his first visit to South Africa.

Karin Hannweg

› Contact

Dr. Karin Hannweg, ISHS and SASHS Council member, Agricultural Research Council – Tropical and Subtropical Crops, Private Bag X11208, Nelspruit Mpumalanga 1200, South Africa, e-mail: karin@arc.agric.za

› Prof. Rod Drew receiving a token of appreciation from the South African Society for Horticultural Sciences from Mr. Mark Penter (SASHS President, left), Dr. Nhlanhla Mathaba (SASHS Secretary, second from left) and Dr. Karin Hannweg (SASHS Council, second from right).

› Delegates learning about low-chill apple production in Limpopo Province. The farmer exports a large percentage of his crop.

From the Secretariat

New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Argentina: Assoc. Prof. Ana María Castagnino; **Australia:** Assoc. Prof. Rebecca Ford, Dr. Dane Thomas, Dr. James Robinson, Dr. Karma Pearce, Dr. Maryam Shirmohammadi, Dr. Mohammad Hassani, Dr. Peter Hayman, Dr. Shuang-Xi Zhou, Dr. Stephen Morris, Dr. Vinod Phogat, Mr. Adam Upton, Mr. Ian Quin, Mr. Muneer Rehman, Mr. Paul Dalley, Mr. Tim Pitt, Mr. Yan Zhi Lee, Mr. Zeshan Ali, Ms. Hebah AL Ubeed; **Belgium:** Assoc. Prof. Annemie Geeraerd, Audrey Miserez, Dr. Ans De Roeck, Dr. Moges Retta, Mekdim Assefa Kerisima, Mr. Birhane Tekilu, Siem Janssen; **Bosnia and Herzegovina:** Assist. Prof. Tatjana Jovanovic-Cvetkovic, Dr. Duska Delic; **Brazil:** Dr. Marcos Fonseca, Mr. Cleriton Souza, Prof. Carlinne Guimarães de Oliveira, Prof. Dr. Angelo Pedro Jacomino, Prof. Dr. Fernanda Souza, Prof. Dr. Ozenice dos Santos, Prof. Victor Maia; **Cameroon:** Mr. Pierre Marie DEFO, Mr. Robert Chauffeur Malli; **Canada:** Dr. Chanda Siddoo-Atwal, Dr. Marion Tétégan Simon, Mr. Jamie Dalimonte, Mr. Nicholas Nolet, Mr. Tyson Jennett, Mr. Zak Motala, Ms. Stéphanie Boudreau, Ms. Sylvie Petitclerc; **Chile:** Cristián González Rojas, Dr. Carolina Fredes, Dr. Mauricio Ortiz, Jean Paul Joublan, Mr. Javier Sánchez Contreras, Ms. Veronica Herrera, Prof. Dr. J.E. Alvaro Martinez-Carrasco, Prof. Dr. Julio Haberland, Prof. Giovanni Lobos; **China:** Assist. Prof. Xiaofeng Li, Assoc. Prof. Feng Cheng, Dr. Gaihua Qin, Dr. Jie Zhang, Dr. Rana Naveed Ur Rehman, Dr. Xiu Hu, Dr. Yong Li, Dr. Zong Yu, Guocheng Zu, Huiqin Zhang, Mr. Can Cen, Mr. Pan Liang, Prof. Chang Sheng Zhou, Prof. Dr. Kaichun Zhang, Prof. Dr. Linchun Mao, Prof. Dr. Pingsheng Leng, Prof. Dr. Yuanfeng Pan, Prof. Dr. Yuying Zhu, Prof. Shuhua Li, Prof. Yan Bin Hao, Prof. Yongping Zhang, Prof. Zhengguo Li, Prof. Zhongyun Piao, Yun Xiang Huang; **Chinese Taipei:** Dr. Hsin-Fu Yen, Dr. Wen-Li Lee; **Costa Rica:** Alexandra Miranda-Vindas, Dr. Luis Barboza-Barquero, Dr. Mario Araya, Mr. Johanny Castro; **Croatia:** Ales Vokurka; **Czech Republic:** Assoc. Prof. Ales Horna, Assoc. Prof. Miroslav Vosatka, Jan Námestek; **Denmark:** Dr. Alexandru Luca; **Ecuador:** Assist. Prof. Sofia Carvalho, Dr. Sandra Horvitz; **France:** Dr. Bénédicte Wenden, Dr. Claire Grosbellet, Mr. Antoine Martinez, Mr. Bernard Le Moine, Mr. Guillaume Beaugey, Sonia Meilland guibert; **Germany:** Dr. Christoph Weinert, Dr. Ludger Aldenhoff, Florian Demling, Jan-Christoph Richter, Ms. Eva Heinrich, Ms. Nadine Klein, Prof. Dr. Nicole van Dam; **Greece:** Mr. Georgios Foteinakis, Prof. John Gelegenis; **India:** Assist. Prof. Dadepeer Peerajade, Assist. Prof. K. Periannagounder Shanmugam, Assist. Prof. Sridhar Ramachandra, Dr. Anu Kalia, Dr. Bal Krishna, Mr. Ashok Meena, Mr. Jagmeet Singh, Ms. HarAmrit Kaur, Ms. N.C. Surakshitha, Narayanaswamy Papanna; **Indonesia:** Dr. Prita Sari Dewi, Gomos Silitonga, Ms. Laila Rahmawati, Prof. Dr. Daniel Saputra; **Iran:** Ali Nikbakht, Amene Ghorbani, Assist. Prof. Ali Azizi, Assist. Prof. Azizollah Khandan-Mirkohi, Assist. Prof. Kazem Kamali Ali Abad, Assist. Prof. Mousa Rasouli, Assist. Prof. Seyed Alireza Salami, Assoc. Prof. M. Reza Mehrnejad, Bita Khansarinejad, Dr. Lotfali Naseri, Dr. Mazaher Yousefi, Ehsan Ranjbaran, Elahe Armiyoun, Fahimeh Ghaemizadeh, Fatemeh Naseri, Ghazaleh Rouhani, Hassan Pirani, Hossein Gorgini Shabankareh, Hossein Sharifzadegan, Houman Sharifi, Khadijeh Alekasir, Khodayar Hemmati, Leila Hakimi, Mahdieh Karimi, Majid Shokrpour, Mansoureh Tavan, Maryam Haghighi, Marziye Rahimi Rizi, Masoud Naderpour, Massume Karbasi, Mehdi Sabet Jahromi, Mina Darehei, Mohamad Sadegh Sadeghi, Mohammad Mehdi Arab, Mohammad Sayyari, Mohammad Tabeei, Mostafa Joodaki, Mr. Ali Rezaei, Mr. Mohsen Yoosefzadeh-Najafabadi, Nabiyollah Ashrafi, Nastaran Hemmati, Prof. Mahmood Esna-Ashari, Raziyeh Rostami, Safdar Pour Mombeini, Sanaz Yousefi, Sarah Khorasaninejad, Seyed Samad Moradi Heydarabad, Shadi Mohamadinezhad, Siamak Kalantari, Sima Shirahmadi, Sirvan Mansouri, Somayeh Amraee Tabar, Somayeh Bahrami, Zahra Sarem; **Israel:** Dr. Rotem Harel Beja, Dr. Smadar Harpaz-Saad, Mr. Amit Fahima, Mr. Moshe Emergui, Prof. Eliezer E. Goldschmidt; **Italy:** Alexandra Boini, Assist. Prof. Salvatore La Bella, Christian Andergassen, Dr. Annalisa Marchese, Dr. Aziz Akkak, Dr. Federico Ferioli, Dr. Francesca Biondi, Dr. Loriana Cardone, Prof. Leonardo Schena; **Jamaica:** Clinton Boyd; **Japan:** Assist. Prof. Yozo Mitarai, Assoc. Prof. Kaori Kikuchi, Assoc. Prof. Katsumi Ohyama, Assoc. Prof. Ken Takahata, Dr. Horikoshi Humberto Mitio, Dr. Masahumi Johkan, Dr. Sharon Marie Garrido, Kana Shirai, Kosei Awaji, Mr. Hiroyuki Tomiyama, Mr. Hong Lin, Mr. Mkoto Ishiguro, Mr. Takayuki Ando, Mr. Takuya Nakagawa, Mr. Yogendra Gharti Magar, Mr. Yoshiro Harada, Ms. Ampa Kongsuwan, Ms. Hatsumi Kumagai, Ms. Hsiao-Wen Wang, Ms. Luciana Isabel Sales Lopez de Lima, Ms. Misaki Ishibashi, Ms. Mizuki Kitayama, Ms. Sirinan Suktawee, Ms. Sorawee Thunyamada, Prof. Yasutaka Kubo, Shun Hashimoto, Sofia Penabaz-Wiley, Surina Boerzhijin, Takumi Taguchi, Tenri Tou, Yui Tsunoda; **Korea (Republic of):** Assoc. Prof. Yang Gyu Ku, Dr. Chun Hwan Kim, Dr. Dong Sub Kim, Dr. HyeRan Kim, Dr. Jeongyeo Lee, Dr. Me Hea Park, Eom-Ji Hwang, Joonyup Kim, Mr. Do Su Park, Mr. Jingi Yoo, Mr. Joong Gon Kim, Mr. Nay Myo Win, Ms. A Reum Han, Ms. Gyeong-dan Yu, Ms. Sewon Oh, Ms. Youngbin Jung, Prof. Nam-il Park, Yongiu Choi; **Kosovo:** Ms. Iliriana Miftari; **Latvia:** Dr. Karina Juhnevica-Radenkova, Inese Drudze, Ms. Inese Drudze, Vitalijs Radenkovs; **Lebanon:** Mr. Muhamad Baquer; **Lithuania:** Dr. Danguole Juskeviciene, Dr. Rasa Karkleliene, Sergej Marmazov; **Mexico:** Angelica Torres Avila, Dr. Daisy Perez-Brito, Dr. Élida Gastélum-Martínez, Dr. Enrique Vazquez Garcia, Dr. Laura Silva, Dr. Sweetia Ramirez, Mr. Theojary Crisantes Enciso; **Mongolia:** Mr. Davaanyam Davaajav; **Morocco:** Mr. Paul-Eric Jarry; **Netherlands:** Arman Beyraghdar Kashkooli, Assist. Prof. Julian Verdonk, Dr. Bastiaan Brouwer, Dr. Suzan Gabriels, Mr. Ahmed Nzibo, Mr. Alex van Schaik, Mr. Koen van den Hurk, Mr. Rob Veltman, Ms. Wilhelmine Geuijen, Nafiseh Gheshnizjani; **New Zealand:** Mr. Andrew Barnett, Ms. Jeritah Tongonya; **Nigeria:** Mr. Sumeet Pandey; **Norway:** Fredd Vergara; **Oman:** Mr. Shauwn Basson; **Pakistan:** Assist. Prof. Rana Muhammad Atif, Assist. Prof. Shaghef Ejaz; **Paraguay:** Mr. Alberto Britez; **Philippines:** Dr. Matilde Maunahan, Dr. Perlita Nuevo, Prof. Dr. Fabian Dayrit; **Poland:** Dr. Dawid Olewnicki, Dr. Kalina Sikorska-Zimny, Dr. Wenjing Chen, Ms. Aneta Matulska, Ms. Ewa Badelek, Prof. Dariusz Grzebelus; **Portugal:** Flávia Fernandes, Mr. Mário Oliveira; **Reunion:** Dr. Elodie Dorey, Dr. Jean-Christophe Meile; **Romania:** Dr. Alexandru Ciric, Mr. Nazar Alghasheem, Ms. Amuza Angela; **Russian Federation:** Dr. Irina Chernobay, Dr. Natalya Marko, Gleb Zakharian; **Saudi Arabia:** Prof. Dr. Ahmed Mohammed AlJabr; **Senegal:** Dieynaba Sall, Moctar Fall, Oumar Sock; **Serbia:** Djordje Boskov, Dr. Darko Jevremovic, Dr. Milena Djordjevic, Dr. Olga Mitrovic, Ivana Glii263, Mr. Uros Cakar; **Slovenia:** Prof. Dr. Denis Stajnko; **South Africa:** Belinda Potgieter, Danie Vaughan, Dr. Alemayehu Tsige, Dr. Asanda Mditshwa, Dr. Buliyaminu Alimi, Dr. Letitia Schoeman, Dr. Waafeka Vardien, Dr. Walter Fourie, Mr. Anton Huysamer, Mr. Daan Brink, Mr. Frederik Voigt, Mr. James Wonder Doe, Mr. Joseph Hulbert, Mr. Kenias Chigwaya, Mr. Olaoluwa Olarewaju, Mr. Rudolph Cronje, Mr. Stenford Matsikidze, Ms. Anel Botes, Ms. Chiedza Tsvakirai, Ms. Feroza October, Ms. Suzane Pols, Prof. Dr. Johan Spies, Prof. Michael Pillay, Prof. Paul Fourie; **Spain:** Dr. Almudena Bayo-Canha, Dr. Antonio Vicent, Dr. Francisco Beitia, Dr. Gregorio López-Ortega, Dr. Isabel

Mendiara, Dr. Joaquim Bellvert Rios, Dr. Jose Francisco García González, Dr. Marta Francisco, Dr. Martin Carlos Mottura, Dr. Paco Romero, Dr. Roberto Moreno Pinel, Juan Gil, Julia Morales Alfaro, Mr. Ayoub Fathi Najafabadi, Mr. Daniel Fernández, Ms. Carla Guijarro Real, Ms. Laia Torregrosa, Ms. Marina Cano Lamadrid, Ms. Rebeca Gil, Pilar Legua Murcia, Prof. Dr. Asunción Amorós, Prof. Dr. Cordoba Ramos, Prof. Dr. Encarna Gómez-Plaza, Prof. Dr. Fátima Martínez Ruiz, Prof. Dr. Francisca Hernández García, Prof. Dr. Juan José Martínez Nicolás, Prof. Santiago Ruiz-Moyano, Sara Herrera; **Spain - Canary Islands:** Juan Alberto Cabrera García; **Sri Lanka:** Dr. DLC Kumari Fonseka, Dr. Ilmi Hewajulige, Dr. W.A.J.P. Wijesinghe, Ms. Madushika Ranasinghe; **Switzerland:** Dr. Wentao Wu; **Thailand:** Assist. Prof. Panida Boonyaritthongchai, Assist. Prof. Sutthiwal Setha, Assist. Prof. warangkana srichamnong, Dr. Hataitip Nimitkeatkai, Dr. Issaya Pusittigul, Dr. Rattapon Saengrayap, Dr. Rattapong Suwalak, Dr. Rujira Tisarum, Dr. Songsin Photchanachai, Dr. Supreena Srisaikham, Mr. Sitthisak Intarasit, Mr. Suwit Chaikiattiyos, Mr. Uthai Noppakoonwong, Ms. Kanokwan Panjama, Ms. Kittiya Boonrod, Ms. Orrawan Pluemjit, Ms. Ratchadawan Puangradab, Ms. Sirinrat Phuyodying, Ms. Sureeporn Sukporn, Ms. Wanichaya Chaiwimol, Ms. Yaowarat Wongsrisakulkaew, Nuttapong Ruttanadech, Wanwarang Pattanapo; **Turkey:** Assoc. Prof. Kazim Gunduz, Assoc. Prof. Mehmet Sutyemez, Dr. Melike Cetinbas, Dr. Stuart Lucas, Esra Alim, Fusun Cagan, Mr. Ali Riza Sahinoglu, Nazim Arundar, Prof. Dr. Ahmet Balkaya, Prof. Dr. Dilek Anaç, Prof. Dr. Güner Arkun; **United Kingdom:** Dr. Joanna Niziolomski, Dr. Lorraine Fisher, Dr. Wiktor Jurkowski, Mr. Harry Wright, Mr. John Williamson, Mr. Matthew Casey, Mr. Richard Colgan, Mr. Simon Fox, Ms. Angela Navarro-Calderon, Ms. Charlotte Taylor, Ms. Claire Donkin, Ms. Rosalind Fisher; **United States of America:** Alex Harkess, Aleyda Acosta Rangel, Angelyn Hilton, Anne Spafford, Assist. Prof. Orville Baldos, Assoc. Prof. Frederick Michel, Astrid Volder, Brian Gardener, Brian Whipker, Catherine Mae Culumber, Charles Burks, Dirk Muntean, Dr. Andreas Westphal, Dr. Cain C. Hickey, Dr. Garrett Owen, Dr. Jennifer Randall, Dr. Lesley Judd, Dr. Michele Scheiber, Dr. Nikki Rothwell, Dr. Phoebe Gordon, Dr. Steven McArtney, Dr. Xinwang Wang, Emily Pochubay, Eric Hager, James Smith, Joanne Norris, Jon Munk, Jonathan Brosmer, Laura Kaderabek, Miguel Macias, Mike Key, Mr. David Doll, Mr. David Haviland, Mr. Hunter Landis, Mr. Jacob Snelling, Mr. Leslie Slack, Mr. Paul Bartley, Mr. Stephen Vernon, Mr. Wade Blanchard, Mr. William Radler, Mr. Zach Steeno, Ms. Abbey Noah, Ms. Carolina Pinto, Ms. Dessiree P. Zerpa Catanho, Ms. Diep Tran, Ms. Eleinis Avila-Lovera, Ms. Hannah Lepsch, Ms. Paige Herring, Nastaran Basiri Jahromi, Patricia Klein, Prof. Anthony Varghese, Prof. J. Chris Pires, Ronald Revord, Ruth Kobayashi, Suzanne Sanxter, Taylor Chae, Tripti Vashisth, Yi-Wen Wang, Zach Bagley; **Uruguay:** Dr. Fernando Rivas, Erika Paulsen, Ms. Magdalena Irazoqui

› In memoriam

Dr. Jordi Marsal (1965-2017)

It is with great sadness that we announce the passing of our friend and colleague, Dr. Jordi Marsal, on March 12, 2017, after a 10-month struggle with cancer. Jordi was Head of the Efficient Use of Water Program at IRTA, the Research and Technology Institute for Agriculture and Food, of the Government of Catalonia in Spain. He was dedicated to conducting research and educating farmers and policy makers on ways to improve irrigation efficiency and management of perennial horticultural crops in the Mediterranean climate of north-eastern Spain. He, along with his colleagues, conducted some of the most data-intense, field experiments ever reported on regulated deficit irrigation of multiple crops, including peach, pear, grape, apple, almond and cherry. He was not satisfied with just determining the water use of crops and critical periods for water stress, but his focus was on developing a thorough understanding of the environmental and physiological drivers of plant water use. In the latter years of his career, he focused on developing and improving environmentally-based models for predicting crop water during the growing season. Dr. Marsal was a meticulous and extremely thoughtful researcher who was always focused on the quality of the data his team collected, as well as the thoroughness with which the data were analyzed. He, along with the team of researchers that he was associated with, have provided the foundation for greatly improved irrigation efficiency of horticultural crops in general, and specifically for the Catalonian region, which is a major center for fruit crop production in southern Europe.

Dr. Marsal was active in several scientific organizations, particularly ISHS. He was a leader in the ISHS irrigation of horticultural crops area, convened and chaired its latest symposium (VIII International Symposium on Irrigation of Horticultural Crops) held in Lleida, Spain, in 2015, and was Chair of the ISHS Water Relations Working Group at the time of his death. He was also co-organizer of the VII International Peach Symposium that was held in Lleida in 2009. He served on the editorial review board of a number of scientific journals and was respected and sought after for his scientific expertise regarding horticultural crop water use.

Jordi was born in Tarragona, Spain on March 21, 1965. He was a good young tennis player but found that he had greater interests in nature than in sport at a young age. He studied agricultural engineering at the Polytechnic University of Catalonia in Barcelona and the University of Lleida. He received a PhD in Agricultural Engineering at the University of Lleida in 1997. After receiving his doctoral degree, he served as the research supervisor for several PhD students at the University of Lleida. He enjoyed nature and really felt alive walking in the mountains, observing natural landscapes and studying plants and birds. After meeting his future wife, Silvia, he gained a fondness for fine French wine and cheeses. He was a bit of a "renaissance man" and enjoyed classical music, studied the writings of Greek philosophers and liked to tune into "A Prairie Home Companion: News from Lake Wobegon" on US National Public Radio when he had the opportunity. Jordi approached science and life with an intensity that naturally commanded respect but at the same time had a self-deprecating humor that made him a friend of all who really knew him. IRTA and Catalonia have lost an irreplaceable leader in their Efficient Use of Water Program, the horticultural community has lost a valued scientific colleague, and others of us have lost a true friend.

Ted DeJong, UC Davis, USA, and Chair ISHS Section Pome and Stone Fruits; Joan Girona, IRTA, Spain; Merce Mata, IRTA, Spain; Boris Basile, Università degli Studi di Napoli Federico II, Italy

› 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 Section, Commission 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 2017

- July 10-16, 2017, Baise City, Guangxi (China): **XII International Mango Symposium.** Info: Wen-ming Huang, Tiandong County People's Government, Baise City, China. Phone: (86)776-5232669, Fax: (86)776-5232669, E-mail: tdxfb37@163.com or Prof. Dr. Xinhua He, 100 Daxue Rd, College of Agriculture, Guangxi University, Nanning, Guangxi, 530004, China. Phone: (86)771-3270184, Fax: (86)771-3235612, E-mail: honest66222@163.com or Prof. Cheng-xin He, Guangxi Institute of Botany, Chinese Academy of Sciences, Yanshan Town, Guilin city, China. Fax: (86)773-3550067, E-mail: 228268892@qq.com E-mail symposium: mango2017_china@163.com Web: http://www.mango2017.com.cn
- August 15-19, 2017, Atakum, Samsun (Turkey): **IX International Congress on Hazelnut.** Info: Prof. Dr. Celal Tuncer, Ondokuz Mayis University, Faculty of Agriculture, Department of Plant Protection, 55139 Atakum, Samsun, Turkey. Phone: (90)3623121919, Fax: (90)3624576034, E-mail: celalt@omu.edu.tr Web: http://www.hazelnut2017.org
- August 20-24, 2017, Beijing (China): **Greensys 2017 - International Symposium on New Technologies for Environment Control, Energy-Saving and Crop Production in Greenhouse and Plant Factory.** Info: Prof. Dr. Qichang Yang, 211, IEDA, CAAS, 12#, Zhongguancun South Street, Haidian District, Beijing City, 100081, China. Phone: (86)010-82105983, Fax: (86)010-82106021, E-mail: yangqichang@caas.cn or Prof. Dr. Weihong Luo, College of Agriculture, Nanjing Agricultural University, No 1 Rd Weigang, Nanjing, Jiangsu, 210095, China. Phone: (86)25-84399100, Fax: (86)25-84399100, E-mail: lwh@njau.edu.cn E-mail symposium: greensys2017@chinastargroup.com Web: http://www.greensys2017.org
- August 20-25, 2017, Portland, Oregon (United States of America): **International Symposium on Growing Media, Soilless Cultivation, and Compost Utilization in Horticulture.** Info: Brian Jackson, NC State University, Horticulture, 114 Kilgore Hall - Campus Box 7609, Raleigh, NC 27695-7809, United States of America. Phone: (1)9195133187, Fax: (1)9195133191, E-mail: brian_jackson@ncsu.edu Web: http://newbeginningsmanagement.com/compsubsci2017/
- August 27-31, 2017, Chiba (Japan): **XIII International Symposium on Plant Bioregulators in Fruit Production.** Info: Prof. Dr. Satoru Kondo, Gratuate School of Horticulture, Chiba University, Matsudo, Chiba, 271-8510, Japan. Phone: (81)-47-308-8800, Fax: (81)-47-308-8800, E-mail: s-kondo@faculty.chiba-u.jp E-mail symposium: pgr-fruit2017@jtbcom.co.jp Web: http://www.pgr-fruit2017.org/
- September 3-6, 2017, Potsdam (Germany): **XIV International Asparagus Symposium.** Info: Dr. Jan Graefe, Institute of Veg.& Ornam.Crops, Theodor-Echtermeyer-Weg, 14979 Grossbeeren, Germany. Phone: (49) 033701 78 353, E-mail: graefe@igzev.de or Carmen Feller, Inst. of Vegetable and Ornamental Crops, Theodor Echtermeyer Weg 1, 14979 Grossbeeren, Germany. Phone: (49)3370178368, E-mail: feller@igzev.de or Dr. Bernhard Brueckner, Leibniz-Institute of Veg and Ornamentals, Theodor-Echtermeyer-Weg 1, 14979 Grossbeeren, Germany. Phone: (49)33701 78252, Fax: (49)33701 55391, E-mail: brueckner@igzev.de E-mail symposium: ias2017@igzev.de Web: http://www.ias2017potsdam.org/
- September 4-7, 2017, Stellenbosch (South Africa): **VII International Conference on Managing Quality in Chains (MQUIC2017) and II International Symposium on Ornamentals in association with XIII International Protea Research Symposium.** Info: Prof. Dr. Umezuruike Linus Opara, University of Stellenbosch, Faculty of AgriSciences, Private Bag X1, Stellenbosch 7602, South Africa. Phone: (27) 21 808 4064, Fax: (27) 21 808 2121, E-mail: opara@sun.ac.za or Dr. Lynn Hoffman, PO Box 3318, Matieland, 7602, Stellenbosch, South Africa. Phone: (27)218082383, Fax: (27)218082121, E-mail: ewh@sun.ac.za or Ms. Emily Rigby, PO Box 418, Mapleton, Queensland 4560, Australia. Phone: (61)754423055, Fax: (61)754423044, E-mail: emilyr@cedarhill.com.au E-mail symposium: reventer@netactive.co.za Web: http://www.ishs2017stellenbosch.co.za
- September 4-7, 2017, Tehran (Iran): **I International Conference & X National Horticultural Science Congress of Iran (IrHC2017) - Theme: Productivity of horticultural crops in Iran: potentials, production limitations, possible solutions and international collaborations.** Info: Prof. Kazem Arzani, Department of Horticultural Science, Tarbiat Modares University (TMU), P.O.Box 14115-336, Tehran, Iran. Phone: (98)2148292094, Fax: (98)2148292200, E-mail: arzani_k@modares.ac.ir E-mail symposium: IrHC2017@gmail.com Web: http://www.IrHC2017.org
- September 5-8, 2017, Bengaluru (India): **International Symposium on Horticulture: Priorities and Emerging Trends.** Info: Dr. M.R. Dinesh, Principal Scientist - President SPH, Division of Fruit Crops - ICAR, Sadashivanagar - IIHR, Bangalore, Karnataka, 560089, India. Phone: (91)80-228466471, Fax: (91)80-28466291, E-mail: drmrdinesh@gmail.com or Dr. C. Aswath, Principle Scientist & Head, Division, Ornamental Crops, Vice-President, SPH, ICAR-Indian Institute of Hort. Research, Hessaraghatta Lake Post, Bengaluru, 560089, India. Phone: (91)8028466420, Fax: (90)8028466291, E-mail: aswath@iihr.res.in or Dr. Prakash C. Tripathi, Principle Scientist & Head (I/C), Division of Plant Genetic Resources, ICAR-Indian Institute of Hort. Research, Hessaraghatta Lake Post, Bengaluru 560089, India. Phone: (91)8028466420, Fax: (91)8028466291, E-mail: prakaashtripathii2000@yahoo.co.in E-mail symposium: goldjubiihrsym@gmail.com Web: http://www.intsym.com
- September 6-9, 2017, Porto (Portugal): **IX International Symposium on Kiwifruit.** Info: Prof. Dr. Maria Dulce Antunes, Universidade Do Algarve, FCT, Campus de Gambelas, 8005-139 Faro, Portugal. E-mail: mantunes@ualg.pt or Prof. Dr. Pedro Pablo Gallego, Faculty of Biology, University of Vigo, Campus Universitario, 36310 Pontevedra Vigo, Spain. Phone: (34) 986812995, Fax: (34) 986812556, E-mail: pgallego@uvigo.es E-mail symposium: IXISK@aphorticultura.pt Web: http://www.aphorticultura.pt/ixisk.html
- September 12-15, 2017, Bologna (Italy): **International Symposium on Greener Cities for More Efficient Ecosystem Services in a Climate Changing World.** Info: Dr. Francesco Orsini, University of Bologna, Viale fanin, 44, Bologne 40127, Italy. Phone: (39)0512096677, Fax: (39)0512096241, E-mail: f.orsini@unibo.it or Teodoro Georgiadis, National Research Council, via P.Gobetti 101, 40129 Bologna, Italy. E-mail: t.georgiadis@ibimet.cnr.it or Prof. Dr. Giorgio Prosdocimi Gianquinto, Dip. Scienze Agrarie, DiPSA, Università degli Studi di Bologna, Viale Fanin, 44 - 40127 Bologna, Italy. Phone: (39) 0512096663, Fax: (39) 0512096245, E-mail: giorgio.gianquinto@unibo.it E-mail symposium: greencities2017@sistemacongressi.com Web: http://www.greencities2017.org/
- September 12-14, 2017, Jeonju (Korea (Republic of)): **IV Asia Symposium on Quality Management in Postharvest Systems.** Info: Dr. Ji Gang Kim, Nat. Institute of Hort.and Herbal Science, Nongsaengmyung Ro 100, 55364 Wanju, Korea (Republic of). Phone: (82) 63-238-6500, E-mail: kjg3@korea.kr E-mail symposium: info@asiapostharvest2017.kr Web: http://asiapostharvest2017.kr/
- September 18-22, 2017, Elche, Valencia (Spain): **IV International Symposium on Pomegranate and Minor Mediterranean Fruits.** Info: Dr. Julian Bartual, Estación Experimental Agraria, Ctra Dolores Km.1, 03290 Elche, Alicante, Spain. Phone: (34)965455952, E-mail: bartual_jul@gva.es or Dr. Maria Luisa Badenes, Secretary General EUCARPIA, IVIA, 4 Apartado Oficial, 46113 Moncada (Valencia), Spain. Phone: (34)9634 24049, Fax: (34)9634 24106, E-mail: badenes_mlu@gva.es E-mail symposium: science@pomegranate2017.org Web: http://pomegranate2017.org

- September 18-22, 2017, Antananarivo (Madagascar): **International Symposium on Survey of Uses of Plant Genetic Resources to the Benefit of Local Populations.** Info: Prof. Dr. Romaine Ramananarivo, Dept Agro-Management, Ecole Sup. de Sciences Agronomiques, Univ. d'Antananarivo, 101 Antananarivo, Madagascar. Phone: (261)20 24 812 92, E-mail: agromanagement1@yahoo.fr E-mail symposium: contact@madashs-pgr.com Web: http://www.madashs-pgr.com/
- October 2-6, 2017, Trebinje (Bosnia and Herzegovina): **II International Symposium on Fruit Culture along Silk Road Countries.** Info: Prof. D Gordana Djuric, University of Banjaluka, Genetic Resources Institute, Bulevar vojvode Petra Bojovica 1A, 78000 Banjaluka, Bosnia and Herzegovina. Phone: (387)51461392, Fax: (387)51463024, E-mail: gordana.djuric@igr.unibl.org E-mail symposium: info@silksym2017.org Web: http://silksym2017.org/
- October 9-13, 2017, Samsun (Turkey): **VI International Chestnut Symposium.** Info: Prof. Dr. Umit Serdar, Ondokuz Mayis University, Faculty of Agriculture, Horticultural Department, 55139 Samsun, Turkey. Phone: (90)3623121919, Fax: (90)3624576034, E-mail: userdar@omu.edu.tr Web: http://chestnut2017.org/
- October 15-19, 2017, Havana (Cuba): **IX International Pineapple Symposium.** Info: Dr. Juliette Valdés-Infante, IIFT, Ave. 7ma e/ 30 y 32, Miramar, Playa, 10100 C. Habana, Cuba. Phone: (53-7) 209-3585, Fax: (53-7) 204-6794, E-mail: mejoramiento@iift.cu E-mail symposium: fruticultura2017@iift.cu Web: http://www.fruticulturacubana.co.cu/fruticultura.html
- October 17-20, 2017, Madrid (Spain): **VI International Conference Postharvest Unlimited.** Info: Prof. Dr. Daniel Valero, University Miguel Hernandez, Ctra. Beniel Km. 3,2, 3312 Orihuela (Alicante), Spain. Phone: (34)966749743, Fax: (34)966749677, E-mail: daniel.valero@umh.es or Dr. Maria I. Gil, CEBAS-CSIC, Campus Universitario de Espinardo, Ed. 25 (Apdo 164, Espinardo), Murcia 30100, Spain. Phone: (34)968396315, Fax: (34)968396213, E-mail: migil@cebas.csic.es Web: http://www.postharvest-unlimited2017.org
- October 24-27, 2017, Mérida Yucatán (Mexico): **V International Symposium on Papaya.** Info: Dr. Jorge Manuel Santamaría-Fernandez, Centro de Investigación Cientifica, de Yucatan A.C., Biotecnología, Calle 43 No. 130 Col. Chuburná de Hidalgo, Mérida, Yucatán CP 97200, Mexico. Phone: (52)9999428330ext203, Fax: (52)9999813900, E-mail: jorgesm@cicy.mx E-mail symposium: symposium.papaya@cicy.mx Web: http://www.cicy.mx/sitios/V-Symposium-on-papaya/index.html
- November 4-7, 2017, Taichung (Chinese Taipei): **I International Symposium on Bonsai.** Info: Dr. Hsueh-Shih Lin, Director, TDAIS, Council of Agriculture, No.370 Song-Hwai Road, 51544 Changhua Tatsuen Village, Chinese Taipei. Phone: (886)48522624, Fax: (886)48521148, E-mail: hslin@tdais.gov.tw or Dr. Hsin-Fu Yen, No. 1, Guancian Rd., 40453 Taichung, Chinese Taipei. Phone: (886)4-23285320, E-mail: hfyen@mail.nmns.edu.tw or Dr. Sean SC Huang, 10, Lane 91, Zhong Xiao Street, 510 Taiwan Yuanlin City, Changhua, Chinese Taipei. E-mail: seanschuang@yahoo.com.tw E-mail symposium: 2017bonsai@gmail.com Web: http://www.bonsai2017.com.tw/
- November 5-9, 2017, Adelaide (Australia): **VII International Symposium on Almonds and Pistachios.** Info: Dr. Michelle Wirthensohn, Discipline of Wine and Horticulture, Waite Campus, University of Adelaide, PMB 1 Glen Osmond SA 5064, Australia. Phone: (61)883136653, E-mail: michelle.wirthensohn@adelaide.edu.au Web: http://www.isap2017.com.au
- November 29 - December 1, 2017, Santiago (Chile): **VIII International Symposium on Walnut, Cashew and Pecan.** Info: Alvaro Jimenez, v. Kennedy 6690 of. 301 Vitacura, Santiago 7650672, Chile. Phone: (56)228257904, E-mail: ajimenez@chilenut.cl or Vittorio Bianchini, Avenida La Dehesa 1201 office 522, Lo Barnechea, Santiago, Chile. E-mail: vbianchini@frunut.cl E-mail symposium: chilenut@chilenut.cl Web: http://www.chilenut.cl/symposium

Year 2018

- March 7-9, 2018, Goyang (Korea (Republic of)): **III International Orchid Symposium.** Info: Prof. Dr. Ki Sun Kim, Department of Plant Science, CALS, Seoul National University, Seoul 151-921, Korea (Republic of). Phone: (82)2-880-4561, Fax: (82)2-873-2056, E-mail: kisun@snu.ac.kr E-mail symposium: info@ios2018.kr Web: http://ios2018.kr
- March 26-28, 2018, Bangkok (Thailand): **III International Symposium on Plant Cryopreservation.** 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: cryosymp2018@gmail.com Web: http://www.sc.mahidol.ac.th/scpl/cryosymp2018
- May 29-31, 2018, Bordeaux-Arcachon (France): **XXI CIPA Congress on Agriculture, Plastics and Environment.** Info: Mr. Bernard Le Moine, CIPA-CPA-APE, Plasticulture in Agriculture, 125 rue Aristide Briand, 92300 Levallois Perret, France. Phone: (33)144011649, E-mail: b.lemoine@plastiques-agriculture.com Web: http://cipa-congress.com/
- June 11-15, 2018, Athens (Greece): **XV International Symposium on Processing Tomato - XIII World Processing Tomato Congress.** Info: Prof. Dr. Montaña Cámara, Dpto. Nutrición y Bromatología II, Facultad Farmacia. UCM, Plaza Ramón y Cajal sn, 28040 Madrid, Spain. Phone: (34) 913941808, Fax: (34) 913941799, E-mail: mcamara@farm.ucm.es or Dr. Luca Sandei, ssica, Tomato area, Viale f.Tanara 31/a, 43121 Parma PR, Italy. Phone: (39) 0521795257, Fax: (39) 0521771829, E-mail: luca.sandei@ssica.it or Dr. Panagiotis Kalaitzis, Mediterranean Agronomic Inst. Of Chania, 85, Macedonia Str. P.O. Box 85, 73100 Chania, Greece. Phone: (30)2821035030, E-mail: panagiot@maich.gr E-mail symposium: wptc2018@tomate.org
- July 15-20, 2018, Bordeaux (France): **XII International Conference on Grapevine Breeding and Genetics.** Info: Prof. Serge Delrot, ISVV, 210 Chemin de Leysotte, 33882 Villenave d'Ornon, France. Phone: (33) 631122791, Fax: (33)557575903, E-mail: serge.delrot@inra.fr E-mail symposium: gbg2018@u-bordeaux.fr Web: http://gbg2018.u-bordeaux.fr/en

- August 12-16, 2018, Istanbul (Turkey): **XXX International Horticultural Congress: IHC2018.** Info: Prof. Dr. Yüksel Tüzel, Ege University, Agriculture Faculty, Department of Horticulture, 35100 Bornova Izmir, Turkey. Phone: (90)2323111398, Fax: (90)2323881865, E-mail: yuksel.tuzel@ege.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org

Symposia at IHC2018:

- August 12-16, 2018, Istanbul (Turkey): **XIX International Symposium on Horticultural Economics and Management and VII International Symposium on Improving the Performance of Supply Chains in the Transitional Economies and II International Symposium on Horticulture Economics, Marketing and Consumer Research.** Info: Prof. Dr. Ismet Boz, OMU Faculty of Agriculture, Department of A, OMU Faculty of Agriculture, Department of A, OMU Faculty of Agriculture, 55139 Samsun, Turkey. Phone: 3623121919, E-mail: ismet.boz@omu.edu.tr or Prof. Dr. Peter J. Batt, 3 Rodondo Place, Shelley, WA 6148, Australia. Phone: (61)401636242, Fax: (61)8 9266 3063, E-mail: peterjbatt@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S24.html
- August 12-16, 2018, Istanbul (Turkey): **VIII International Symposium on Education, Research Training and Consultancy.** Info: Dr. Rémi Kahane, CIRAD, Dept Persyst TA B-DIR/09, Avenue Agropolis, 34398 Montpellier cedex 5, France. Phone: (33)467614938, E-mail: remi.kahane@cirad.fr or Prof. Dr. Ismet Boz, OMU Faculty of Agriculture, Department of A, OMU Faculty of Agriculture, Department of A, OMU Faculty of Agriculture, 55139 Samsun, Turkey. Phone: 3623121919, E-mail: ismet.boz@omu.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S36.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Evaluation of Cultivars, Rootstocks and Management Systems for Sustainable Production of Deciduous Fruit Crops.** Info: Dr. Gregory L. Reighard, Department of Horticulture, 170 Poole Agricultural Center, Box 340319, Clemson, SC 29634-0319, United States of America. Phone: (1)8646564962, Fax: (1)8646564960, E-mail: grghrd@clemson.edu or Brunella Morandi, Università di Bologna, Viale Fanin 44, 40127 Bologna, Italy. E-mail: brunella.morandi@unibo.it or

Prof. Dr. Ayzin B. Küden, University of Cukurova, Dean of the Faculty of Agriculture, Department of Horticulture, 01330 Adana, Turkey. Phone: (90)3386364/3386447, Fax: (90)3386364/3386447, E-mail: abkuden@cu.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S09.html

- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Viticulture: Primary Production and Processing.** Info: Prof. Dr. Zeki Kara, Selcuk University Faculty of Agriculture, Department of Horticulture, 42003 Konya Selcuklu, Turkey. Phone: (90)332-2232899, Fax: (90)332-2410108, E-mail: zkara@selcuk.edu.tr or Prof. Dr. Gökhan Söylemezoglu, Ankara University, Faculty of Agriculture, Department of Horticulture, Ankara 06110, Turkey. Phone: (90)3125961304, Fax: (90)3123179119, E-mail: soylemez@agri.ankara.edu.tr or Prof. Dr. Ahmet Altindisli, Ege University Faculty of Agriculture, Department of Horticulture, 35100 BornovaIzmir, Turkey. Phone: (90)2323882622, Fax: (90)2323881865, E-mail: ahmet.altindisli@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S13.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Soilless Culture.** Info: Prof. Dr. Michael Raviv, Agric. Res. Organization, Newe Ya'ar Research Center, PO Box 1021, Ramat Yishay 30095, Israel. Phone: (972)49539505, Fax: (972)49836936, E-mail: mraviv@volcani.agri.gov.il or Prof. Dr. Ayse Gül, Department of Horticulture, Faculty of Agriculture, Ege University, 35100 Bornova Izmir, Turkey. Phone: (90)2323884000, Fax: (90)2323881865, E-mail: ayse.gul@ege.edu.tr or Prof. Dr. H. Yildiz Dasgan, Cukurova University, Agricultural Faculty, Horticultural Department, 01330 Adana, Turkey. Phone: (90)3223386388, Fax: (90)3223386388, E-mail: dasgan@mail.cu.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S18.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Root and Tuber Crops: Value Added Crops for the Next Generation.** Info: Dr. Ali Fuat Gokce, Ömer Halisdemir University, Faculty of Agric. Sci. and Technologies, Department of Agri. Genetic Engineering, 51240 Nigde, Turkey. Phone: (90)05365434241, E-mail: gokce01@yahoo.com or Prof. Dr. Umezuruike Linus Opara, University of Stellenbosch, Faculty of AgriSciences, Private Bag X1, Stellenbosch 7602, South Africa. Phone: (27) 21 808 4064, Fax: (27) 21 808 2121, E-mail: opara@sun.ac.za E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S19.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Advances in Production and Processing of Medicinal and Aromatic Plants.** Info: Prof. Dr. Bhimanagouda Patil, VFIC, Texas A&M University, Department of Horticulture, 1500 Research Parkway Ste A120, College Station, TX 77845, United States of America. Phone: (1)9794588090, Fax: (1)9798624522, E-mail: b-patil@tamu.edu or Dr. Fatma Uysal Bayar, BATEM, Antalya, Turkey. E-mail: uysal.fatma@tarim.gov.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S29.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Culinary Herbs and Edible Fungi.** Info: Prof. Dr. Lyle Craker, Dept. of Plant & Soil Science, University of Massachusetts, Stockbridge Hall, Amherst, MA 01003-7245, United States of America. Phone: (1)413-545-2347, Fax: (1)413-545-3958, E-mail: craker@pssci.umass.edu or Prof. Dr. Aysun Peksen, Ondokuz Mayis University,, Faculty of Agriculture,, Department of Horticulture, Samsun 55139, Turkey. Phone: (90)3624576020/1137, Fax: (90)3624576034, E-mail: aysunp@omu.edu.tr or Mr. Mustafa Kemal Soylu, Atatürk Central Horticultural Research Inst, 77102 Yalova, Turkey. Phone: (90)2268142520, Fax: (90)2268141146, E-mail: mksoylu@hotmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S30.html
- August 12-16, 2018, Istanbul (Turkey): **IV International Conference on Turfgrass Management and Science for Sports Fields: Bridging the Needs and Research on Turfgrass at the Age of Climate Change.** Info: Prof. Dr. Giorgio Prosdocimi Gianquinto, Dip. Scienze Agrarie, DiPSA, Università degli Studi di Bologna, Viale Fanin, 44 - 40127 Bologna, Italy. Phone: (39) 0512096663, Fax: (39) 0512096245, E-mail: giorgio.gianquinto@unibo.it or Erik Ervin, Virginia Polytechnic Inst.& State University, Dept of Crop and Soil Environment Sciences, 335 SMY TH, Blacksburg 24061, VA, United States of America. Phone: (1)5402315208, Fax: (1)5402313431, E-mail: eervin@vt.edu or Assoc. Prof. Songul Sever Mutlu, Akdeniz University, Ziraat Fakultesi, Peyzaj Mimarligi bolumu, Antalya, Turkey. Phone: (90)242-2455, E-mail: songulmutlu@akdeniz.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S26.html
- August 12-16, 2018, Istanbul (Turkey): **VIII International Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops.** Info: Prof. Dr. Daniel Leskovar, 1619 Garner Field Rd., Texas A&M AgriLife Research, Texas AM Univeristy, Uvalde Texas 78801, United States of America. Phone: (1)830-278-9151, Fax: (1)830-278-1570, E-mail: daniel.leskovar@agnet.tamu.edu or Prof. Dr. Ahmet Korkmaz, KSU, Faculty of Agriculture, Dept. of Horticulture, Kahramanmaras, Turkey. Phone: 90-344-2802035, E-mail: akorkmaz@ksu.edu.tr or Prof. Dr. Halit Yetisir, Deparment of Horticulture, Faculty of Agriculture, University of Erciyes, 38039 Kayseri, Turkey. E-mail: yetisir1@yahoo.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S35.html
- August 12-16, 2018, Istanbul (Turkey): **V International Symposium on Plant Genetic Resources: Sustainable Management and Utilization for Food, Nutrition and Environmental Security.** Info: Dr. Sandhya Gupta, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, Delhi, 110 012, India. Phone: (91)9958499781, Fax: (91)11-25842495, E-mail: sandhya_gupta87@yahoo.com or Hülya Ilbi, Ege University, Faculty of Agriculture, Dept. Of Horticulture, 35100 Bornova Izmir, Turkey. E-mail: hulya.ilbi@ege.edu.tr or Assoc. Prof. Birsen Cakir, Ege University Faculty of Agriculture, Department of Horticulture, Bornova, 35100 304zmir, Turkey. Phone: (90) 232 3112633, Fax: (90)2323881865, E-mail: birsen-cakir@hotmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S01.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Tropical and Subtropical Vegetable Production: Tackling Present and Future Global Biotic and Abiotic Stressors.** Info: Prof. Dr. Hakan Aktas, Suleyman Demirel University, Agriculture, Faculty, Horticulture Dept, 32260 Isparta, Turkey. Phone: (90)2462118533, E-mail: aktashakan33@gmail.com or Dr. Srinivasan Ramasamy, AVRDC-The World Vegetable Center, 60 Yi Minga Liao, Shanhua, 74151 Tainan Tainan, Chinese Taipei. Phone: (886)6-5852499, Fax: (886)6-5830009, E-mail: srini.ramasamy@worldveg.org or Prof. Dr. Umezuruike Linus Opara, University of Stellenbosch, Faculty of AgriSciences, Private Bag X1, Stellenbosch 7602, South Africa. Phone: (27) 21 808 4064, Fax: (27) 21 808 2121, E-mail: opara@sun.ac.za or Assist. Prof. Golgen Bahar Oztekin, Ege University, Faculty of Agriculture, Department of Horticulture, 35100 Bornova Izmir, Turkey. Phone: (90)2323112577, Fax: (90)2323881865, E-mail: golgen.oztekin@ege.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S16.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Mechanization, Precision Horticulture, and Robotics.** Info: Dr. Reza Ehsani, University of Florida, Citrus Research and Education Ctr., 700 Experiment Station Rd., Lake Alfred, FL 33850, United States of America. Phone: (1)8639568770, Fax: (1)8639564631, E-mail: ehsani@ufl.edu or Assoc. Prof. Selçuk Arslan, Uludag Univesity Faculty of Agriculture, 16059 Bursa, Turkey. Phone: +90 224-2941606, E-mail: sarslan@uludag.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S31.html
- August 12-16, 2018, Istanbul (Turkey): **IV International Jujube Symposium.** Info: Prof. Dr. Mengjun Liu, Research Center of Chinese Jujube, Agricultural Univesity of Hebei, Baoding, Hebei, 71001, China. Phone: (86)312754342, Fax: (86)3127521251, E-mail: lmj1234567@aliyun.com or Prof. Dr. Florin Stanica, University of Agronomic Sciences, Faculty of Horticulture, B-dul Marasti, 59, Sector 1, 011464, Bucuresti, Romania. Phone: (40)722641795, Fax: (40)213182888, E-mail: flstanica@yahoo.co.uk or Assoc. Prof. Kazim Gunduz, Mustafa Kemal University, A287riculture Faculty, Department of Horticulture, 31034 Hatay Antakya, Turkey. Phone: +90 0326 245 5845, Fax: +90 0326 245 5832, E-mail: kgunduz44@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S08.html

- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Understanding Fruit Tree Behaviour in Dynamic Environments.** Info: Dr. Evelyne Costes, INRA UMR AGAP, 2, place Viala, 34060 Montpellier Cedex 1, France. Phone: (33)499612787, Fax: (33)499612616, E-mail: costes@supagro.inra.fr or Dr. Pasquale Losciale, Council for Agric. Research & Economics, Research Centre for Agric. & Environment, Via Celso Ulpiani 5, Bari, Italy. Phone: (39)0805475036, Fax: (39)0805475023, E-mail: pasquale.losciale@crea.gov.it or Prof. Dr. Ayzin B. Küden, University of Cukurova, Dean of the Faculty of Agriculture, Department of Horticulture, 01330 Adana, Turkey. Phone: (90)3386364/3386447, Fax: (90)3386364/3386447, E-mail: abkuden@cu.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S10.html
- August 12-16, 2018, Istanbul (Turkey): **III International Berry Fruit Symposium.** 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 or Prof. Dr. Sedat Serçe, Nigde University, Faculty of Agricultural Sciences and Techn., Dept. Agricultural Genetic Engineering, Nigde, 51240, Turkey. Phone: (90) 388 2254463, Fax: (90) 388 2254440, E-mail: sedatserce@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S12.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Carob: a Neglected Species with Genetic Resources for Multifunctional Uses.** Info: Prof. Dr. Hamide Gubbuk, Akdeniz University, Faculty of Agriculture, Department of Horticulture, 07058 Antalya, Turkey. Phone: (90)2423102422), Fax: (90)2422274564, E-mail: gubbuk@akdeniz.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S37.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Ornamental Horticulture: Colour Your World.** Info: Prof. Dr. Rina Kamenetsky, Institute of Plant Sciences, Agricultural Research Organization, The Volcani Center, Rishon LeZion, 7528809, Israel. Phone: (972)39683511, Fax: (972)39660589, E-mail: vhrkamen@volcani.agri.gov.il or Prof. Dr. Yüksel Tüzel, Ege University, Agriculture Faculty, Department of Horticulture, 35100 Bornova Izmir, Turkey. Phone: (90)2323111398, Fax: (90)2323881865, E-mail: yuksel.tuzel@ege.edu.tr or Ass. Prof. Soner Kazaz, Ankara University, Faculty of Agriculture, Department of Horticulture, Diskapi - Ankara, Turkey. Phone: (90)312-596 12 87, Fax: (90)312-317 91 19, E-mail: skazaz@ankara.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S15.html
- August 12-16, 2018, Istanbul (Turkey): **III International Symposium on Innovation and New Technologies in Protected Cultivation.** Info: Dr. Murat Kacira, Dept. of Agric. and Biosystems Enginering, 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@cals.arizona.edu or Dr. Silke Hemming, Wageningen UR, Plant Research International, PO Box 16, 6700 AA Wageningen, Netherlands. Phone: (31)317 4 86921, Fax: (31)317 423110, E-mail: silke.hemming@wur.nl or Prof. Dr. Yüksel Tüzel, Ege University, Agriculture Faculty, Department of Horticulture, 35100 Bornova Izmir, Turkey. Phone: (90)2323111398, Fax: (90)2323881865, E-mail: yuksel.tuzel@ege.edu.tr or Dr. Hatice Filiz Boyaci, Demircikara Mah. Pasakavaklara Cad. P.O35, Muratpasa, 07100 Antalya, Turkey. Fax: (90)242-3211512, E-mail: filiz_boyaci@yahoo.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S17.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Water and Nutrient Relations and Management of Horticultural Crops.** Info: Prof. Dr. Esmaeil Fallahi, University of Idaho, Parma Res. & Extension Center, 29603 University of Idaho Lane, Parma, ID 83660-6699, United States of America. Phone: (1)2087226701 ext225, Fax: (1)2087226708, E-mail: efallahi@uidaho.edu or Prof. Dr. Dilek Anaç, Kaz305mdirik mahallesi 156 sokak No. 132, Nur Apt. Bornova-304zmir, 35040 Bornova, Turkey. E-mail: dilek.anac@ege.edu.tr or Dr. Alon Ben-Gal, Environmental Physics and Irrigation, Gilat Research Center, Agricultural Research Organization, Mobile Post Negev 2 85280, Israel. Phone: (972)8 9928644, Fax: (972)8 9926485, E-mail: bengal@agri.gov.il or Mr. Janjo de Haan, Soesterweg 410, 3812BK Amersfoort, Netherlands. Phone: (31)320291211, E-mail: janjo.dehaan@wur.nl or Dr. Clive Rahn, 60 Ettington Close, Wellesbourne, Warwick, CV35 9RJ, United Kingdom. E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S33.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Quality and Safety of Horticultural Products.** Info: Dr. Kamer Betul Ozer, Ege University, Faculty of Agriculture, Department of Horticulture, Evka-3, 35100 Izmir Bornova, Turkey. Phone: (90)232-3112631, E-mail: betul.sintra@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S21.html
- August 12-16, 2018, Istanbul (Turkey): **VII International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2018.** Info: Prof. Dr. Julian Heyes, Inst of Food, Nutrition & Human Health, Massey University, Private Bag 11222, Palmerston North, New Zealand. Phone: (64)63505963, Fax: (64)63517050, E-mail: j.a.heyes@massey.ac.nz or Dr. Trevor George, King's College London, 150 Stamford Street, London, SE1 9NH, United Kingdom. Phone: (44)2078484433, E-mail: trevor.george@kcl.ac.uk or Prof. Dr. Uygun Aksoy, Ege University, Faculty of Agriculture, Department of Horticulture, 35100 Bornova - Izmir, Turkey. Phone: (90)2323884000x2742, Fax: (90) 2323881864, E-mail: uygunaksoy@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S22.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Jackfruit and Other Moraceae.** Info: Prof. Dr. Sisir Kumar Mitra, B-12/48, Kalyani, Nadia, West Bengal 741235, India. Phone: (91)9432174249, Fax: (91)3325828460, E-mail: sisirm55@gmail.com or Dr. Hannah Jaenicke, Burghof 26, Schloss Gelsdorf, 53501 Grafschaft-Gelsdorf, Germany. Phone: (49)2225-8389895, E-mail: hannah.jaenicke@t-online.de or Assoc. Prof. Mustafa Akbulut, Recep Tayyip Erdogan Universitesi, Ziraat ve Doga Bil. Fak. Bahce Bit. Bol., Faculty of Agricultural and Nature Science, Depart. of Horticulture Pazar / Rize, 53300, Turkey. Phone: +90(464)6127317, Fax: +90(464)6127316, E-mail: makbuluttr@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S07.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Date Palm.** Info: Dr. Yuval Cohen, Volcani Research Center, Department of Fruit Tree Sciences, Institute of Plant Science, Bet Dagan 50250, Israel. Phone: (972) 3-9683407, Fax: (972) 3-9669583, E-mail: vhyuvalc@volcani.agri.gov.il or Assist. Prof. Hatice Ikten, Akdeniz University Agricultural Faculty, Department of Agricultural Biotechnology, 07070 Antalya, Turkey. Phone: +90 242 3106557, E-mail: hikten2@hotmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S34.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Fruit and Vegetables for Processing.** Info: Prof. Dr. Mehmet Ali Koyuncu, Süleyman Demirel University, Agriculture Faculty, Department of Horticulture, 32260 Isparta, Turkey. Phone: (90)246 2118529, Fax: (90)246 2118696, E-mail: koyuncu.ma@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S27.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Micropropagation and In Vitro Techniques.** Info: Dr. Maurizio Lambardi, IVALSA/Trees and Timber Institute, National Research Council (CNR), Polo Scientifico, via Madonna del Piano 10, I-50019 Sesto Fiorentino, Firenze, Italy. Phone: (39) 055 5225685, Fax: (39) 055 5225656, E-mail: lambardi@ivalsa.cnr.it or Aylin Ozudogru, CNR-IVALSA, Via Madonna del Piano 10, 50019 Sesto Fiorentino, FI, Italy. E-mail: elifaylinozudogru@yahoo.it or Prof. Dr. Yesim Yalcin Mendi, Department of Horticulture, Faculty of Agriculture, University of Cukurova, Adana, Turkey. E-mail: ymendi@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S02.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Plant Breeding in Horticulture.** Info: Prof. Dr. Nebahat Sari, Cukurova University, Agricultural Faculty, Dept. of Hort/Balcali, 01330 Adana, Turkey. Phone: (90)3223386497, Fax: (90)3223386388, E-mail: nesari@cu.edu.tr or Prof. Dr. Yildiz Aka Kacar, University of Cukurova, Faculty of Agriculture, Horticulture Dept. Lab for Plant Biotech., 01330 Adana, Turkey. Phone: (90)322-3387142, Fax: (90)322-

3386615, E-mail: ykacar@cu.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S20.html

- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Organic Horticulture for Wellbeing of the Environment and Population.** Info: Dr. Martine Dorais, Horticultural Research Center, Laval University, Envirotron Bldg, Room 2120, Quebec G1K 7P4, Canada. Phone: (1)418-6562131, Fax: (1)418-6563515, E-mail: martine.dorais.1@ulaval.ca or Prof. Dr. Uygun Aksoy, Ege University, Faculty of Agriculture, Department of Horticulture, 35100 Bornova - Izmir, Turkey. Phone: (90)2323884000x2742, Fax: (90) 2323881864, E-mail: uygunaksoy@gmail.com or Prof. Dr. Roberto Ugás, Universidad Nacional Agraria La Molina, Programa de Hortalizas, Apartado 12-056, Lima, Peru. Phone: (511)3485796, Fax: (511)3485796, E-mail: rugas@lamolina.edu.pe E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S23.html
- August 12-16, 2018, Istanbul (Turkey): **II International Symposium on Innovative Plant Protection in Horticulture.** Info: Dr. David Hunter, 13 Graves Crescent, St. Catharines, Ontario, L2S 3Y7, Canada. Phone: (1)9056853851, E-mail: davidmhunter13@gmail.com or Prof. Dr. Ana Paula Ramos, Instituto Superior de Agronomia - ULisboa, Tapada da Ajuda, 1349-017 Lisboa Lisboa, Portugal. E-mail: pramos@isa.ulisboa.pt or Prof. Dr. Kadriye Caglayan, Mustafa Kemal University, Agriculture Faculty, Plant Protection Department, 31034 Antakya-Hatay, Turkey. Phone: (90)326 2455836 Ext.1347, Fax: (90)326 2455832, E-mail: kcaglayano@yahoo.com or Assoc. Prof. Feza Can Cengiz, MKU. Agriculture Faculty Plant Protection D, Mustafa Kemal University, Hatay, 31000 Antakya, Turkey. Phone: (90)3262455845/1328, Fax: (90)3262455832, E-mail: cezafan_onurcan@hotmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S28.html
- August 12-16, 2018, Istanbul (Turkey): **XI International Symposium on Postharvest Quality of Ornamental Plants.** Info: Prof. Dr. Fisun Çelikel, Ondokuz Mayis University, Faculty of Agriculture, Dept. Horticulture, Kurupelit, Atakum, 55200 Samsun, Turkey. Phone: (90)362-3121919, Fax: (90)362-4576034, E-mail: fgcelikel@omu.edu.tr or Dr. Shimon Meir, Dept.Postharvest Sci.Fresh Pr., The Volcani Center, ARO, PO Box 6, Bet Dagan 50250, Israel. Phone: (972)39683667, Fax: (972)39683622, E-mail: shimonm@volcani.agri.gov.il E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S14.html
- August 12-16, 2018, Istanbul (Turkey): **VII International Symposium on Tropical and Subtropical Fruits.** Info: Prof. Dr. Sisir Kumar Mitra, B-12/48, Kalyani, Nadia, West Bengal 741235, India. Phone: (91)9432174249, Fax: (91)3325828460, E-mail: sisirm55@gmail.com or Dr. Hannah Jaenicke, Burghof 26, Schloss Gelsdorf, 53501 Grafschaft-Gelsdorf, Germany. Phone: (49)2225-8389895, E-mail: hannah.jaenicke@t-online.de or Assoc. Prof. Mustafa Akbulut, Recep Tayyip Erdogan Universitesi, Ziraat ve Doga Bil. Fak. Bahce Bit. Bol., Faculty of Agricultural and Nature Science, Depart. of Horticulture Pazar / Rize, 53300, Turkey. Phone: +90(464)6127317, Fax: +90(464)6127316, E-mail: makbuluttr@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S05.html
- August 12-16, 2018, Istanbul (Turkey): **I International Symposium on Avocado.** Info: Prof. Dr. Sisir Kumar Mitra, B-12/48, Kalyani, Nadia, West Bengal 741235, India. Phone: (91)9432174249, Fax: (91)3325828460, E-mail: sisirm55@gmail.com or Assist. Prof. Hatice Ikten, Akdeniz University Agricultural Faculty, Department of Agricultural Biotechnology, 07070 Antalya, Turkey. Phone: +90 242 3106557, E-mail: hikten2@hotmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S06.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Nuts and Mediterranean Climate Fruits: Advances in Breeding and New Strategies of Horticultural Management for Sustainable Production.** Info: Prof. Dr. Tiziano Caruso, Department of Agricultural & Forest Science, University of Palermo, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39) 09123861207, E-mail: tiziano.caruso@unipa.it or Dr. Moshe A. Flaishman, Department of Fruit Trees Sciences, ARO - The Volcani Center, PO Box 6, 50-250 Bet Dagan, Israel. Phone: (972)39683394, Fax: (972)39683793, E-mail: vhmoshea@volcani.agri.gov.il or Dr. Louise Ferguson, 2037 Wickson Hall, Plant Sciences Department Mail Stop II, UC Davis 1 Shields Ave. Davis CA 95616, United States of America. Phone: (1) 559 737 3061, Fax: (1) 530 752 8502, E-mail: lferguson@ucdavis.edu or Deniz Sanal, Alata Horticultural Research Station, Mersin, Erdemli, Turkey. E-mail: denizsanal06@gmail.com E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S11.html
- August 12-16, 2018, Istanbul (Turkey): **VII International Conference on Landscape and Urban Horticulture.** Info: Federica Larcher, Largo P. Braccini 2, 10095 Grugliasco, Torino, Italy. E-mail: federica.larcher@unito.it or Jesus Ochoa, Universidad Politécnica de Cartagena, Paseo Alfonso XIII, 48, 30203 Cartagena, Murcia, Spain. E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S25.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Applied Functional Molecular Biology.** Info: Prof. Dr. Rosario Muleo, Dept.. Crop Production, Università dellea Tuscia, Via S.C. De Lellis snc, Viterbo 01100, Italy. Phone: (39)0761357532, Fax: (39)761357531, E-mail: muleo@unitus.it or Assoc. Prof. Birsen Cakir, Ege University Faculty of Agriculture, Department of Horticulture, Bornova, 35100 304zmir, Turkey. Phone: (90) 232 3112633, Fax: (90)2323881865, E-mail: birsencakir@hotmail.com or Prof. Dr. Ali Ergul, Ankara University Biotechnology Institute, Central Laboratory, 06100 Ankara, Turkey. Phone: +90-312-2225816, Fax: +90-312-2225872, E-mail: ergul@ankara.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S03.html
- August 12-16, 2018, Istanbul (Turkey): **XI International Symposium on Banana: ISHS-ProMusa Symposium on Growing and Marketing Banana under Subtropical Conditions.** Info: Prof. Dr. Hamide Gubbuk, Akdeniz University, Faculty of Agriculture, Department of Horticulture, 07058 Antalya, Turkey. Phone: (90)2423102422), Fax: (90)2422274564, E-mail: gubbuk@akdeniz.edu.tr or Dr. Thierry Lescot, CIRAD, RU GECO, Persyst Department, Boulevard de la Lironde, TA B26/PS4, 34398 Montpellier, France. Phone: (33)467615666, Fax: (33)467615821, E-mail: thierry.lescot@cirad.fr or Dr. Víctor Galán Sauco, Isaac Albéniz 17, 38208 La Laguna, Tenerife, Canary islands, Spain. Phone: (34)922261647, E-mail: vgalan46@gmail.com or Dr. Inge Van den Bergh, Bioversity International, C/O KULeuven, W. De Croylaan 42 bus 2455, 3001 Leuven, Belgium. Phone: (32)16377067, E-mail: i.vandenbergh@cgiar.org E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S04.html
- August 12-16, 2018, Istanbul (Turkey): **International Symposium on Strategies and Technologies to Maintain Quality and Reduce Postharvest Losses.** Info: Dr. Mustafa Erkan, Akdeniz University, Department of Horticulture, 07058 Antalya, Turkey. Phone: +90 242 3102428, Fax: +90 242 2274564, E-mail: erkan@akdeniz.edu.tr E-mail symposium: secretariat@ihc2018.org Web: http://www.ihc2018.org/en/S32.html

- September 9-13, 2018, Heraklion and Hersonissos, Crete (Greece): **IX International Symposium on Soil and Substrate Disinfestation.** Info: Eleftherios Tjamos, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece. E-mail: ect@aua.gr E-mail symposium: secretariat@sd2018crete.gr Web: http://www.sd2018crete.gr/
- September 19-22, 2018, Krakow (Poland): **II International Symposium on Carrot and Other Apiaceae.** Info: Prof. Dariusz Grzebelus, Institute of Plant Biology and Biotechnolog, Faculty of Biotechnology and Horticulture, University of Agriculture in Krakow, 31-425 Krakow, Poland. Phone: (48)12-6625399, E-mail: d.grzebelus@ogr.ur.krakow.pl E-mail symposium: carrotsymposium@targi.krakow.pl
- October 15-17, 2018, Plovdiv (Bulgaria): **III International Symposium on Wild Relatives of Subtropical and Temperate Fruit and Nut Crops.** Info: Assist. Prof. Stefan Gandev, Fruit Growing Institute, Ostromila 12, 4004 Plovdiv, Bulgaria. Phone: (359)32 69 23 49, E-mail: s.gandev@abv.bg Web: http://symposium.fruitgrowinginstitute.com
- November 13-16, 2018, Taichung (Chinese Taipei): **International Symposium on Horticultural Therapies: Past, Present and Future.** Info: Dr. Hsueh-Shih Lin, Director, TDAIS, Council of Agriculture, No.370 Song-Hwai Road, 51544 Changhua Tatsuen Village, Chinese Taipei. Phone: (886)48522624, Fax: (886)48521148, E-mail: hslin@tdais.gov.tw

For updates logon to www.ishs.org/symposia

› Available issues of *Acta Horticulturae*

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

Acta Number	Acta Title	Price (EUR)
1162	COST Cherry FA 1104 Working Group 2 Cherry Phenology, Modelling and Climate Change	39
1161	VII International Cherry Symposium	151
1160	X International Symposium on Modelling in Fruit Research and Orchard Management	97
1159	XIV International Symposium on Processing Tomato	69
1158	I International Symposium on Moringa	110
1157	IX International Symposium on Grapevine Physiology and Biotechnology	103
1156	VIII International Strawberry Symposium	213
1155	VI International Symposium on Production and Establishment of Micropropagated Plants	141
1154	V International Symposium on Applications of Modelling as an Innovative Technology in the Horticultural Supply Chain	72
1153	International Symposium on Carrot and Other Apiaceae	75
1152	III International Conference on Agricultural and Food Engineering	102
1151	V International Symposium on Cucurbits	78
1150	VIII International Symposium on Irrigation of Horticultural Crops	119
1149	II International Workshop on Bacterial Diseases of Stone Fruits and Nuts	40
1148	II World Congress on the Use of Biostimulants in Agriculture	56
1147	IX International Symposium on Artichoke, Cardoon and Their Wild Relatives	102
1146	III International Symposium on Organic Matter Management and Compost Use in Horticulture	75
1145	International Symposium on Biotechnology and Other Omics in Vegetable Science	58
1144	III International Symposium on Postharvest Pathology: Using Science to Increase Food Availability	112
1143	VII International Symposium on Edible Alliaceae	87
1142	VI Balkan Symposium on Vegetables and Potatoes	108
1141	III International Conference on Fresh-Cut Produce: Maintaining Quality and Safety	91
1140	Proceedings of the 2015 Annual Meeting of the International Plant Propagators' Society	100
1139	III Balkan Symposium on Fruit Growing	166
1138	EUFRIN Thinning Working Group Symposia	46
1137	International Symposium on Innovation in Integrated and Organic Horticulture (INNOHORT)	88
1136	I International Symposium on Grapevine Roots	77
1135	III International Symposium on Citrus Biotechnology	56
1133	XI International Rubus and Ribes Symposium	118
1132	XVIII International Symposium on Horticultural Economics and Management	60
1131	III International Conference on Quality Management in Supply Chains of Ornamentals	52
1130	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposia on the Physiology of Perennial Fruit Crops and Production Systems and Mechanisation, Precision Horticulture and Robot	146
1129	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Impact of Asia-Pacific Horticulture - Resources, Technology and Social Welfare	58
1128	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Horticulture in Developing Countries and World Food Production	83
1127	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Plant Breeding in Horticulture	117
1126	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): Plenary Sessions of IHC2014 and VII International Symposium on Education, Research Training and Consultancy	75
1125	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): V World Congress on Medicinal and Aromatic Plants and International Symposium on Plants, as Factories of Natural Substances, Edible and Esse	99
1124	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): III International Genetically Modified Organisms in Horticulture Symposium - Past, Present and Future	54
1123	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on High Value Vegetables, Root and Tuber Crops, and Edible Fungi Production, Supply and Demands	70
1122	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): III International Conference on Turfgrass Management and Science for Sports Fields	58
1121	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): XII International People Plant Symposium: Horticulture and Human Communities	52
1120	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposia on Postharvest Knowledge for the Future and Consumer and Sensory Driven Improvements to Fruits and Nuts	114
1119	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposia on Abscission Processes in Horticulture and Non-Destructive Assessment of Fruit Attributes	86
1118	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Root and Tuber Crops: Sustaining Lives and Livelihoods into the Future	69
1117	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): I International Berry Fruit Symposium: Interactions! Local and Global Berry Research and Innovation	92

For an updated list of all titles (in print or ActaHort CD-rom format) logon to www.actahort.org