A publication of the International Society for Horticultural Science

Chronica Horticulturae

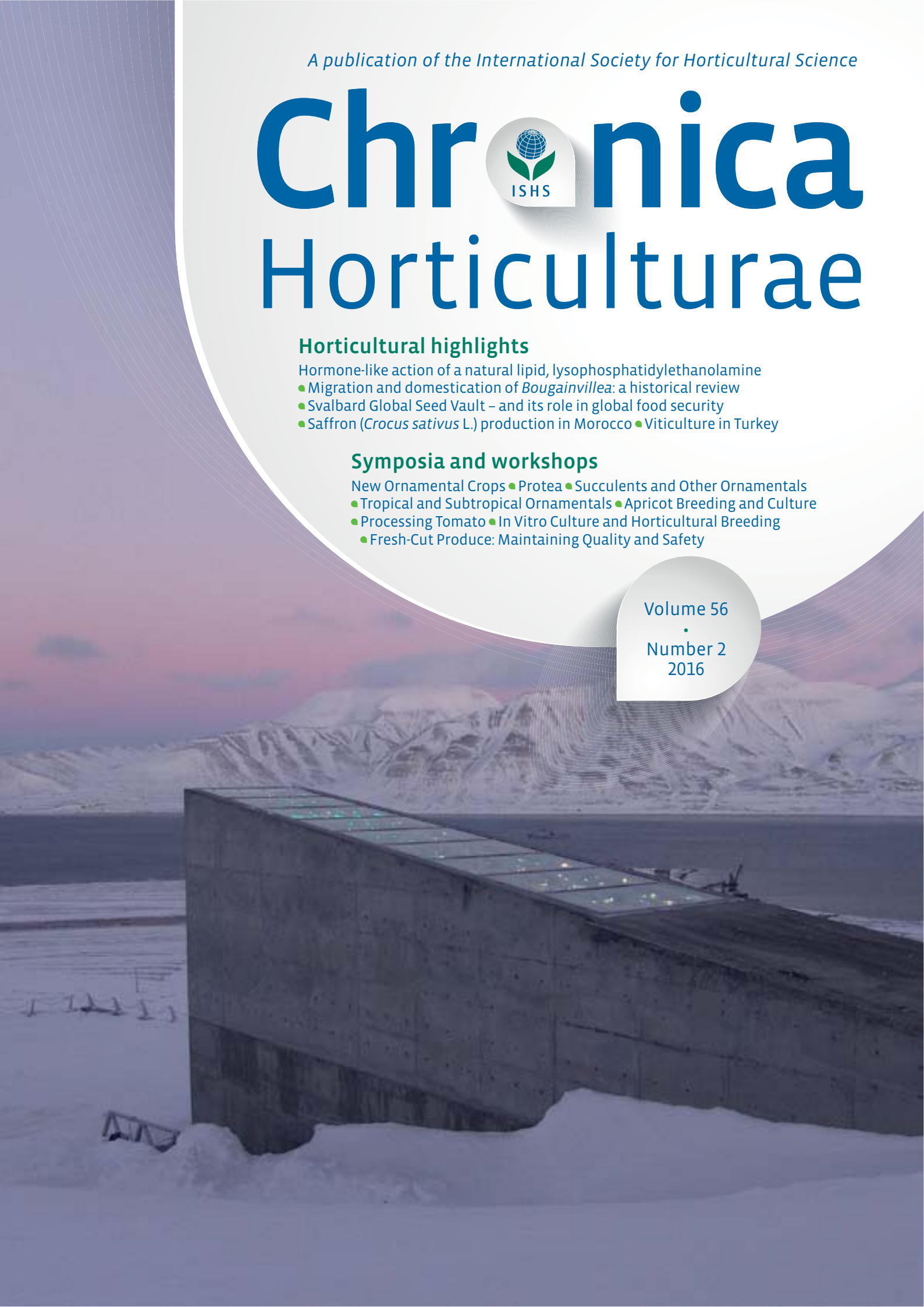
Horticultural highlights

Hormone-like action of a natural lipid, lysophosphatidylethanolamine
- Migration and domestication of *Bougainvillea*: a historical review
- Svalbard Global Seed Vault – and its role in global food security
- Saffron (*Crocus sativus* L.) production in Morocco
- Viticulture in Turkey

Symposia and workshops

New Ornamental Crops
- Protea
- Succulents and Other Ornamentals
- Tropical and Subtropical Ornamentals
- Apricot Breeding and Culture
- Processing Tomato
- In Vitro Culture and Horticultural Breeding
- Fresh-Cut Produce: Maintaining Quality and Safety

Volume 56
•
Number 2
2016



Chronica Horticulturae

Chronica Horticulturae© Volume 56 – Number 2; June 2016; ISSN: 0578-039X.
Published quarterly by the International Society for Horticultural Science, Leuven, Belgium. Lay-out and printing by Drukkerij Geers, Gent, Belgium. ISHS© 2016. All rights reserved. No part of this magazine may be reproduced and/or published in any form, photocopy, microfilm or any other means without written permission from the publisher. All previous issues are also available online at **www.ishs.org.** Contact the ISHS Secretariat for details on full colour advertisements (1/1, 1/2, 1/4 page) and/or mailing list options.

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

Editorial staff
Jill Stanley, Editor, **jill.stanley@plantandfood.co.nz**
Kelly Van Dijck, Associate Editor, **kelly.vandijck@ishs.org**
Peter Vanderborght, Associate Editor - Production & Circulation, **peter.vanderborght@ishs.org**

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

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

Acta Horticulturae
Acta Horticulturae is the series of proceedings of ISHS Scientific Meetings, Symposia or Congresses (ISSN: 0567-7572). ISHS Members are entitled to a substantial discount on the price of *Acta Horticulturae*. A complete and accurate record of the entire *Acta Horticulturae* collection, including all abstracts and full text articles is available online at **www.actahort.org**. ISHS Individual Membership includes credits to download 15 full text *Acta Horticulturae* articles. All *Acta Horticulturae* titles - including those no longer available in print format - are available 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 discounted submission fees. eJHS is available in print + online Open Access. Additional information can be viewed on **www.ishs.org/ejhs**.

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 Journal of Horticultural Science & Biotechnology, Journal of the American Pomological Society, Journal of the International Society for Mushroom Science, Fruits, Proceedings of the International Plant Propagators' Society, Journal of the Interamerican Society for Tropical Horticulture, Plant Breeding Reviews, Horticultural Reviews, etc.
Additional information can be viewed on the PubHort website **www.pubhort.org**.

Cover photograph: Svalbard Global Seed Vault, Norway.
Photo credit: Norwegian Ministry of Agriculture and Food. See article p.16.

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

ISHS Board's reflection on the inspirational life of Norm Looney

Roderick Drew, President of ISHS

› Roderick Drew

We were all saddened at the passing of Norm Looney. We convey our sincere condolences to his wife Norah and to his family. Norm made a bountiful and long-lasting contribution to ISHS. We are deeply thankful for his remarkable legacy of leadership, service and warm friendship to the worldwide community of ISHS. We would also like to acknowledge Norah for her contribution in accompanying, supporting and encouraging him in his years of service to the Society.

Norm not only made a major contribution to ISHS in his eight years as President but also made a major contribution to horticultural science and was a leader and advocate for horticulture worldwide. Norm's passion and advocacy for horticulture resulted in an increased number of ISHS members (peaking at 7500 during his Presidency) and new country members from Eastern Europe, sub-Saharan and Northern Africa, Caucasus and Asia. In addition, Norm established many new relationships between horticulture industries, international organisations and ISHS. His vision for the Global Horticulture Initiative (GHI) reflected his compassion for the world's poorest people and his unwavering belief in the role of horticulture to improve global health and prosperity through production and consumption of horticultural crops. When writing this editorial, I reflected on what we could learn from the leader and statesman who was Norm Looney.

The people who make the greatest impact as leaders have great passion. It fuels their commitment to focus beyond personal gain to strive for a greater good. Norm's passion was for global horticulture. He was able to identify and realistically focus on current challenges, as well as lift his eyes to the bigger global view and into the future. Great leaders see both what can be done now and what is required to build going forward. Being President of ISHS involves representing the Society as its ambassador at official levels, while also serving and mentoring those within our Society. Authority and responsibility go hand-in-hand. An ISHS President is entrusted to represent the Society but also to facilitate and encourage the Board, Executive Committee and Council to make the best decisions on behalf of all Society members.

When I reflect on the cycle of life, Norm's passing reminds us that we are entrusted with responsibility for our Society for a period of time and for us that time is now. Each generation of ISHS members has the opportunity to contribute to the betterment of society, to the world of horticulture and to the world as it exists now. We need to accept the challenges we face today and continue to make ISHS a focus for those who want to make a difference in the world through horticulture. In a world that is increasingly aware of the many who are undernourished and malnourished, horticulture has an increasingly important role to play. As horticulturists, we need to work together to realize the potential of horticultural crops to meet the needs of all people. Societies and initiatives, such as ISHS and GHI, provide a network for communication, and promote the benefits of horticultural products and their potential to meet the increasing needs of our worldwide community. The horticultural scientists of our time are continually making breakthroughs in the understanding of plant function and are developing new horticultural technologies to increase and diversify horticultural production. ISHS and GHI can assist in making the links between scientists, and facilitate training where it is needed. It is an exciting and rewarding era to be working in horticulture.

The past Presidents, Boards, Executive Committees and Councils have left us a substantial legacy and made ISHS into the number one horticultural science society. Part of our responsibility is to be looking to those who will replace us and continue the work of ISHS into the future. I have the privilege to lead the current Board, which is comprised of highly committed and talented horticulturists who each has an excellent track record in leadership in horticultural science. They have taught and mentored many of the next generation of horticulturists. They have vision and passion and are prepared to invest their time and energy into the building of our Society. We as a Board are particularly keen to reach out to the next generation of students and young scientists about the importance of global horticulture and the important role that ISHS has to play.

One of the many tasks of each Board that serves ISHS is to be mindful of those who will follow them and be able to hand over our responsibilities to passionate talented leaders to work into the future. They are likely to be those who are already members and who already contribute many hours of voluntary work, largely unseen, in convening symposia, workshops, editing volumes of *Acta Horiculturae*, writing volumes of *Scripta Horiculturae*, providing articles for eJHS and *Chronica Horiculturae*, and promoting ISHS in their own countries. We need to acknowledge and support them, and then look beyond to an even younger generation who are at the beginning of their horticultural careers. We must encourage and nurture them within our Society, realizing that their time to take the reins will come in the years ahead. ISHS is a society that has the capacity to facilitate much change that is good in our world. The involvement and efforts of all members of ISHS are important to the current Board and to me. All countries are important to us. Let us all continue to work together and promote ISHS to all generations in all countries as we stress the increasing importance of horticulture in a needy world.

We need many more Norm Looneys in our Society! He was a great man and many of us were touched by his spirit and generosity. We feel very privileged to have known Norm and are grateful for what he has done for us. He will stay alive in our memories forever!

Spotlight on Honoured ISHS Members

› Anthony David Webster

› Dr. Webster in front of a trial of pear trees planted on different rootstocks and trained in different planting systems at the East Malling Research Station in the 1990s.

Position or previous position

Senior researcher at East Malling Research Station, United Kingdom. Retired in 2001.

ISHS honour

Honorary Member

1. Tell us a bit about yourself (hometown, current locale, family, hobbies and community involvement).

I was born in Derby in the Midlands of England, where I lived and worked until the age of 21. I then moved to London to study/work at the Royal Botanic Gardens, Kew, for three years followed by a further four years at Bath University in the west of England. All of my research career was spent at East Malling Research Station in Kent, working on temperate tree fruit species.

After taking early retirement in 2001, and a few years undertaking independent consultancy, my wife, who I met at East Malling, and I moved away from the crowded south east of England. Currently, we share our time between our small house in Malmesbury, on the fringes of the beautiful Cotswolds region of the UK, and our small cottage at Bassurels in the Cevennes National Park in southern France. I am still fascinated by plants and their cultivation and much of my spare time is taken up with tending my large and challenging French garden. There we grow a full range of vegetables and fruits as well as a rich selection of woody and herbaceous ornamentals. My only other hobby is savouring wonderful French food and wine. Not very laudable I am afraid but hugely enjoyable! My involvement in the community is limited by my being in France or Britain for only six months each year and by my somewhat limited skills in the French language. We do, however, help with various village fetes and gatherings.

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

As a very small boy my father took me out to the countryside in the west midlands of the UK each weekend. The result was my initial career aspiration to be a farmer. This changed when my father took me on several occasions to a local nursery. I became fascinated with growing seeds, taking cuttings, etc. My career goal became set at that time. My subsequent educational route to an eventual career in horticultural research was far from typical. The reasons for this were complicated and brought about partly by the very premature death of my father. Instead of taking higher academic qualifications at school and progressing immediately to university to study horticulture, my career route was much more circuitous and slow. Periods working at a small nursery raising bedding plants and for a local parks department were followed by a three year student gardener course at the Royal Botanic Gardens at Kew and thereafter a four year course at Bath University to study for a horticultural BSc. As well as formal study, the course at Bath also involved up to six months working in the industry each year; my work experience embraced protected cultivation of vegetables and flowers, wholesale marketing and fruit research and development.

After university, I was encouraged to apply for PhD awards and one such award was being offered by East Malling Research Station. Whilst I was not offered the studentship, much to my surprise they did offer me a full time job as a fruit researcher.

3. Give a brief overview of your career achievements.

My initial responsibilities at East Malling involved working with plum (*Prunus domestica*) and sweet cherry (*Prunus avium*). The goals were to find ways of controlling shoot growth and cropping. The search for dwarfing rootstocks was a major objective but one which proved frustratingly difficult and slow to achieve. It was assumed, quite wrongly in hindsight, that as East Malling had bred/selected very successful dwarfing rootstocks for apples, it would prove just as simple to do the same for stone fruit species. Picking up on the work of my research predecessors I was, however, able to develop a new rootstock for European plums, which was released as 'Pixy'. It is far from perfect, but if trees grafted onto it are kept well irrigated and their fruits thinned, it goes some way to fulfilling the research goal. Sweet cherries proved more difficult, with most of the initially promising rootstock selections proving graft incompatible after several years in the orchard. One selection, however, a *P. avium* x *P. pseudocerasus* hybrid, did reduce vigour of some cultivars on some soil types quite well and was released as 'Colt'. Whilst 'Colt' remains popular in a few countries of the world, it has been superseded by more dwarfing selections, the best of which originate in Germany.

Back in the 1970s and 1980s it was perceived that rootstocks were proving slow to develop and a faster solution to the problems of excessive growth and poor cropping was deemed necessary. Like many other scientists around the world, I was encouraged to explore the regulation of tree growth and cropping using plant growth regulators. Employing sprays of gibberellins, auxins and/or cytokinins, I endeavoured to improve the fruit set and yields of both plums and cherries. It was at this period that I completed a PhD on the fruit set of the European plum. Treatments to delay flowering in spring were also developed with the aim of reducing or spreading the risk of spring frost damage. In contrast, in some seasons, plums cropped excessively and the aim was to reduce set

› Diplomatic visit to China in the 1990s together with Dr. Alwyn Thompson, Director of East Malling Research Station.

and improve fruit size. Very many synthetic chemicals were tested with this goal in mind and a large collaborative team of researchers worked on this in Europe. Although some synthetic chemicals proved effective, changes in the legislation affecting agrochemical approval in Europe and the small market for these products meant that nowadays they are largely unavailable. Control of excessive shoot growth was a further objective and I was involved in much of the early development R&D with the gibberellin inhibitor paclobutrazol (Cultar®) on stone fruits. Unfortunately, research involving synthesised plant growth regulators is currently very unfashionable in Europe and I sometimes reflect on whether the research conducted was time well spent or perhaps a 'blind alley'. However, some of these products are still used successfully in many parts of the world where the consumers are not so irrationally neurotic concerning agrochemicals.

In the 1980s my responsibilities spread to cover research on apples and pears. One challenge was to find improvements to the range of rootstocks available. In collaboration with fruit breeding colleagues at East Malling many new dwarfing rootstocks were produced and subsequently one new rootstock for each crop was released. I also conducted research on controlling the growth and cropping of temperate fruit crops employing modern methods of root restriction and root pruning. Root restriction, unfortunately, proved somewhat uneconomic. Although both techniques could be very effective, this was only true if used in conjunction with very careful and appropriate tree management practices, especially irrigation.

With the closure of Long Ashton Research Station for fruit research in the 1980s I was asked to take on additional programmes and to manage some of the staff transferred to East Malling. A self-fertile clone of the apple cultivar, 'Queen Cox', produced by the Long Ashton team was successfully developed and now accounts for a significant proportion of the trees of this cultivar planted in the UK. It permitted growers to reduce or eliminate the need to plant unprofitable pollinating cultivars in the orchard.

4. What do you consider were your greatest achievements?

I have never considered what I did to be particularly special. Perhaps my main contribution to temperate fruit research has been in terms of information transfer. Information transfer to grower groups both in the UK and abroad was, hopefully, beneficial. Collating information from my own research with that of colleagues from throughout the world and presenting this in the form of papers, lectures and orchard talks has always been a great joy to me. I was joint editor and a major contributor to two text books; one on sweet cherries with Norman Looney and another on temperate fruit physiology with Bob Wertheim and Jan Tromp. Collaboration with Bob Wertheim also led to chapters in a book on apple culture. Cultural guides for use by UK apple and pear growers were also produced.

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

Leaving school at only 16 years of age meant that when, a few years later, I aspired to further my career in the more academic branches of horticulture I did not have the necessary academic qualifications to get into university. This I rectified by studying in all of my spare evenings and weekends during the three years whilst training/working at Kew Gardens. This was particularly tough on social relationships! However, being singularly unattractive to the opposite sex helped, and meant that I was not, at that time, constrained by the need to support a wife or family! Trying to complete a PhD on a part-time basis at East Malling was also not easy and took at least twice as long as the conventional three years. Only the encouragement, help and patience of an understanding wife got me through to completion.

In hindsight, I ask myself whether this unconventional route to a career in research was beneficial or not. It could be considered negative in terms of the several years delay before achieving a research post. However, I now realise that the considerable knowledge of plants achieved at Kew and the quite wide experience of many sectors of horticulture gained in those preliminary years proved of great value. Wide ranging experience gained in early career can be a real asset.

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

The interesting experiences are too numerous to mention and are associated mainly with my travels to the many countries growing temperate fruits. A sabbatical in New Zealand was particularly interesting. In contrast, a very memorable but upsetting experience was chairing a session at a conference in northern Italy and being handed a note asking me to halt the session and announce the ongoing tragedy of the 9/11 twin towers outrage. I have always enjoyed socialising with colleagues and they have frequently had a joke at my expense. For instance, a bottle of wine brought back for me by colleagues attending an Italian symposium, when opened proved to be vintage Italian tap water! A case of real wine sent to me by Guglielmo Costa (known as Mimmo) and labelled as research equipment was impounded by the UK customs and East Malling was obliged to pay duties on it. I never did tell them what was really in the big box! At an ISHS meeting in Korea other members of the Executive Committee managed to organise it so that I was obliged to go on stage at a theatre full of people and make an ass of myself. But it was all good fun.

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

I joined ISHS in the early part of my research career at East Malling, as I did also the ASHS. My objective was to gain access to as much research information as I could in order to focus and refine my research goals. I then became involved in the Rootstock Breeding and Evaluation Working Group within the Fruits Section and subsequently became its Chair. Following encouragement from Norman Looney I was subsequently elected

› Dr. Webster in front of a 'Merchant' cherry tree on an experimental hexaploid clone of 'Colt' rootstock, which resulted in slightly more dwarfing than the normal diploid 'Colt', in the 1990s.

› Dr. Webster in his garden in France.

Chairman of the very large Fruits Section. When this overlarge section was rationalised by the ISHS Board, I became Chair of the slightly smaller Pome and Stone Fruits Section. During my ten year tenure in this role, I made it my goals to oversee the well-being of all the working groups within the Section, encourage the organisation of symposia and ensure the subsequent publication of the associated *Acta Horticulturae*. Work involving the *Acta* publications was often fraught and I apologise to all those symposia organisers who I badgered/harangued into preparing these publications. I felt that I owed it to the many developing young scientists to ensure that their publications made it into print.

One of the main joys of being an active member of the ISHS was the tremendous friendships that I made over the years. This is something I miss since retiring from the Executive Committee. Horticultural scientists are a particularly friendly group who work hard, are willing to share and discuss their research and also to relax and share a joke and a few drinks together.

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

I agree entirely with Dan Cantliffe (see *Chronica Horticulturae 55* (4), 18–19) in that we should work very hard but at the same time have fun and enjoy our career vocation. Do not cling too doggedly to a particular hypothesis but adjust your thinking on the evidence of each successive trial. Also, be willing to try a few unorthodox strategies in your work. Always communicate your results promptly and efficiently either in the written or oral form. Networking with colleagues throughout the world is essential and ISHS can help greatly with this. Initially, do not be put off pursuing a career in horticulture by school teachers, many of whom for some reason believe agriculture/horticulture to be inferior professions.

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

Whilst agriculture will undoubtedly play the major role in feeding the anticipated 9 to 10 billion people populating the planet in the next 5 to 10 years, horticulture will also have a vital role to play. Adapting/tailoring crops, via breeding or management techniques, to tolerate changing climatic conditions, especially potential water shortages, will be vital. Also of great importance will be plant conservation and the screening of much of this material for its health or nutritional benefits. It is possible to consider also the delivery of health benefits/cures via the genetic modification of food crops to include beneficial pharmaceutical active ingredients. However, for this to be achieved we must somehow break down the irrational ignorance of much of the population concerning the genetic modification of plants.

Horticultural Science News

Hormone-like action of a natural lipid, lysophosphatidylethanolamine

Zienab Ahmed

Lysophosphatidylethanolamine (LPE) is the breakdown product of a class of phospholipids found in membranes. LPE is an important bio-regulator in plants and animals and has been found to play a critical role in plant growth and development. LPE speeds up ripening and delays aging in plants by two different mechanisms. The aim of the present study was to understand the mechanism of hormonal action of LPE and test the possibility of maintaining apical dominance and promoting plant root growth of potato shoot culture by including LPE in the root zone. LPE inclusion in the media improved the overall growth of plants compared to the control. LPE affected root growth by increasing the number and length of adventitious roots initiated at the base of the cultured stem cuttings. LPE also mitigated the calcium deficiency symptoms on cultured potato plants by reducing shoot tip damage and axillary shoot development. LPE may have mitigated calcium deficiency symptoms by increasing root growth that, in turn, increased calcium uptake by the shoot, which reduced injury to the shoot apex and maintained apical dominance. Because apical dominance and root development are regulated by auxin, we suggest that LPE may have the potential to act in a similar way to this hormone, or interact with it, to regulate many aspects in plant growth such as root development.

What is LPE and where is it coming from?

Lipids are major components of every living cell membrane structure. Membrane phospholipid bilayers consist of phospholipid molecules. Each one consists of a polar head group, either choline or ethanolamine and glycerol (hydrophilic), and two fatty acid tails (hydrophobic) (Lodish et al., 2000). Phosphatidylethanolamine (PE) and phosphatidylcholine (PC) are the primary phospholipids and are approximately 60% of total membrane phospholipids (Liang et al., 2010).

The phospholipase A2 (PLA2) enzyme hydrolyzes PE and releases a bioactive structure containing a head and one fatty acid tail called LPE (Figure 1). LPE is always present in plant and animal tissue and is involved in cell metabolism. Commercially used LPE, which has bio-regulator effects, is mostly derived from egg or soy (18:0) (Cowan, 2009).

The mechanism of action of LPE

The physiological and biochemical roles of lipids, as membrane structure components, in signal transduction and in metabolic fuel storage, are well known. Numerous reports provide evidence that phospholipids and lysophospholipids, such as LPE, are signaling molecules, which can regulate plant growth and development (Cowan, 2006; Laxalt and Munnik, 2002; Meijer and Munnik, 2003). Many studies reported that LPE was able to regulate or inhibit the activity of enzymes that contribute to cell senescence, such as phenylalanineammonia-lyase, acid invertase, polygalacturonase (Hong et al., 2009a; Ryu et al., 1997), and phospholipase D, a key enzyme considered to be responsible for cell membrane lipid breakdown and subsequent senescence (Ryu et al., 1997; Thompson et al., 1998). Pre- or postharvest exogenous application of LPE on fruits, such as cranberry and banana, was shown to improve fruit ripening and retard senescence by modulating ethylene production (Ahmed and Palta, 2011; Ozgen et al., 2005). There is also evidence that the presence of LPE in the root zone of micropropagated *Arabidopsis* plants promoted root growth and elongation (Jeong et al., 2012). Although there is evidence that phospholipids and lysophospholipids play a role as potential growth regulators, the mechanism of action is still not clear (Cowan, 2009; Hong et al., 2009b). This study formed part of a research program that aimed to understand the mechanism of action of LPE.

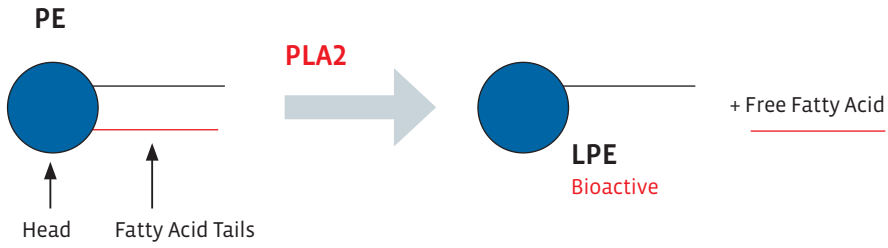


Figure 1. Lysophosphatidylethanolamine (LPE) formation by the action of phospholipase (PLA). PE = Phosphatidylethanolamine 30%.

In vitro calcium deficiency and plant growth

Calcium (Ca) is known to be an essential nutrient for plant growth and is required to complete their life cycle. In vitro cultured plants with insufficient Ca often showed abnormal growth and Ca deficiency symptoms. Busse et al. (2008) and Sha et al. (1985) demonstrated that Ca deficiency symptoms of micropropagated potato plantlets appeared first in the shoot apex, which led to shoot tip damage (necrosis) and loss of apical dominance, resulting in lateral bud growth and axillary shoot development. This system, which studied potato plants growing in vitro in low Ca medium, was utilized in the study reported here.

The objective of the present study

This study was conducted to test the hormonal action of LPE and compare this action to that of auxin by answering two questions: I. Can LPE maintain apical dominance in a low Ca environment? II. Can LPE improve plant root growth if it is present in the root zone of micropropagated potato plants? This article reports the highlights of the effect of LPE on shoots and roots of potato plants in low Ca in

vitro medium. This was one aspect of a larger PhD study conducted by the author.

Can LPE mitigate Ca deficiency symptoms and maintain shoot apical dominance?

Micropropagated potato plants grown in media with all essential nutrients provided at their optimal level, had un-branched stems compared to those grown in low Ca media, which showed shoot meristem damage, lateral bud growth, and axillary and secondary shoot development (Busse et al., 2008). We observed the effect of LPE on the growth characteristics of micropropagated potato plants grown in Ca deficient medium. Plants grown in low calcium medium showed similar calcium deficiency symptoms to those in previous reports. However, when LPE was included in this medium, there was less damage to the shoot tip, so that only a single shoot developed, and internodes were longer (Table 1). The presence of LPE in the root zone reduced the Ca-deficient symptoms so that shoot tip injury decreased by about 33, 42 and 38% when the concentration of LPE increased in the medium from 300 to 400 and 500 ppm, respectively, compared to the control (Table 1). As a result of reducing damage to the shoot meristem, axillary shoot number was reduced by about 25% when LPE (400 ppm) was present in the medium.

It was suggested that when the shoot tip is damaged, the shoot apical meristem will die and the plant will lose apical dominance, thus the lateral buds will be induced to grow and develop axillary shoots (Busse et al., 2008). These results are consistent with this hypothesis and suggest that LPE may maintain apical dominance by increasing the Ca uptake from the root to the shoot of the plant. The Ca concentration in the plant shoot increased in the presence of LPE in the medium (data not shown). This supports the hypothesis that the presence of LPE in the medium was able to alleviate low Ca symptoms in plants by increasing calcium accumulation (uptake) by the shoot, or by acting in a similar way to auxin and increasing root growth, which enables increased Ca uptake by roots (Vanneste and Friml, 2009; Woodward and Bartel, 2005).

Can LPE influence root growth and development of micropropagated plants?

In this trial, the presence of LPE in a Ca-deficient medium increased both root length (data not shown) and number of roots that developed lateral roots (Figure 2). This supports results from a recent study in which LPE increased root length and the number of lateral roots of micropropagated *Arabidopsis* plants (Jeong et al., 2012). Auxins are well known to be involved in the initiation of adventitious roots on cutting bases (Ahkami et al., 2013). LPE was able to increase the number of roots initiated on the stem cutting base as well as roots initiated from the axillary buds of the stem cutting when present in the root zone (Figure 2).

This improvement of root growth in the presence of LPE could be a reason for more Ca uptake by these new roots (increased root surface in contact with the medium), which was then transported to the shoot and led to mitigation of Ca-deficient symptoms in the shoot. The regulatory action of LPE in maintaining the apical dominance and promoting root growth suggests that LPE has a potential auxin-like effect or that it interacts with auxin to produce this effect. More studies are required to provide more direct evidence for the auxin-LPE interaction in regulating different plant growth aspects.

Table 1. The effect of different concentrations of LPE included in a medium with low calcium concentration (250 µM), on shoot length, node number, proportion of shoot tip injury and number of axillary shoots of 'Dark Red Norland' potato plants after 25 d. Values in a column that have the same letter were not significantly different ($P<0.05$). This table is abridged from a table in an *Acta Horticulturae* paper in press, with permission from ISHS.

LPE (µM)	Shoot length (cm)	Shoot tip injury (%)	Axillary shoot (No.)	Node (No.)
0	7.3 b	61.9 a	1.5 a	6.4 a
300	9.3 a	29.3 b	0.48 bc	4.9 b
400	10.3 a	19.5 c	0.38 c	4.2 c
500	9.8 a	23.8 bc	0.76 b	4.0 c

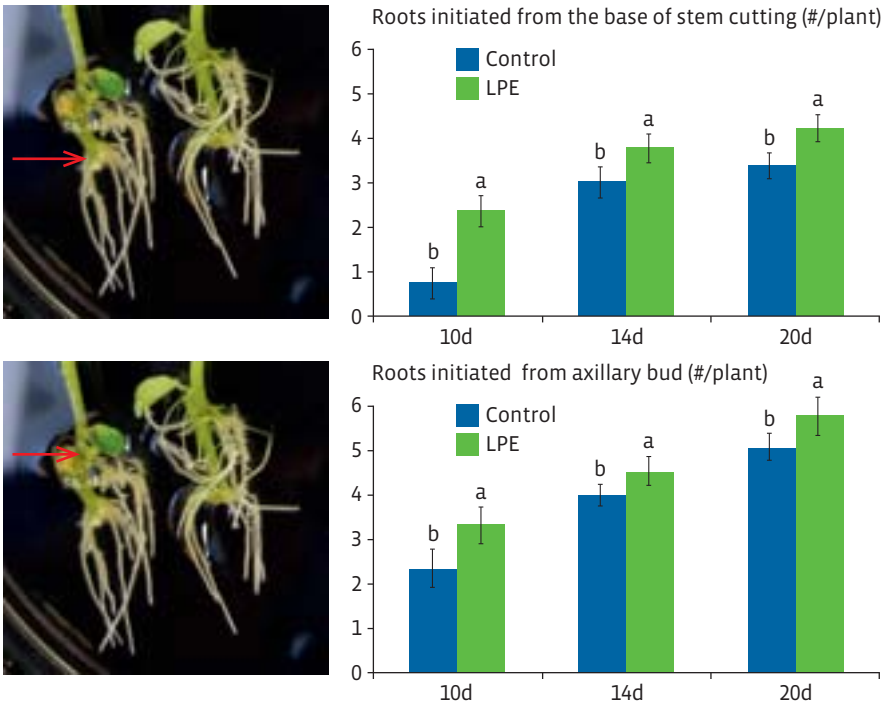


Figure 2. Effect of LPE on the initiation of roots of 'Dark Red Norland' potato plants grown in low calcium medium. The number of roots initiated from the cutting base (A) or from the axillary bud (B) was counted after 10, 14 and 20 d after transfer. The arrows in the insets show the cutting base and axillary bud locations on the cutting.

Acknowledgments

The financial support for this work was generously provided by South Valley University, Egypt and by the College of Agricultural and Life Sciences, University of Wisconsin-Madison, USA.

I'm grateful to Dr. Jiwan Palta, Professor of Horticulture at the University of Wisconsin-Madison, USA, for providing the facilities to conduct this research, and for his critical review of this article.

About the author

Dr. Zienab Ahmed is an assistant professor at the Horticulture Department, South Valley University, Qena, Egypt. She is working in the areas of horticulture crop physiology, micropropagation and postharvest quality. Her research interests are linked to fruit tree production, fruit quality in response to biotic and abiotic stresses, as well as improvement of postharvest quality using plant growth regulators, such as LPE. Zienab won a governmental scholarship from her country, Egypt, to carry out her PhD, which was conducted under the supervision of Dr. Jiwan Palta, at the University of Wisconsin-Madison, USA. She won an ISHS award for the best student oral presentation at the IX International Symposium on In Vitro Culture and Horticultural Breeding, which was held at Giza, Egypt from 13-17 March, 2016. E-mail: zinabriad@yahoo.com

References

Ahkami, A., Melzer, M., Ghaffari, M., Pollmann, S., Ghorbani Javid, M., Shahinnia, F., Hajirezaei, M., and Druege, U. (2013). Distribution of indole-3-acetic acid in *Petunia hybrida* shoot tip cuttings and relationship between auxin transport, carbohydrate metabolism and adventitious root formation. Planta *238*, 499–517.

Ahmed, Z.F.R., and Palta, J.P. (2011). Hormone-like effect of a natural lipid, lysophosphatidylethanolamine, can mitigate calcium deficiency injury in potato shoot cultures. HortSci *46*, S273 (Abstr.).

Busse, J.S., Ozgen, S., and Palta, J.P. (2008). Influence of root zone calcium on subapical necrosis in potato shoot cultures: localization of injury at the tissue and cellular levels. J Amer Soc Hort Sci *133*, 653–662.

Cowan, A.K. (2006). Lyso-phosphatidylethanolamine (LPE) as a plant bioregulator. Acta Hortic *727*, 527–536.

Cowan, A.K. (2009). Plant growth promotion by 18:0-lyso-phosphatidylethanolamine involves senescence delay. Plant Signal Behav *4*, 324–327.

Hong, J., Chung, G., and Cowan, A. (2009a). Lyso-phosphatidylethanolamine-enhanced phenylalanine ammonia-lyase and insoluble acid invertase in isolated radish cotyledon. Plant Growth Reg *57*, 69–78.

Hong, J.H., Chung, G., and Cowan, A.K. (2009b). Delayed leaf senescence by exogenous lyso-phosphatidylethanolamine: towards a mechanism of action. Plant Physiol Biochem *47*, 526–534.

Jeong, S., Park, C., Kim, M.-K., Nam, S., Hong, J., and Kim, S.-K. (2012). Effect of lysophosphatidylethanolamine and brassinosteroids on development of *Arabidopsis* roots. J Plant Biol *55*, 178–184.

Laxalt, A.M., and Munnik, T. (2002). Phospholipid signaling in plant defence. Curr Opin Plant Biol *5*, 1–7.

Liang, F.T., Xu, Q., Sikdar, R., Xiao, Y., Cox, J.S., and Doerrler, W.T. (2010). BB0250 of *Borrelia burgdorferi* is a conserved and essential inner membrane protein required for cell division. J Bacteriol *192*, 6105–6115.

Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., and Darnell, J. (2000). Molecular Cell Biology, 4th edn (New York: W. H. Freeman).

Meijer, H.J.G., and Munnik, T. (2003). Phospholipid-based signaling in plants. Annu Rev Plant Biol *54*, 265–306.

Ozgen, M., Farag, K.M., Ozgen, S., and Palta, J.P. (2005). Lysophosphatidylethanolamine accelerates color development and promotes shelf life of cranberries. HortSci *40*, 127–130.

Ryu, S.B., Karlsson, B.H., Özgen, M., and Palta, J.P. (1997). Inhibition of phospholipase D by lysophosphatidylethanolamine, a lipid-derived senescence retardant. Proc Nat Acad Sci *94*, 12717–12721.

Sha, L., McCown, B.H., and Peterson, L.A. (1985). Occurrence and cause of shoot-tip necrosis in shoot cultures. J Amer Soc Hort Sci *110*, 631–634.

Thompson, J.E., Froese, C.D., Madey, E., Smith, M.D., and Hong, Y. (1998). Lipid metabolism during plant senescence. Prog Lipid Res *37*, 119–141.

Vanneste, S., and Friml, J. (2009). Auxin: a trigger for change in plant development. Cell *136*, 1005–1016.

Woodward, A.W., and Bartel, B. (2005). Auxin: regulation, action, and interaction. Ann Bot *95*, 707–735.

History

Migration and domestication of *Bougainvillea*: a historical review

R.K. Roy and Shilpi Singh

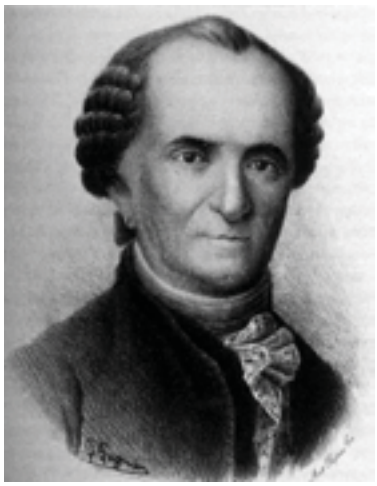


Figure 1. Philibert Commerson (1727-1773).

Figure 2. Louis Antonie de Bougainville (1729-1811).

The discovery of *Bougainvillea* dates back to 1768 A.D. The plant was discovered in Rio de Janerio, Brazil, by Dr. Philibert Commerson (1727-1773), a French explorer and naturalist (Figure 1). In 1766, a ship called La Boudeuse sailed from Nantes on a round-the-world voyage (1766-69), commissioned by the French Government. Louis Antonie de Bougainville (1729-1811), a mathematician and admiral, was in command of the ship (Figure 2). When it reached Rio de Janierio, horticultural history was made as the plant *Bougainvillea* was discovered and collected for the first time.

Dr. Commerson named the newly collected plant after his close friend and admiral of the ship – Louise Antonie de Bougainville. Twenty years after Commerson's discovery, the genus name *Bougainvillea* appeared in Genera Plantarum by A.L. de Jussieu in 1789 (De Jussieu, 1789; Holttum, 1938). The generic name underwent several transformations and was finally adopted as *Bougainvillea* by E. Spach in 1841 and subsequently published in the Index Kewensis (*Supp. 9*, 1931–35).

History of migration

Migration of plants occurs naturally as outlying plants spread seeds, slowly extending the habitat range. This phenomenon has usually been accelerated by travelers, missionaries, botanists, plant lovers and diplomats in various ways and has enabled migration of individual species across the world. Attractive flowers, fruits, fragrance, foliage and medicinal values were some of the criteria that motivated people to collect and relocate plants from one country to another, however, often seeds or plant fragments were unintentionally transferred in luggage or on clothing of travelers. Many ornamental plants have been introduced and domesticated in various parts of the world as a result of non-planned migration (Roy, 2011; Roy et al., 2012). The most fascinating example of plant migration to India is bougainvillea. *Bougainvillea spectabilis* was first introduced by the Agricultural-Horticultural Society of India (AHSI), Alipore, Calcutta (Kolkata), India in 1860 (Anonymous, 1864). The arrival of bougainvillea in India therefore happened well over 150 years ago. The current popularity and use of bougainvilleas in Indian gardens is simply amazing. No other introduced ornamental has played such a significant role in adorning Indian gardens and landscapes (Pal, 1959; Pal and Swarup, 1974; Sharma, 1996).

The colourful and attractive bracts were one of the reasons for the introduction of bougainvillea to different parts of the world and its subsequent domestication. Bougainvilleas are now well domesticated and naturalized in all parts of world except in extremely cold countries (Roy et al., 2015a) (Figure 3). The route, timing and point of introduction are not always known. Some idea of events can be determined by gathering historical records of bougainvillea introductions. One route of migration was from Brazil to Europe and subsequently to many other countries under British rule during the early 19th century, especially to many Asian countries. Other bougainvillea plants were introduced via tropical Africa to various destinations by explorers and amateur collectors.

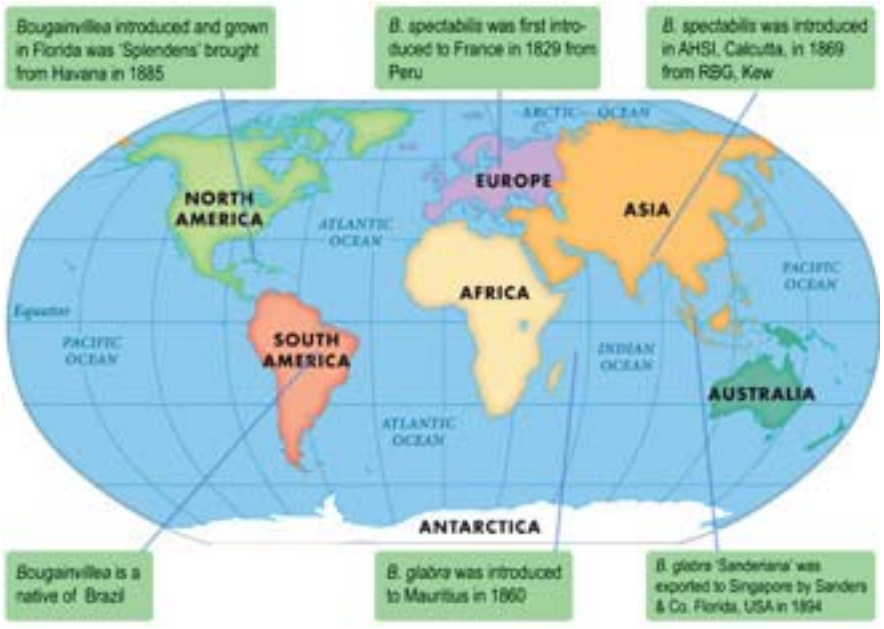


Figure 3. Migration routes of bougainvillea to different countries.

Figure 4. Buddha Jayanti Park, New Delhi.

Figure 5. *Bougainvillea peruviana* 'Isabel Greensmith' introduced at Lalbagh Botanic Garden.

Figure 6. *Bougainvillea spectabilis* 'Refulgens' at AHSI, Calcutta.

Europe

It was reported in Paxton's Botanical Magazine that *Bougainvillea spectabilis* was introduced into France in 1829 from Peru. The plant flowered successfully in Paris around 1835. Subsequently, *B. spectabilis* was introduced into the United Kingdom in 1844 from southern Brazil. However, the newly introduced plant did not flower and attempts to domesticate it were unsuccessful. A few years later, J.D. Damiels, Thames, succeeded in obtaining profuse flowering of a container-grown plant, which resulted in a lot of interest among plant lovers. The popularity of bougainvilleas grew slowly. Other species of *Bougainvillea*, namely *B. glabra* and *B. peruviana*, were introduced to the United Kingdom in around 1860.

Also in the early 1900s, a crimson *Bougainvillea* was discovered by Mrs. R.V. Butt in Cartagaea, a Spanish port in the Mediterranean region (Anonymous, 1923). It was thought to be a distinct species, but was later found to be a natural hybrid between *B. glabra* and *B. peruviana*. It was named after its discoverer, 'Mrs. Butt'. Thereafter, occurrence of natural hybrids all over the world became common. The main species yielded many hybrids spontaneously when grown together, and have been reported in East Africa, Canary Islands, Australia, North America, Philippines and India (Iredell, 1990).

USA

The history of domestication of *Bougainvillea* in Florida, USA, dates back to 1881. Introduction into Florida was the result of an individual effort by the nurseryman, Pliny Reasoner (Reasoner's Tropical Nursery), long before the establishment of the Plant Introduction Bureau, USDA. The subsequent introduction of *Bougainvillea* to Florida was 'Splendens' brought from Havana in 1885. *Bougainvillea* 'Splendens' had previously been exhibited in London in 1861 (Hackett and Sachs, 1966). Following that introduction, which increased awareness of bougainvillea, several cultivars of *B. spectabilis* and *B. glabra* were introduced, multiplied and sold to garden lovers (Gobly, 1970). *B. glabra* 'Sanderiana' was introduced from South America and first reported in USA in 1894. Subsequently, this cultivar was exported to Singapore.

As the popularity of bougainvillea grew, many other cultivars were introduced and developed as a result of cross breeding carried out by nurserymen and amateur growers. Some notable cultivars were 'Afterglow' (orange), 'Crimson Lake' (Crimson), 'Helen Coppinger' (purplish rose-pink), 'Panama Pink' (soft pink), 'Rosa-Catalina' (rose), 'Refulgens' (purple), and 'Lateritia' (mauve).

Asia

The migration and introduction of *Bougainvillea* to Asian countries also dates back to the 1800s. The main centers of introduction and cultivation were the Philippines, Mauritius, India, and Singapore. Some of the cultivars were introduced into Asian countries directly from South American countries whereas others arrived via England. Initially, amateur plant lovers, travelers, colonial civil servants and their family members introduced several cultivars. According to reports, *B. glabra* 'Sanderiana' was exported to Singapore by Sanders & Co., Florida, USA, in 1894. Similarly, *B. glabra* was introduced to Mauritius in 1860 and subsequently brought to Calcutta in 1869 (Anonymous, 1894).

The Agricultural and Horticultural Societies established by the British Government in India played a significant role in the introduction and domestication of bougainvilleas and other ornamental plants in India (Figure 4). In particular, the Agricultural and Horticultural Society of India at Alipore, Calcutta, played a pioneering role. *B. spectabilis* was introduced to India in 1860 by this society from the Royal Botanic Garden at Kew, UK. Development of new cultivars of *Bougainvillea* started thereafter within the society by renowned British horticulturist, S. Percy Lancaster. He is credited with the development of the first cultivar of *Bougainvillea* in India, 'Scarlet Queen Variegata', in 1926 (Lancaster, 1959; Sharma, 1996). Introduction of another cultivar, 'Mrs. Butt', from the Royal Botanic Garden, Kew, to AHSI in 1923 created a sensation and paved the way for further popularity of *Bougainvillea* in India. Consistent efforts by S. Percy Lancaster and the development of a new cultivar, 'Mary Palmer', helped the popularity of *Bougainvillea* in different parts of the country. In 1935, the Agri-Horticultural Society in Madras developed a new cultivar named 'Princess Margret Rose', which further increased the popularity of bougainvilleas in India.

Similar to the work done at the AHSI, Alipore, Calcutta, the Lalbagh Botanic Garden in Bangalore was responsible for bougainvillea introductions and for the development of new cultivars. Some introductions from Kenya, Africa, included the cultivars 'Isabel Greensmith' (Figure 5), 'Asia', 'No. 2', 'Elizabeth', 'Kayata', 'Closeburn', 'Glady's Hepburn', 'Natalli' (Durban, South Africa),

Table 1. A list of selected *Bougainvillea* cultivars introduced to India (Choudhary and Singh, 1981).

Name of the cultivars	Year of introduction	Place of introduction	Description
Alba	1961	Lalbagh Botanic Garden, Bangalore	Bracts white, recurved and greenish when tender
Asia	1961	Lalbagh Botanic Garden, Bangalore	Bracts cyclamen-purple in colour
Brilliant	1961	Lalbagh Botanic Garden, Bangalore	Bracts brilliant flame in colour
Charles Wilson	1961	Lalbagh Botanic Garden, Bangalore	Bracts hot pink in colour
Closeburn (Syn. Temple Fire)	1961	Lalbagh Botanic Garden, Bangalore	Bracts opal fading to lighter shade
Floribunda	1961	Lalbagh Botanic Garden, Bangalore	Bracts purple and midrib prominent and thick green in colour
Formosa	1904	Lalbagh Botanic Garden, Bangalore	Bracts pale rosy-mauve changing to redder tint when old
Golden Glow	1961	Lalbagh Botanic Garden, Bangalore	Bracts yellow shaded Spanish orange in colour
Jennifer Fernie	1961	Lalbagh Botanic Garden, Bangalore	Bracts white in colour
Kayata	1961	Lalbagh Botanic Garden, Bangalore	Bracts neyron rose in colour
Killie Campbell	1961	Lalbagh Botanic Garden, Bangalore	Bracts coppery-red in colour
Lady Mary Baring	1961	Lalbagh Botanic Garden, Bangalore	Bracts yellow in colour with greenish veins
Lady Richards	1961	Lalbagh Botanic Garden, Bangalore	Bracts lightish rose in colour
Machakos	1961	Lalbagh Botanic Garden, Bangalore	Bracts orange-red in colour
Mahara (Syn. Manila Red)	1961	Lalbagh Botanic Garden, Bangalore	Bracts purple in colour
Mrs. Butt (Syn. Ruby Crimson Lake)	1923	Royal Botanic Garden, Kew, England to India	Bracts fuchsia purple, ovate
No. 2	1961	Lalbagh Botanic Garden, Bangalore	Bracts phlox purple
Philips	1961	Lalbagh Botanic Garden, Bangalore	Bracts begin with garnet brown, change to rose opal
Princess Margaret	1935	Agri-Horticultural Society, Madras	Bracts scarlet rose to fuchsin pink
Refulgens (Figure 6)	1961	Lalbagh Botanic Garden, Bangalore	Bracts cyclamen purple or deep purplish mauve
Rhodamine	1961	Lalbagh Botanic Garden, Bangalore	Bracts rhodamine purple and ovate
Scarlet Queen	1920	Eastern Bengal Railway	Bracts fuchsia purple ovate but with slightly darker
Snow White	1940	Madras	Stars prominent and yellow
Splendens (Figure 7)	1961	Lalbagh Botanic Garden, Bangalore	Bracts magenta rose
Sydney	1961	Lalbagh Botanic Garden, Bangalore	Bracts pale purple with green veins and thick green midribs

'Mahara', and 'Roseville's Delight'. New cultivars were developed at the Lalbagh Botanic Garden by exploiting the introduced germplasm collection, for example, 'Trinidad', 'Raman', and 'Gagarin' (Marigowda, 1960). A list of many of the cultivars introduced into India are listed in Table 1.

Australia

In Australia bougainvilleas are very popular, however the history of their introduction and development is not clearly documented. Jan and Peter Iredell, Brisbane, Queensland, carried out significant collection, introduction and subsequent development of new cultivars. As a result, a series of cultivars known as 'Bambino' were developed as early as 1997. These cultivars are naturally dwarf, less thorny and floriferous. These features have made them highly suitable

Figure 7. *Bougainvillea spectabilis* 'Splendens'.

Figure 8. Bougainvillea garden in NBRI, Lucknow.

for pot culture and hanging baskets. Some outstanding cultivars of this series are 'Bluey', 'Jezebel', 'Jazzi', 'Jellibene', 'Majik', 'Panda', 'Zulii', and 'Zuki'.

Popularity and development of new cultivars in India

Attractive bract colours and the easy adaptability of bougainvilleas to Indian agro-climatic conditions have made them a popular ornamental in Indian gardens. They captured the attention of plant lovers and breeders alike. As bougainvilleas became more popular, they were included in breeding programmes during the early 20th century. In this regard, the role played by the Agri-Horticultural Society of Calcutta and Madras was remarkable and pioneering (Roy et al., 2015a). Initially, these two societies (Calcutta and Madras) and Lalbagh Botanic Garden, Bangalore were the centre of developmental work (Roy et al., 2007).

During the post-independence era, the Indian Council of Agricultural Research (ICAR) and the Council of Scientific and Industrial Research (CSIR), New Delhi, planned breeding and development work on bougainvillea, which was conducted in their various horticultural/biological institutes. Large germplasm collections were established as a basic genetic resource in CSIR - National Botanical Research Institute (NBRI), Lucknow. A collection of more than 200 cultivars has been built up as a 'National Germplasm Collection Centre'. ICAR - Indian Agricultural Research Institute (IARI), New Delhi, has also been maintaining authentic germplasm collections (Figures 8 and 9). Many spectacular cultivars have been developed and commercialized. CSIR-NBRI alone has developed 26 new cultivars of *Bougainvillea*. It is estimated that about 150 new cultivars have so far been developed in India from sports or by breeding. A list of some of the Indian-bred cultivars is shown in Table 2 (Choudhary and Singh, 1981).

Several societies, individuals, nurserymen, and institutions have played a significant role in the development of new cultivars (Anonymous, 1961). Cultivars developed by various societies and institutes include 'Princess Margaret Rose' (AHSI, Madras, 1935), 'Mary Palmer' (AHSI, Calcutta, 1949), 'Dr. B.P. Pal' (NBRI, Lucknow, 1969), 'Fantasy' (B. Rama Rao, Madras), 'Louise Wathen' (AHSI, Madras, 1932), 'Alick Lancaster' (AHSI, Calcutta, 1930), 'Scarlet Glory' (K. Gopalaswamienger & Sons, Bangalore, 1952), 'Mrs. H.C. Buck' (Soundarya Nursery, Madras, 1930), 'Jaya', 'Jayalakshmi Variegata', 'Suverna' and 'Silver Top' (Bhabha Atomic Research Institute, Mumbai) (Roy et al., 2015b) (Figure 10).

Development of hybrids

Development of new cultivars was started by hybridization, selection and bud sports. Several cultivars have arisen from seedling selection as a result of natural crossing. Some artificial hybridization and subsequent development of new cultivars has

Figure 9. Bougainvillea germplasm collection at A) NBRI, Lucknow, B) IARI, New Delhi.

Figure 10. New cultivars released by CSIR-NBRI, Lucknow: A) *Bougainvillea* × *buttiana* 'Dr. P.V. Sane' (2011), B) *Bougainvillea peruviana* 'Dr. A.P.J. Abdul Kalam' (2015).

■ Table 2. Some outstanding Indian-bred cultivars.

Name of the cultivars	Year of release	Description of the cultivar	Breeders (individual/institutional)
Alick Lancaster (syn. Lilac Queen)	1930	Bracts cyclamen purple, elliptic with acute tip	A. Percy Lancaster, Delhi
Arjuna	1974	Leaves variegated (creamish white, dark and light green); bracts pinkish purple, elliptic, non-persistent	M.N. Gupta and R. Shukla, NBRI, Lucknow
Aruna	2008	Bracts pinkish orange	S.C. Sharma, S.K. Datta and R.K. Roy, NBRI, Lucknow
Amarault	1938	Bracts rose madder to rose bengal, later changing to carmine when old	S. Percy Lancaster, Calcutta
Begum Sikander	1969	Bracts medium, resin purple margin and white centre in cooler months	S.N. Zadoo and T.N. Khoshoo, NBRI, Lucknow
Bhabha	1960	Leaves with cream variegation, bracts empire rose in colour	Lalbagh Botanic Garden, Bangalore
Celia Braganza	1986	Bracts purple, flowering profuse	Verna Nagpal, Bombay
Chitra	1981	Bracts large magenta, geranium-like (multi-coloured)	T.N. Khoshoo, D. Ohri and S.C. Sharma
Common Rose	1959	Bracts China rose in colour	S. Percy Lancaster, NBRI, Lucknow
Daya	1966	Bracts faint pink colour, flowering in both summer and winter seasons	Sh. V.N. Palekar and others, Bombay
Dr. H.B. Singh	1979	Bracts light violet-purple, medium to big size, cordate base and an acute tip	IIHR, Bangalore
Dr. R.R. Pal	1959	Bracts fuchsia purple, young bracts red, free flowering	Dr. B.P. Pal, New Delhi
Godrej Cherry blossom (Syn. Gogrej Centenary)	1997	Bracts creamy yellow triangular and persistent after flowering	K.V. Krishna Rao
Krumbiegel	1954	Bracts rhodamine purple, ovate with cordate base	M/s K.S. Gopalaswamienger Son, Bangalore
Lady Mary Baring	1961	Bracts small, yellow with greenish veins	Lalbagh Botanic Garden, Bangalore
Los Banos Variegata	1990	Leaves yellow variegation, ovate shaped, cordate base	S.K. Datta, B.K. Banerji and S.C. Sharma, NBRI, Lucknow
Louise Wathen Variegata	1935	Bracts golden orange changing to pinkish when old	Royal Agri-Horticultural Society of India, Calcutta
Magenta Queen	1945	Bracts magenta-purple	A. Rama Rao, Madras
Mary Palmer Special	1974	Bracts medium, chimera with no definite patterns, may be white, magenta or blotched, flowers borne in trusses	S.N. Zadoo and T.N. Khoshoo, NBRI, Lucknow
Dr. A.P.J. Abdul Kalam (Figure 10B)	2015	Bright red to red-purple bracts; leaves variegated (creamy-yellow margins with dark green and grey-green middle portion)	R.K. Roy, NBRI, Lucknow
Odisee	1977	Bracts white or pink with white dots at maturity	P. Das, O.U.A.T., Bhubaneswar
Pallavi	1987	Bracts orange coloured, ovate shape, acute tip, cordate base, persistent	B.K. Banerji and S.K. Datta, NBRI, Lucknow
Dr. P.V. Sane (Figure 10A)	2011	Profuse, red purple; leaves variegated (yellow green)	R.K. Roy, NBRI, Lucknow
Shubhra	1965	Bracts white, large; stars yellow in colour	S.C. Sharma, NBRI, Lucknow
Tetra Mrs. McClean	1969	Bracts medium burnt orange with greenish veins, flower tube slender, tinged with orange	S.N. Zadoo and T.N. Khoshoo, NBRI, Lucknow

also been carried out (Khoshoo and Zadoo, 1969). The first controlled cross pollination was achieved by Jim Hendry, Florida, in 1927 between 'Rosa Catalina' (male) and 'Lateritia' (female).

Two excellent hybrids were developed and named 'Margaret Bacon' (lavender rose-pink) and 'Daniel Bacon' (dark purple-pink). Another report from Peru mentioned two new hybrids made by W.N. Sands. He raised 'Lady Seton James' (rose) as a cross between 'Sanderiana' and 'Lateritia' followed by 'Lady Watls' (terracotta to salmon pink) as a result of a cross between 'Rosa Catalina' × 'Lateritia'. Similarly, another new hybrid 'Barbara Karst' was developed, which was predominantly available and used in Florida, California and South Texas.

Conclusion

The worldwide popularity of bougainvillea is an excellent example of the beneficial effect of non-restricted transfer and exchange of plant species. With the enactment of the Convention of Biological Diversity (CBD) in 1993, there are now restrictions on exchange of germplasm collections from one country to another, to take account of sovereignty

issues and to guard against over-exploitation that could lead to extinction.

Research and development work carried out in India and other Asian countries on bougainvillea has resulted in the development of a large number of new cultivars. The way bougainvilleas have influenced gardens and landscapes of tropical and subtropical countries, particularly in Asia, Australia and America, is noteworthy (Roy, 2013). In addition, production of bougainvilleas in the nursery trade has contributed positively to generating employment and sustaining livelihoods.

Therefore, sustaining interest in developing new cultivars should be a continuing goal for horticulturists and bougainvillea lovers alike.

References

Anonymous. (1864). *Bougainvillea spectabilis*. Curtis's Bot. Mag. 4810.

Anonymous. (1894). *Bougainvillea glabra* var. 'Sanderiana'. Proc. R. Hort. Soc. *17*, 8.

Anonymous. (1923). 'Mrs Butt'. Proc. R. Hort. Soc. *48*, 46.

Anonymous. (1961). New varieties of Bougainvilleas. Indian Hort. *5*(*3*), 11.

Choudhary, B., and Singh, B. (1981). The International *Bougainvillea* Check-List (New Delhi: Indian Agricultural Research Institute).

De Jussieu, A.L. (1789). *Bougainvillea* Commer. In Genera Plantarum (New York: Whelden and Wesley Ltd.), p.91.

Gobly, E.V. (1970). History of *Bougainvillea* in Florida. In Flowering Vines of the World: An Encyclopedia of Climbing Plants, E.A. Menninger (New York: Hearthside Press Inc., Publishers), p.138–145.

Hackett, W.P., and Sachs, R.M. (1966). Factors affecting flowering of *Bougainvillea* 'San Diego'. Proc. Am. Soc. Hort. Sci. *88*, 606–612.

Holttum, R.E. (1938). The cultivated Bougainvilleas. Gardeners Chronica *103*, 164–165.

Iredell, J. 1990. The *Bougainvillea* Growers Handbook (Brookvale: Simon and Schuster, Australia), pp. 111.

Khoshoo, T.N., and Zadoo, S.N. (1969). New perspectives in *Bougainvillea* breeding. Journal of Heredity *60*(*6*), 357–360.

Lancaster, S.P. (1959). *Bougainvillea*. Bull. 41 (Lucknow: National Botanical Gardens), p.31.

Marigowda, M.H. (1960). Short notes on Bougainvilleas in Lalbagh. Lalbagh Journal of Mysore Horticultural Society *5*, 25–28.

Pal, B.P. (1959). Introducing four new Bougainvilleas. Indian Horticulture *4*(*1*), 16–22.

Pal, B.P., and Swarup, V. (1974). Bougainvilleas (New Delhi: ICAR).

Roy, R.K., Banerji, B.K., and Goel, A.K. (2007). Bougainvillea – germplasm collections at NBRI. Indian Bougainvillea Annual 20, 10–13.

Roy, R.K. (2011). Introduction and migration of ornamental trees to India. Chronica Hortic. *51*(*1*), 29–33.

Roy, R.K., Kumar, S., and Sindhu, S.S. (2012). History of migration of bougainvilleas and development of Indian bred varieties. Indian Bougainvillea Annual *24*, 4–13.

Roy, R.K. (2013). Fundamentals of Garden Designing (New Delhi: New India Publishing House), pp.699.

Roy, R.K., Singh, S., and Rastogi, R.R. (2015a). Bougainvillea: Identification, Gardening and Landscape Use (Lucknow: CSIR-National Botanical Research Institute), pp.144.

Roy, R.K., Singh, S., Rastogi, R.R., and Verma, S. (2015b). Development of new varieties of bougainvillea: the contribution of CSIR-NBRI. Indian Bougainvillea Annual *26*, 11–15.

Sharma, S.C. (1996). Bougainvilleas in India (Lucknow: EBIS, National Botanical Research Institute), pp.74.

About the authors

› R.K. Roy

› Shilpi Singh

Dr. R.K. Roy is the Senior Principal Scientist (Horticulture) and Head of the Botanic Garden, Floriculture and Landscaping Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, 226001, India. His research interests include ornamental horticulture, particularly breeding and development of new cultivars (he has developed 16 new cultivars of *Gladiolus*, *Bougainvillea*, *Canna,* etc.); collection and conservation of ornamental trees and designing theme gardens. He also has an interest in historical aspects of ornamental plants. E-mail: roynbri@rediffmail.com

Ms. Shilpi Singh is a Ph.D. scholar at the Botanic Garden, Floriculture and Landscaping Division, CSIR-National Botanical Research Institute, Lucknow, India. She has been working on conservation of collections of live *Bougainvillea*, *Canna* and *Gladiolus* and on characterization of ornamentals, especially newly developed cultivars. E-mail: shilpisinghbmw@gmail.com

The world of Horticulture

Svalbard Global Seed Vault – and its role in global food security

Åsmund Asdal

The Svalbard Global Seed Vault (SGSV or "The Vault") was opened in 2008 and provides a safety facility for the international conservation of plant genetic resources (PGR). At the time of writing this article, 66 gene banks and research institutes have deposited 881,473 accessions of seeds, representing more than 5000 species of crops and their wild relatives, in The Vault. This means that about 40% of the known diversity of crop plants conserved in gene bank collections globally are duplicated in SGSV.
The aim of SGSV is to contribute to the long-term security of genetic diversity of crop plants important to future food production. As with all insurance measures, the hope was that seed boxes in The Vault would never be needed. However, the importance and need for the SGSV as a security facility was proven in 2015, when the International Centre for Agricultural Research in the Dry Areas (ICARDA) requested the first retrieval of deposited seeds, as their gene bank collections in Aleppo, Syria needed to be multiplied and conserved in another location.

Background

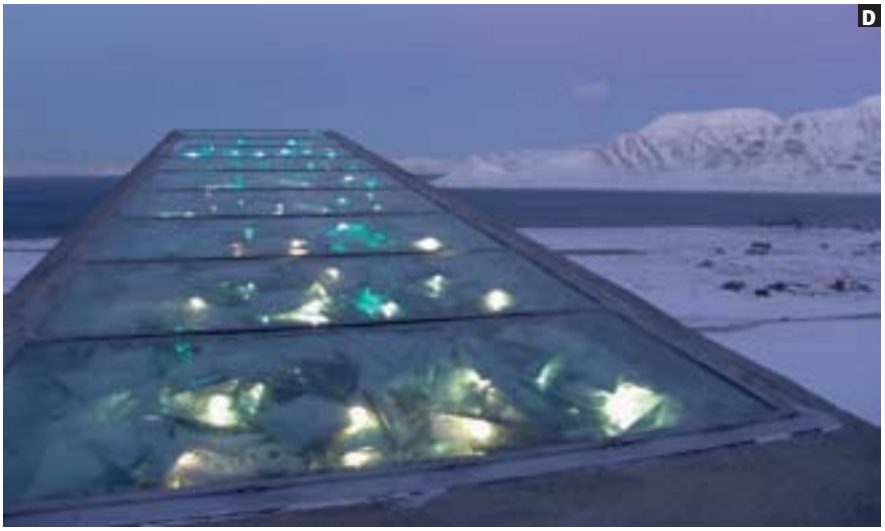
Plant genetic material, held by gene banks and research institutes all over the world, is used for plant breeding, and is perhaps the most vital resource for increasing global food production. The idea of having security storage of gene bank seeds in Svalbard was initiated during the 1980s, when the Nordic Gene Bank placed a collection of seed duplicates in an abandoned coal mine outside Longyearbyen in Svalbard.
The location was perfect for this purpose for many reasons. Permafrost is present in Svalbard, and it is a remote place, far away from regions suffering from conflicts. At the same time, the location benefits from good infrastructure, such as an airport with frequent flight connections.
A major achievement of international efforts focussed on the conservation and use of genetic resources was the establishment in 1983 of the Commission on Genetic Resources for Food and Agriculture (CGRFA). CGRFA was the leading body during international negotiations that resulted in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) in 2004. The Treaty established an international framework for conservation and access to plant genetic resources, and during negotiations the need for a global safety facility was identified. A facility study, requested from the Commission, concluded that Svalbard would be a suitable location. In June 2006, it was announced that Norway would build a seed vault and offer space free of charge for seed deposits from the international community of gene banks.
The Norwegian initiative was launched in accordance with Norwegian commitment and contribution to the international endeavour on biological diversity and genetic resources in particular, and after extensive support for the idea was received from international bodies.
The Svalbard Global Seed Vault was opened in February 2008. During its eight years of operation, gene banks all over the world have deposited seed samples in The Vault. Deposits can be made only following a depositor agreement that is signed by the depositing institute and the Norwegian Ministry for Agriculture and Food. The main issue in this agreement is that deposited seeds remain the property of the depositing gene bank. Seeds are packed and shipped by the gene bank and stored under 'black box' conditions, which means that boxes in The Vault are never opened and seeds can only be sent back to the owner gene bank itself. The depositing gene bank can at any time claim their seeds, if they are needed for any reason.

The facility

The Vault consists of three storage halls embedded in geologically stable and solid rock. The entrance to the halls goes through a 120 m long tunnel from the outside portal in the hillside of Platåfjellet (The Plateau Mountain). The portal itself is adorned with a piece of artwork; "Perpetual Repercussion" by Dyveke Sanne, and it has become a landmark for visitors and tourists to Svalbard.
The entrance is located 130 m above sea level, which is safely above the worst case climate change scenario for sea level rise. Permafrost provides natural frozen conditions, but artificial cooling equipment has been installed to maintain temperatures at -18°C, which is the same temperature as most gene banks use for their long term seed collections. Because of similar storage conditions, monitoring of seed viability remains the responsibility of the depositor, and they can regenerate and ship new seeds when necessary.
The Svalbard Global Seed Vault aims to conserve duplicates of all unique seed accessions that are conserved in national, regional or international gene banks and other holdings. Current estimates indicate that there are approximately 2.2 million unique seed accessions conserved globally. Dimensions in The Vault allow for deposits of approximately 4.5 million accessions, depending on how densely the seed boxes are packed.
The Svalbard Global Seed Vault was constructed and funded by the Norwegian government. Management of The Vault is secured through a three-party agreement between the Norwegian Ministry of Agriculture and Food, the Crop Trust and the Nordic Genetic Resource Centre (NordGen). Surveillance and monitoring of temperatures and other environmental measurements are conducted by Statsbygg, the government body for management of state-owned buildings.
NordGen is responsible for the operation and management of The Vault. The most important part of this is to maintain contact with potential depositor institutes and to facilitate the shipment and transfer of seeds from other gene banks to Svalbard. Normally, The Vault is opened three times a year for deposits. Seed boxes are shipped by air cargo, and NordGen staff transfer them onto the shelves within The Vault.

In The Vault today

NordGen keeps an updated SGSV seed database accessible on the internet, showing details of seeds held in The Vault, such as species, depositor institutes and the origin of seed accessions. The webpage also provides depositor guidelines.



› Outside The Vault. A) The road to The Vault in summer, B) The Vault lit up at night ; the polar bear sculpture was created to celebrate the opening of the Vault in 2008, C) A delivery to The Vault in winter, D) The top of The Vault. Photo credit: Norwegian Ministry of Agriculture and Food.

As of March 2016, the number of seed accessions in the SGSV was 843,400. The number was reduced by 38,073 because of ICARDA's retrieval of seeds in September 2015. Seeds have been deposited from 66 gene banks, research institutes and NGO's and originate from 233 different countries. The high country figure is due to the fact that names of former countries still remain in global databases for conserved PGR. In total 5,128 species and 945 different genera are represented in the collection (Figure 1).

Depositors are mainly international, regional or national gene banks and research centres. A couple of NGO's have also deposited seeds in cooperation with gene banks. Some of the CGIAR centres (Consultative Group for International Agricultural Research) are in charge of the largest numbers of deposited seed samples.

Four of them have deposited more than 100,000 accessions each; CIMMYT (International Maize and Wheat Improvement Center), IRRI (International Rice Research Institute), ICARDA (International Centre for Agricultural Research in Dry Areas) and ICRISAT (International Crop Research Institute for the Semi-Arid Tropics). Four other CGIAR centres are major depositors; CIAT (International Center for Tropical Agriculture), IITA (International Institute of Tropical Agriculture), Africa Rice Center and CIP (International Potato Center).

Fifteen gene banks have deposited more than 10,000 accessions each. The major depositor countries on the national gene bank level are USA, Germany, Canada, The Netherlands, South Korea and Taiwan. NordGen, which is a regional gene bank for the Nordic countries,


A


B


C


D

› Inside The Vault. A) When entering the halls where the seeds are stored, you have to pass through a 120 m long tunnel. B) At the moment, only one of three halls has been equipped with artificial cooling and shelves. Each hall has space for 3168 standard-sized seed boxes. The two other halls will be made ready when more space is needed. C) Shelves filled with seed boxes of different shapes and colours and bearing different logos create an atmosphere of international understanding and co-operation to conserve genetic resources, making any vision of a world filled with conflict feel very far away. D) Nowadays, most gene banks use sealed aluminium envelopes for storing dried seeds for long term conservation. The formerly-used glass tubes are, however, nice to look at, because the tremendous diversity of seed forms can be observed. Photo credit: Norwegian Ministry of Agriculture and Food.

has deposited 19,584 accessions as of March 2016, which is a major part of its total long-term conserved seed collection.
In total, national gene bank collections from 44 different countries are represented in the Svalbard Global Seed Vault.

The first seed withdrawal

Each gene bank that has deposited seeds in The Vault retains full ownership and all rights to the material, and can at any time and for any reason claim the seeds back. In practice, such requests will presumably occur only when plant varieties or seed samples are lost or inaccessible from the primary gene bank or its collaborative gene bank collections.
Such an incident occurred in 2015, when the ICARDA headquarter and gene bank in Aleppo, Syria, experienced issues with their seed collections. The collections were partly destroyed and partly inaccessible because of civil war and evacuation of staff. ICARDA had systematically deposited seeds from the very start of the operation of the Svalbard Global Seed Vault in 2008, and in September 2015, the ICARDA deposits in SGSV had reached 116,484 accessions, comprised of 375 species stored in 325 boxes.
During 2015, ICARDA decided that the best way of restoring their gene bank collection would be to retrieve seeds from the Svalbard Global Seed Vault and use them for multiplication and establishment of a new gene bank outside Syria. ICARDA has units in approximately 30 countries, from India in the East to Morocco in the West.
NordGen and the Norwegian Ministry for Agriculture and Food received the formal request for withdrawal of 38,073 seed samples on the 10th of September 2015. One ICARDA representative assisted the Norwegian staff during the removal of the seeds on the 23rd September. In the first week of October, 71 seed boxes arrived at ICARDA in Morocco and 57 boxes arrived in Lebanon. The withdrawal contained seeds of varieties of wheat, barley, lentil, chickpea, faba bean, pea, grass pea and legume forages (*Medicago, Trifolium* and *Vicia*).
Seeds were sown in November and the process of multiplying varieties for the establishment of a new gene bank and for use in

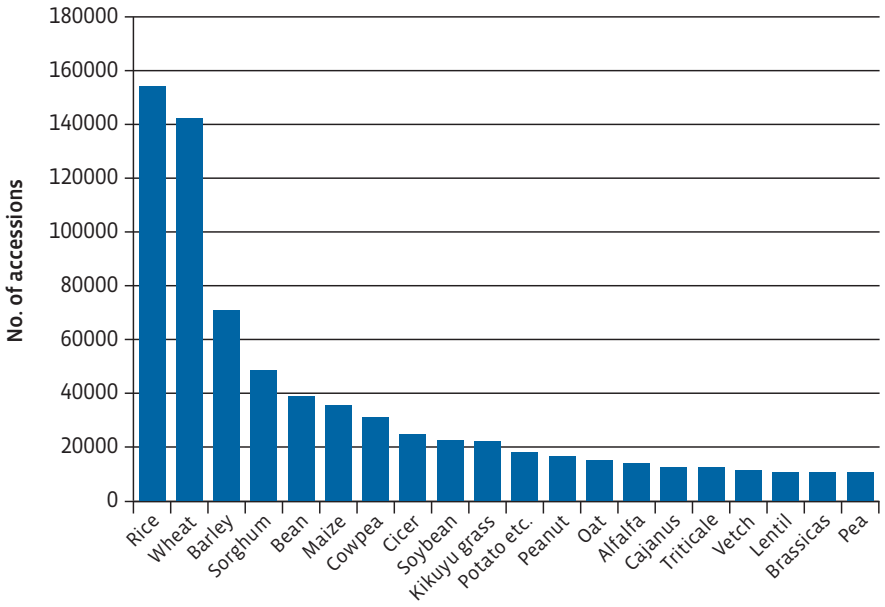


Figure 1. Deposited accessions of the 20 crops/genera in the Svalbard Global Seed Vault. Of the more than 5,000 different species represented, rice and wheat are the most numerous, followed by barley, sorghum, beans and maize. Twenty crops have more than 10,000 unique accessions stored in The Vault.

› Seeds for long term conservation in the Seed Vault are registered and packed at the depositing gene bank before shipment of the sealed boxes. This image shows registering and packing of seeds for SGSV at The International Institute of Tropical Agriculture (IITA) in Abuja, Nigeria. Photo credit: Norwegian Ministry of Agriculture and Food.

plant breeding and research started. ICARDA hopes that it will be possible, within two or three years, to send new samples of the accessions back to Svalbard, replacing those that were taken out in autumn 2015.

Public awareness about PGR conservation and SGSV

In addition to its major role of conserving crop diversity, the Svalbard Global Seed Vault also seeks to advance the larger cause of conservation of crop diversity through increased public awareness and through building political and scientific support.

The Vault has been visited by many politicians and policy makers within international organizations, governments, businesses, and plant breeding and research organisations (Figure 2). The Crop Trust uses The Vault actively in an effort to raise contributions to their endowment fund for safeguarding international collections of crop diversity.

The biggest group of visitors, however, is journalists and media groups. More than 100 media journalists, from TV, radio, newspapers, magazines, film and book projects, have visited The Vault since it was opened, which has resulted in numerous articles in papers and magazines, TV documentaries, radio programmes and internet videos for a global audience. The ICARDA seed withdrawal in 2015 significantly increased media interest in The Vault.

Interest from artists of different kinds is also significant, and The Vault has been opened for photographers, painters, architectural projects and other art forms. Artists are attracted by the beauty of the internal architectural structure, the silence and, not least, by the important and symbolic content of The Vault. Outcomes of these visits can be experienced on many publicly-available platforms such as exhibitions, printed publications, events, performances and internet websites.

For security and capacity reasons access to The Vault is governed by strict policy. In principle, the facility is accessible only to visitors who will contribute positively to the purpose of The Vault. This means that The Vault is not accessible to tourists or even professionals going to Svalbard mainly for touristic reasons.

Figure 2. UN Secretary General, Ban Ki Moon, visited The Vault in 2009, here together with NordGen information officer, Professor Roland von Bothmer. Behind are two Norwegian Ministers, Erik Solheim and Lars Peder Brekk (Photo: NordGen).

On a few occasions, researchers and those undertaking educational projects have been approved access to The Vault. Representatives from depositing gene banks are welcomed to The Vault. Inquiries from companies with requests to use The Vault for commercial projects are always denied.

Interest from the public and from tourists to visit The Vault is quite overwhelming. In order to convey relevant information to the public, an exhibition about The Vault has been prepared and placed at Svalbard Museum in Longyearbyen as an integrated part of the museum exhibitions. People who request entry to The Vault are recommended to pay a visit to the museum and also to see the spectacular Svalbard Global Seed Vault portal, which is accessible by car from Longyearbyen. The entrance of The Vault is probably the most well-known Norwegian building worldwide.

More information

More information about the Svalbard Global Seed Vault and its operations can be seen on webpages of the cooperating partners.

The official SGSV webpage is operated by the Norwegian Ministry for Agriculture and Food: https://www.regjeringen.no/en/topics/food-fisheries-and-agriculture/landbruk/svalbard-global-seed-vault/id462220/

NordGen operates a webpage that contains the Seed Portal and information to depositors at http://www.nordgen.org/index.php/en/content/view/full/2605/. From this webpage the information movie “The back-up copy” can be seen at https://vimeo.com/62688049.

Crop Trust offers information about their work for global PGR conservation and use and in particular about the SGSV at https://www.croptrust.org. An interactive visit into The Vault is available at https://www.croptrust.org/what-we-do/svalbard-global-seed-vault/interactive-visit/

Contact

Mr. Åsmund Asdal is a Norwegian horticulturist and ecologist who, for the past 20 years, has mainly been involved with projects on conservation and use of plant genetic resources (PGR) on a national and Nordic regional level. From 2000 to 2015, he was in charge of the Norwegian national PGR programme. From the mid 1990s, he conducted projects and working groups within the Nordic Gene Bank, and in 2015 he was appointed Coordinator of Operation and Management for the Svalbard Global Seed Vault at the Nordic Genetic Resource Centre (NordGen, former Nordic Gene Bank). E-mail: asmund.asdal@nordgen.org

› Åsmund Asdal.
Photo credit: Anna Filipova.

Saffron (*Crocus sativus* L.) production in Morocco

Mounira Lage, Chaouki Alfaiz and Mohamed Badraoui

Introduction

Positioned in the upper northwest corner of Africa, Morocco is one of the richest Mediterranean countries in terms of biodiversity and range of ecosystems. Furthermore, Morocco is composed of various landforms, including high mountains (Atlas and the Rif chains), deep valleys, lowlands, plains, plateaus with rangelands and deserts. As a consequence, many agro-ecosystems have been established, which utilize specific endemic species and diversified local agricultural products, such as the cultivation of saffron.

Saffron, a glamorous and highly prized spice, has been in large-scale demand for centuries. Highly desirable for its beauty, aroma, and medicinal powers, it is often called "Red Gold" (Poggi, 2009) and is known to be "the most expensive spice in the world." It is derived from the dried stigmas of *Crocus sativus* L., an *Iridaceae* plant that has been traditionally cultivated in different countries in Asia and the Mediterranean region. *Crocus sativus* is a sterile plant that does not produce viable seeds. The crop is propagated by corm multiplication. Saffron is mostly used in the pharmaceutical, food and textile industries. It is considered to be an anti-cancer agent (Negbi, 1999). Its high price results from the large amount of direct labour required for its cultivation, harvesting and handling (White Book, 2005-2007).

Saffron production at a worldwide level is facing difficult challenges, such as the need for new cultural techniques, genetic improvement, propagation of high quality plant material, conservation of genetic resources, new chemical technologies to assess quality and the prevention of product adulteration (White Book, 2005-2007).

An overview of saffron cultivation in Morocco

Saffron cultivation in Morocco

The saffron crop has been cultivated for centuries in Morocco, mainly in the Anti and High Atlas mountains (Figure 1). Approximately 95% of Moroccan saffron production is traditionally produced in the Souss-Massa and Draâ regions at the commune of Taliouine and Taznakht (Figure 1), a remote area with a cold winter and hot summer. This local production is generally identified as "Saffron of Taliouine". The main production sites are characterized by strong geographical isolation and higher altitudes with strong cultural identity. About 1500 to 2000 farmers grow saffron on very small plots of less than one hectare.

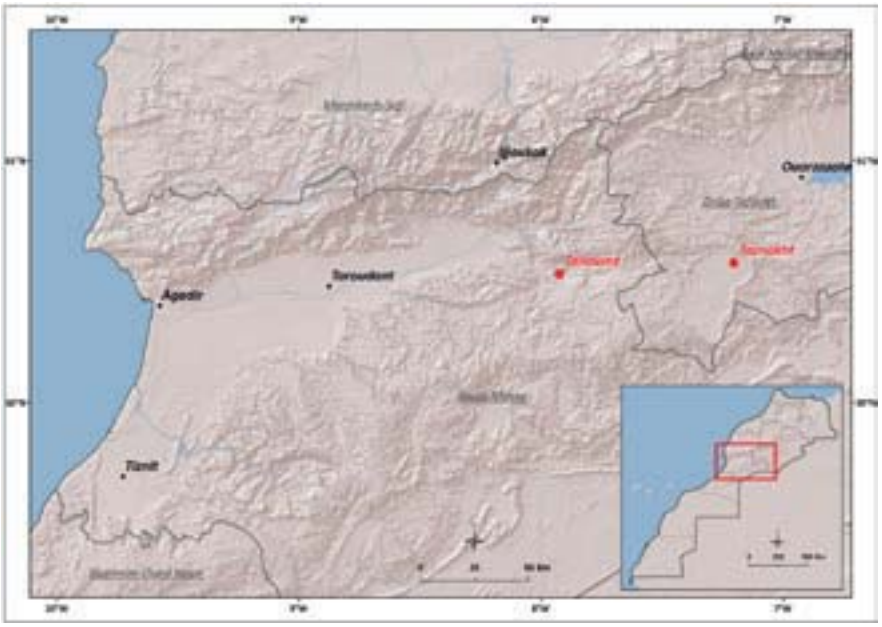


Figure 1. The regions in Morocco where saffron is mostly grown – Taliouine and Taznakht.

Saffron, in these regions, is one of the basic profitable crops. It represents the local cultural identity based essentially on a local knowledge of technical crop production practices and their adaptation to the prevailing changing climatic conditions. In general the yield is low and ranges between 2 and 6 kg ha^{-1}. However, higher yields can be achieved, as demonstrated on some plots, reaching up to 10 kg ha^{-1} (Dubois, 2010). This low productivity in traditional saffron production areas can be attributed to weak technical expertise in selection and improvement of corms and in technical practices of cultivation (Garcin and Carral, 2007). Indeed, as a local and organic-like product, saffron production in Morocco is carried out traditionally, with no application of any chemicals and with no corm selection for new plantings.

In terms of crop evolution, the planted area of saffron and total production showed a slow increase until 2008, after which both area and total production increased more rapidly (Figure 2). From 1998 to 2015, they have almost doubled. An estimate of the saffron sector value in 2011 was 85 million MAD[1] (776256 Euro) (ADA, 2012).

In 2008, Morocco launched a new national strategic agricultural policy called the Green Morocco Plan (GMP), which will operate until 2020. This policy identified opportunities for developing several niche products and marketing procedures for agricultural products like saffron. The GMP has promoted drip irrigation of saffron to overcome water scarcity issues frequently encountered in the arid areas of production. The GMP aims to improve smallholder earnings through agricultural development, to help alleviate poverty in rural areas. In that context, a labelling system was introduced in 2008 to improve awareness of product origin and quality. To date, a total of 30 products have been awarded the "protected origin designation" label, including saffron. In January 2015, an agree-

[1] Average exchange rate in April 2016: 1 Euro = 10.95 MAD. US $ 1 = 9.62 MAD.

■ Table 1. Distribution of the national saffron selling channels (Dubois, 2010).

Saffron selling channels	Proportion of total national market (%)
Traditional informal	61.1
Traditional formal	34.0
Cooperatives	3.3
Integrated[1]	1.2
Tourist	0.4

[1] The "integrated" system: saffron goes through a specialized company that integrates the entire channel from producing corms to selling high quality saffron.

■ Table 2. Proportion of saffron imported into Morocco from different countries (1998-2009) (%) (Office de Change, cited by Dubois, 2010).

Country	Proportion of saffron imported (%)
India	39.9
Spain	21.1
Iran	17.2
France	11.3
United Arab Emirates	8.9
Other countries	1.6

ment was signed between Morocco and the EU for these labels to be recognized.

The success of sustainable production of saffron depends on many factors, including the use of selected seed corms, management of soil fertility, good soil tillage, weed control, and water supply during the critical stages of plant growth and development. Harvesting and postharvest conditions are also major factors that influence saffron quality. Government support, through the GMP, to modernize the saffron value-chain is focused on all of these factors.

As a result, there has been an emergence of new production models in the main saffron region, led in part by foreign investors. They are motivated by the subsidies offered by the government as part of the GMP, including free distribution of saffron corms (ADA, 2012).

The saffron market

National saffron marketing. Locally, the informal and traditional saffron market channels are the most predominant. Cooperatives and eco-tourism are also used for marketing saffron on a much smaller scale (Table 1).

The average selling price of saffron in the local market over the last 17 years has been around 14 MAD g^{-1} (1.28 € g^{-1}), ranging from a minimum value of 8 MAD g^{-1} (0.73 € g^{-1}) to a maximum value of 23 MAD g^{-1} (2.10 € g^{-1}) (Figure 3). Cooperative prices have been higher than local market prices with an average over 17 years of 27 MAD g^{-1} (2.46 € g^{-1}), ranging from 23 to 35 MAD g^{-1} (2.10 to 3.19 € g^{-1}) (Figure 3). A price of 3.50 € g^{-1} was set as a "reference" for cooperatives, following the first purchase by "Altro Mercato" (Fair trade in Italy), but this price does not reflect the reality of the global market (DTF Safran et Dattes – MOR 12 043 11).

Relatively low quantities of saffron are purchased by cooperatives from their members and sold directly to tourists, restaurants, inn-keepers (Rural Solidarity Tourism (TDR) in the saffron region) and at regional and national fairs, with 10% of the production sold being packaged in plastic bags of 1 g. The remaining product is sold through informal channels in the local souks and in big Moroccan cities via intermediaries (Vaes, 2008). The Casablanca market place seems to monopolize a large part of the Moroccan saffron trade. Saffron cooperatives received funding from the Souss Massa Draa General Council to use new packaging (Vaes, 2008).

Moroccan saffron imports. The value of saffron imported into Morocco during the period from 1999 to 2009 varied from 247000 MAD (22557 Euro) in 2003 to 3000 MAD (274 Euro) in 2006 (Figure 4). Furthermore, the quantities imported never exceeded 100 kg $year^{-1}$. Import prices per kilo are not well known. Just over half (55%) of the quantity of saffron imported was in the form of filaments (FAO-ORMVAO, 2009-2010). Almost 90% of saffron imports are sourced from four countries: India, Spain, Iran and France (Table 2).

Moroccan saffron exports. The average national Moroccan saffron production is around 3 t $year^{-1}$, which is 1% of the world's production. Moroccan saffron is exported mainly to the European Union (EU). In 2009, the value of this export was 35 million MAD (3196347 Euro). The major saffron importing countries are Spain (61.4%) and Switzerland (36.6%) (ADA, 2012).

Moroccan saffron is mainly exported as filaments (98%) (Dubois, 2010). Exports to the EU do not have any special pricing conditions (DTF Safran et Dattes – MOR 12 043 11). There is no information on the final destination of Moroccan saffron exported to the EU. An FAO-ORMVAO study (2009-2010) revealed only the names of food companies as the European importers and there was no detailed information on the mechanism for determining price, the quality of saffron sought by the food industry, the volumes purchased (total purchases and that from Morocco) or the technical requirements that the saffron had to meet before being exported.

Institute support of the Moroccan saffron industry

Support institutions are involved in the saffron industry through many activities such as mentoring and training saffron producers, and providing support for production and packaging of saffron (ADA, 2012). Support by government institutes to improve activities along the value-chain, such as export assistance, is limited because of the informal nature of many of the marketing systems. Collaboration between the different support institutions and management of the sector remains an ongoing challenge.

Cooperatives and second order producer organizations

The saffron value-chain has been organized through the GMP as one of the most important local products of the south-western region of Morocco.

The saffron area in both Taliouine and Taznakht is expanding (ORMVAO, 2015) due to government support (drip irrigation and corms distribution). Most of the producers are organized into 57 cooperatives (Figure 5). Female members represent only 29% of the total members in both saffron production regions (Figure 6) (ORMVAO, 2015). However, cooperatives are still characterized by a fragile capacity for financial management. Because of their low level of organization and management, the quantities of saffron sold through cooperatives are still limited (DTF Safran et Dattes – MOR 12 043 11).

Second order organizations have recently been established. Four groups of economic interest (GEI), including a Saffron House, were created in 2011 (DTF Safran et Dattes – MOR 12 043 11). Support for women in the saffron supply chain was achieved by creating a number of women's cooperatives. Two women's cooperatives are already active and a GEI was put in place. However, this GEI needs more support to develop its capacity, especially concerning gender issues.

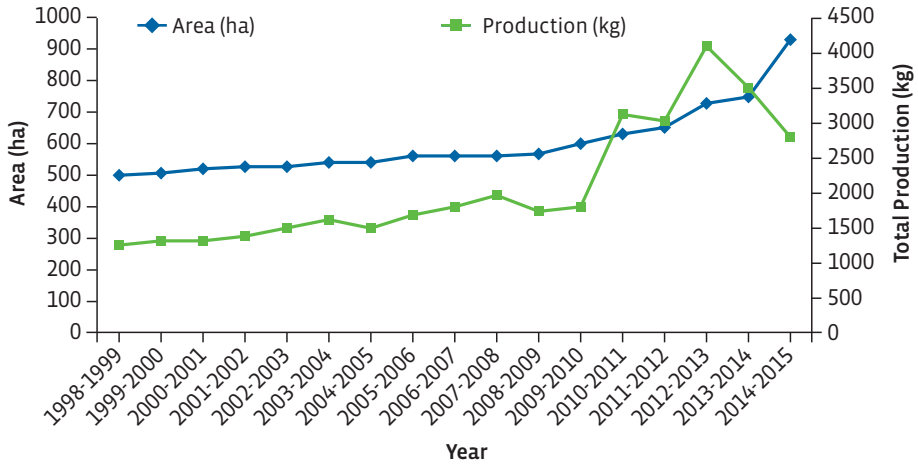


Figure 2. Planted saffron area (ha) and total production (kg) in the main saffron regions (ORMVAO, 2015).

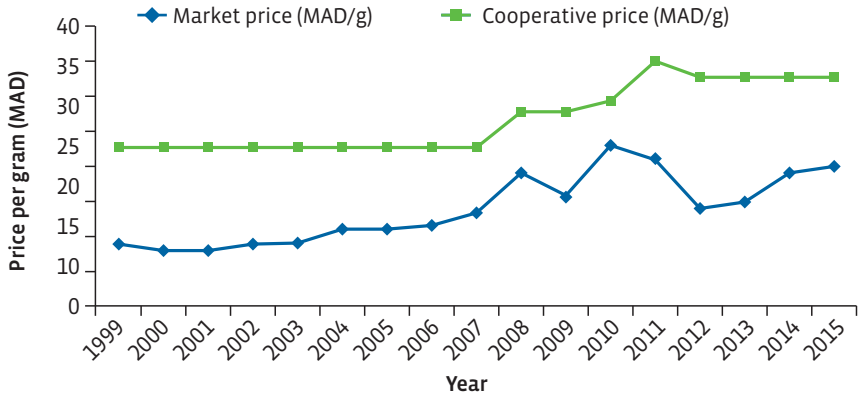


Figure 3. General market price and cooperative price (ORMVAO, 2015).

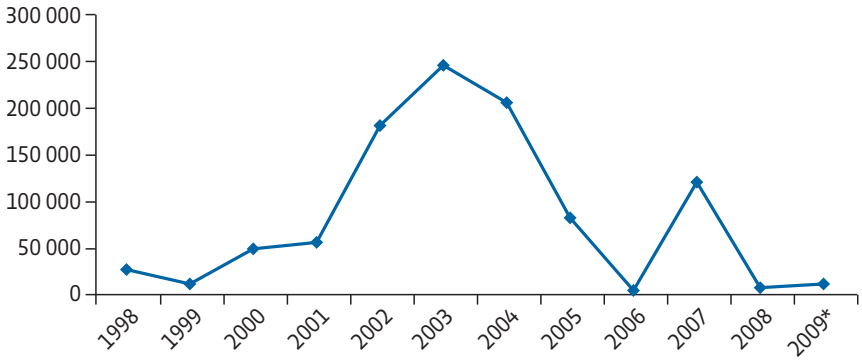


Figure 4. Value of Moroccan saffron imports (1998-2009) in MAD (Office de Change, cited by Dubois, 2010). *2009 from January to September.

There is also an emergence of "new types" of producers and foreign investors, characterized by intensive production systems and motivated by grants from the government under the GMP. The impact of these new types of producers and their expansion of the industry on the traditional smallholder farmer has not yet been evaluated (DTF Safran et Dattes – MOR 12 043 11).

The Moroccan saffron corms trade

In recent years, the cultivation of saffron in Taliouine and Taznakht has faced problems of availability and price of saffron corms. The growing interest in this crop between 2006 and 2009 has increased demand for new saffron corms, almost tripling their market price over this period of time (ORMVAO, 2009). Interest in saffron corms has increased at a national level due to the research activities conducted by the National Institute of Agronomic Research (INRA-Morocco) in other Moroccan regions to develop saffron as a new alternative crop (Lage et al., 2007). As a result, traders developed new corm markets with producers in other Moroccan regions. This trade has also extended internationally, with the export of Moroccan corms to Europe, mainly to the Netherlands (Vaes, 2010). The increase in corm price encouraged farmers to sell their own corms, causing corm scarcity. As a consequence, the high price limited the planting of new saffron plots in the region. In addition, saffron corms produced in the main Moroccan saffron region (Taliouine and Taznakht) became the source for European producers, because the corms were much cheaper than from other countries. Thus, Moroccan corms are being exported to Europe (ORMVAO, 2010). As a result of these issues, some producers have requested that the government prohibit trade of corms outside the main saffron zone. In November 2014, a decision by the Minister of Agriculture and Maritime Fishery was published in their official bulletin, which protects Moroccan corms and requires seed-corms to be certified (Arrêté du Ministre de l'Agriculture et de la Pêche Maritime, 2014). Furthermore, The Nagoya protocol that Morocco ratified, will contribute to the protection of both genetic material and associated local knowledge.

The Green Morocco Plan for the saffron sector (OBG, 2015)

The main objectives of the GMP in the saffron sector for the period 2012-2020 are to:

- increase saffron area to 1,350 ha by 2020;
- improve the production of saffron to reach 9 t year^{-1} by 2020;
- increase the saffron quantity exported to 6 t year^{-1};
- improve production efficiency and saffron quality;
- improve the framework of working conditions within the sector;
- invest in research and development to improve product quality and technical assistance to farmers.

The main commitments of the government are:

- encouraging corm-seed production;
- creation of collective irrigation schemes involving digging of wells or boreholes, their connection to the electricity grid and pumping equipment, storage basins and supply facilities of water to plots;
- consolidation of training and mentoring programs;
- strengthening research and development;
- strengthening marketing activities of saffron products.

The main saffron professional commitments are:

- encouraging the development of seed-corm multipliers;

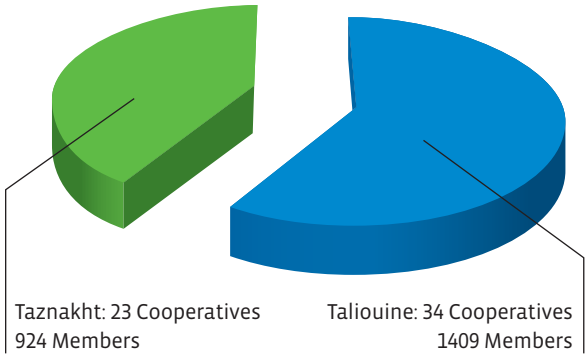


Figure 5. Cooperative distribution in the saffron production region (ORMVAO, 2015).

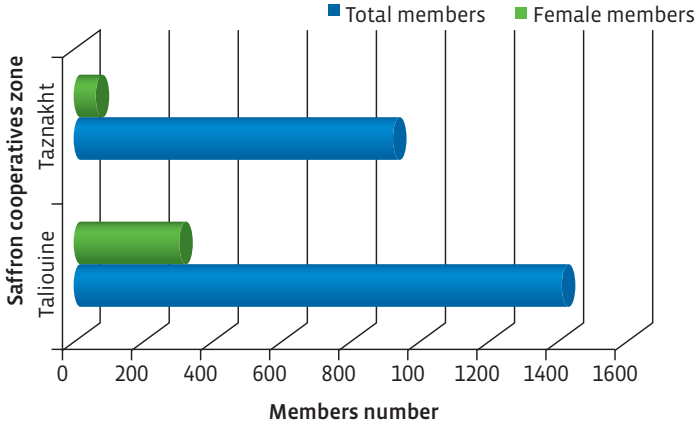


Figure 6. Gender representation within saffron cooperatives in the main saffron producing regions (ORMVAO, 2015).

Figure 7. Dissemination of research work to farmers in some underprivileged Moroccan zones. Corms being collected in the main saffron region for corm selection purposes.

- increase awareness of farmers to use certified seed-corms;
- raising awareness of farmers about establishment of water-saving irrigation systems;
- strengthening training and mentoring programs;
- transfer of knowledge and technology;
- strengthening of marketing actions.

Scientific research conducted on saffron at the National Institute of Agronomic Research (INRA)

In an attempt to extend the cultivation area of saffron to other regions of Morocco, outside of its original regions of the Anti-Atlas Mountains in the southwest, experiments were carried out without major success, because of a lack of well-designed scientific research programs. In fact, even though saffron is an old crop in Morocco, little scientific research work has been devoted to it.

A dedicated team at INRA-Morocco initiated a research project in 2005, to determine whether saffron could grow in some underdeveloped regions, which ranged in environmental conditions. The main goal was to develop saffron as an alternative or complementary crop with high added-value in well suited ecological conditions for socio-economic development of other rural populations. The study investigated the adaptability of saffron to environments other than its original growing area. The studies included the effect of growing region on flowering capacity and on saffron quality, which is the most important trait for this aromatic and medicinal plant. For this purpose, saffron trials were established in eleven different locations that have a range of ecological conditions in terms of elevation, soil type and climate.

The first step of this work was successfully achieved and the potential zones for extending saffron have been identified (Lage and Cantrell, 2009). In order to improve the saffron crop in these new areas, trials on cultural practices and the use of selected plant material (ecotypes) were undertaken. Characterisation of Moroccan saffron germplasm, which likely includes some of the oldest saffron accessions in the world, was necessary to determine the genetic diversity within this population for selection purposes.

A holistic approach, integrating many aspects of saffron cultivation, is under investigation in order to achieve the objectives of this work, which include:

- Genetic improvement of saffron: research is focused on the identification of genetic elites with interesting agronomic characters in relation to saffron yield, saffron quality and corm production in the main saffron zone.
- Characterization of Moroccan saffron population using genetic markers.
- Determination of saffron quality based on biochemical and biotechnological

Figure 8. Dissemination of research work to cooperatives in some underprivileged Moroccan zones and in scientific workshops and international symposia.
A. Women's Cooperative planting a saffron crop – Tetuan (Northern Morocco);
B. Visiting newly-established saffron plot in the Oukeimiden region – Marrakech.

tools. There is increasing international interest in the supply of high quality saffron. Unfortunately, there is a lack of differentiation among saffron types based on their organoleptic features, and competition in the international market is based on the product price. Important differences in saffron quality from different Moroccan regions have been observed. These differences could be caused by many different factors such as cultivation conditions, the flower harvesting and stigma separation process, drying, storage and packaging conditions. However, the existence of genotypic diversity in relation to saffron quality, based on their organoleptic features, has never been studied on Moroccan saffron. A chemical profile of Moroccan saffron has now been identified (Lage et al., 2015).

- Development of a micropropagation procedure for selected genotypes, based on agronomic and quality characteristics. The slow growth of saffron for corm production (only 3 to 4 cormlets per season), and the low yield obtained because of the poor quality of corms used, are limiting factors for saffron propagation in the identified zones. The development of successful micropropagation systems for some genotypes appears to be very promising.
- Dissemination of scientific research.

Demonstration platforms have been established in farmers' fields in different regions of Morocco. Dissemination of research results has also been achieved through regular seminars, workshops, and field days (Figures 7 and 8). Good indicators of the success of this project will include an increase in the number of farmers who adopt this crop in the selected regions, and an increase in the quality of saffron products in the market. A guide to saffron cultivation in Morocco is being published by INRA-Morocco, in the local Amazigh language.

References

ADA (Agence de Développement Agricole). (2012). Guide Investisseur. pp.148.

Arrêté du Ministre de l'Agriculture et de la Pêche Maritime n°3403-14 du 12 hija 1435 (7 octobre 2014) portant homologation du règlement technique relatif à la production, au contrôle, au conditionnement et à la certification des bulbes (semences cormes) de safran. BO. n°6306 du 06/11/2014, p.4668.

DTF Safran et Dattes (MOR 12 043 11). Dossier technique et financier: Développement des filières du safran et du palmier dattier dans la région Souss-Massa-Draa. pp.185.

Dubois, A. (2010). Analyse de la filière du safran au Maroc. Thèse de Master de Science, N° 107 (CIHEAM, IAAM), p.1–80.

Garcin, D.G., and Carral, S. (2007). Le safran marocain entre tradition et marché. Étude de la filière du safran au Maroc, en particulier dans la région de Taliouine, province de Taroudannt. Rapport FAO safran TCP/MOR/3201, p.1–178.

FAO-ORMVAO. (2009-2010). Rapports de mission de consultation. Renforcement des capacités locales pour développer les produits de qualité de montagne – cas du safran (FAO-ORMVAO).

Lage, M., Melai, B., Cioni, P.L., Flamini, G., Gaboun, F., Bakhy, K., Zouahri, A., and Pistelli, L. (2015). Phytochemical composition of Moroccan saffron accessions by headspace solid-phase-microextraction. American Journal of Essential Oils and Natural Products *2* (4), 1–7.

Lage, M., and Cantrell, C.L. (2009). Quantification of saffron (*Crocus sativus* L.) metabolites crocins, picrocrocin and safranal for quality determination of the spice grown under different environmental Moroccan conditions. Scientia Horticulturae *121*, 366–373.

Lage, M., Cantrell, C.L., and Faiz, C. (2007). Developmental project for introducing saffron (*Crocus sativus* L.) as an alternative crop in other Moroccan regions. Acta Hortic. *736*, 49–52.

Negbi, M. (1999). Saffron (*Crocus sativus* L.). In Medicinal and Aromatic Plants – Industrial Profiles (Harwood Academic Publishers).

Ministry of Agriculture and Maritime Fishery. http://www.agriculture.gov.ma/.

ORMVAO. (2015). Monographie de la Subdivision de Taliouine (Morocco: ORMVAO).

ORMVAO. (2009). Plan Agricole Régional de Développement du Safran (Morocco: ORMVAO).

ORMVAO. (2010). Fiche d'identification du programme de développement du safran et du palmier dattier. Région de Souss Massa Draa.

Poggi, L.M. (2009). Problematicas y nuevas perspectivas tecnologicas para la produccion de azafran. Horticultura Argentina *28*, 39–62

OBG (Oxford Business Group). (2015). The Report: Morocco 2015: Agriculture, A. Jeffreys, ed. (Oxford Business Group).

Vaes, G.A. (2008). Renforcement des capac-

ités locales pour le développement les produits de qualité de montagne – cas du safran. Projet FAO-TCP-MOR/3201. p.1–31.

Vaes, G.A. (2010). Renforcement des capacités locales pour développer les produits de qualité de montagne – cas du safran. Seconde mission. FAO/TCP/MOR/3201(D). p.1–34.

White Book (2005-2007). European Saffron White Book. Saffron Project (Castilla-La Mancha, Spain / West Macedonia, Greece / Sardinia, Italy: INTEREG IIIC, European Union). http://www.europeansaffron.eu/archivos/White%20book%20english.pdf.

› Mounira Lage

› Chaouki Alfaiz

› Mohamed Badraoui

› About the authors

Dr. Mounira Lage has been a Moroccan researcher and agronomist at the National Institute of Agronomic Research, Morocco, since 1990. Her main research interests are agro-physiology, agro-environment, data analysis, germplasm collection, domestication and conservation of plants, research and development. She has focused on the environmental impact, cultural practices and genetic improvement of the saffron crop. In addition, she has carried out research on cereal crops such as rice and wheat, on sugar plants such as stevia and on bioenergetic plants such as *Jatropha curcas*. E-mail: mlage@fulbrightmail.org

Dr. Chaouki Alfaiz is currently head of the Department of Plant Breeding and Genetic Resource Conservation at the Scientific Division in INRA, Morocco. He has expertise in plant breeding, and has been responsible for breeding tomatoes, forage crops particularly oats and aromatic and medicinal plants. He has successfully selected and registered more than 10 oat varieties and was responsible for establishing germplasm collections for many wild species in Morocco. In 2011, the Grand Prix Hassan II of Environment presented Dr. Alfaiz with an award for his work on both forage and medicinal plant genetic resources. E-mail: faizchawki@yahoo.fr

Prof. Badraoui has served as the director general of INRA, based in Rabat, Morocco, since 2008. He has more than 35 years of experience in agricultural research, specializing in soil science. His work has focused on soil fertility management, crop fertilization and fertigation, soil mapping for land management and soil salinity management under irrigated systems for intensive crop production. He is also experienced in evaluating the sustainability of cropping systems and evaluating and refining agricultural development projects in arid and semi-arid areas. E-mail: mohamedbadraoui@gmail.com

Viticulture in Turkey

Gökhan Söylemezoğlu, Arif Atak, Yılmaz Boz, Akay Unal and Mehmet Sağlam

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

Introduction

Turkey is situated between latitudes 36-42° north and longitudes 26-45° east, a favourable area for viticulture that has a long history in the cradle of civilization. Turkey is one of the top producers of grape (Table 1; Figures 1 and 2). It has 468,792 ha of vineyards and a production of approximately 4 million t. Over 77 million t of grapes are grown worldwide on more than 7.1 million ha. Turkey ranks fifth in terms of growing area, after Spain, France, China, and Italy, and ranks sixth in production after China, Italy, USA, Spain and France.

Table 1. Top grape-producing countries (Faostat, 2013).

Country	Area (ha)	Production (t)
China	730,000	11,550,024
Italy	702,100	8,010,364
USA	394,848	7,744,997
Spain	944,200	7,480,000
France	760,615	5,518,317
Turkey	468,792	4,011,409
World	7,155,187	77,181,122

% World Total	2000	2013
Spain	15.7%	13.6%
France	11.6%	10.5%
Italy	11.6%	10.0%
China	3.8%	9.0%
Turkey	7.3%	6.7%
USA	5.2%	5.4%

Figure 1. Changes in vineyard area between 2000 and 2013 for the top producing countries (1000 ha).

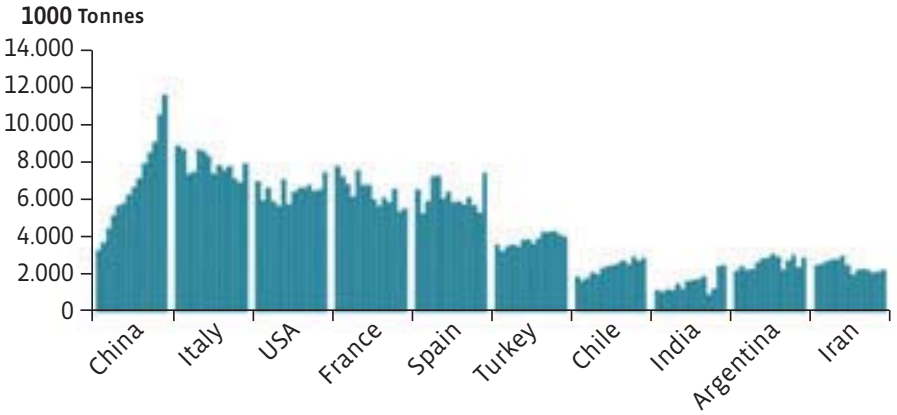


Figure 2. Changes in grape production between 2000 and 2013 for the top producing countries (1000 t).

A large peninsula in Turkey, Anatolia, is surrounded by the Mediterranean, Black and Aegean seas. This peninsula is connected to the Asian continent in the east and also to Caucasia in the north-eastern corner, which is believed to be the primary origin of cultivated grapes. Anatolia includes the area of origin of *Vitis vinifera* ssp. *sylvestris* (wild grape), which can now be found all over the country, especially on river banks, shores of lakes and in forests. Anatolia is also called Asia Minor (Uzun and Bayır, 2010).

In Turkey, grapes have been mainly grown as table grapes (52%), for raisins (38%), and for fruit juice and wine (10%), with around 80 standard cultivars grafted onto mainly six standard rootstocks in nine viticultural regions. Turkey has about 7% of the world's area of vineyards, and produces 6.4% of the world's grape production. In addition, productivity in Turkey has improved by about 40% in the last 15 years, from 6654 kg ha^{-1} in 1998 to 9249 kg ha^{-1} in 2012 (TUIK, 2014).

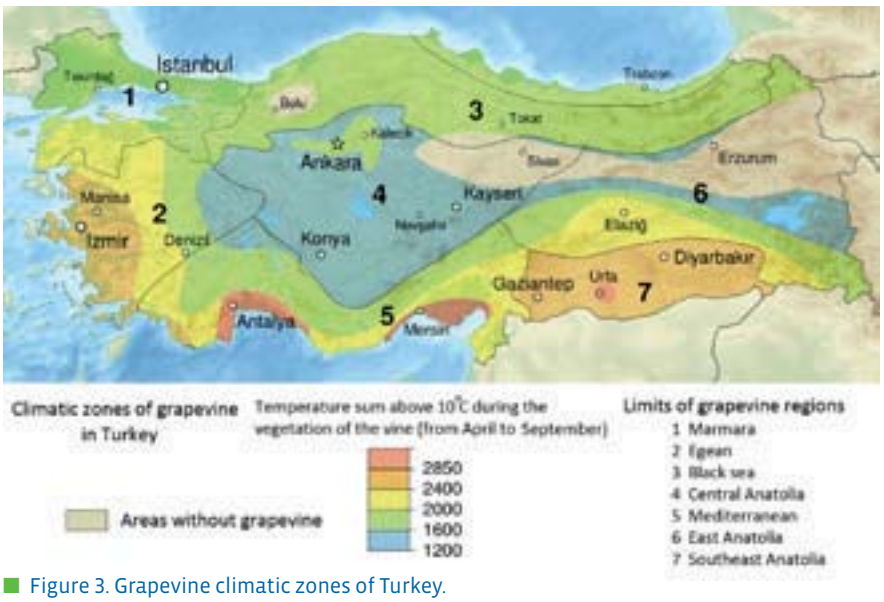


Figure 3. Grapevine climatic zones of Turkey.

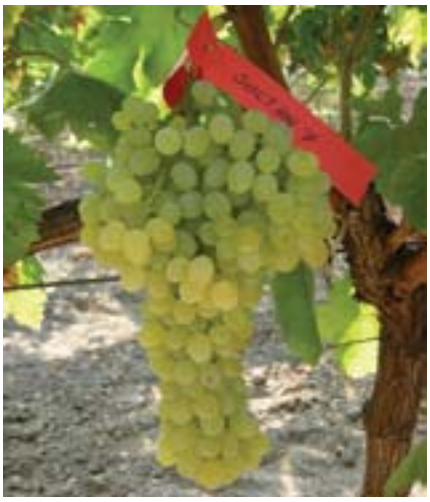


Figure 4. 'Sultan 7', a grape cultivar suitable for raisins, released through a clonal selection program implemented by Manisa Viticulture Research Institute.

Table 2. Grape production in Turkey. Source: www.tarim.gov.tr.

Year	Area (ha)	Production (1000 t)			
		Total	For table	Raisins	For wine use
1988	590000	3350	-	-	-
1989	597000	3430	-	-	-
1990	580000	3500	-	-	-
1991	586000	3600	-	-	-
1992	576000	3450	-	-	-
1993	567000	3700	-	-	-
1994	567000	3450	-	-	-
1995	565000	3550	-	-	-
1996	560000	3700	-	-	-
1997	545000	3700	-	-	-
1998	541000	3600	-	-	-
1999	535000	3400	-	-	-
2000	535000	3600	-	-	-
2001	525000	3250	-	-	-
2002	530000	3500	-	-	-
2003	530000	3600	-	-	-
2004	520000	3500	1900	1230	370
2005	516000	3850	2000	1400	450
2006	513835	4000	2060	1495	444
2007	484609	3612	1912	1217	482
2008	482788	3918	1970	1477	470
2009	479023	4264	2256	1531	475
2010	477785	4255	2249	1543	461
2011	472545	4296	2268	1562	465
2012	462295	4234	2219	1613	400
2013	468792	4011	2132	1423	455
2014	467092	4175	2166	1563	445
2015	461955	3650	1891	1334	423

Main features of the Turkish viticulture industry

Large variations in climatic conditions in Turkey allow for the production of table grapes, raisins and wine grapes (Table 2). In total, 1,200 grape cultivars are grown in Turkey, mostly belonging to the species *Vitis vinifera* L. (Ergül and Ağaoğlu, 2001; Ergül et al., 2002; Uzun and Bayır, 2008). Over 1,170 *Vitis vinifera* L. accessions are being maintained at the Tekirdağ National Germplasm Repository Vineyard.

Although vineyards are spread throughout the country, commercial production is concentrated mainly in the Aegean, Mediterranean, South-Central Anatolian and South Anatolian regions (Figure 3). Ecological conditions favourable for viticulture exist in nearly all regions of Turkey, with the exception of the higher altitudes in Northeastern Anatolia and along the Black Sea Coast, where viticulture is restricted by the excessive rainfall of 2,000 mm annually (Çelik et al., 2008). The Aegean region ranks first in terms of both area of vineyards and grape production, especially *Vitis vinifera* 'Sultana', whereas the Black Sea region ranks last. Due to heavy rainfall in spring and autumn and insufficient sunshine over the vegetation period, European grape cultivars (*Vitis vinifera* L.) do not tend to ripen well in the Black Sea region. According to Cangi et al. (2006), climatic conditions in the region are responsible for widespread fungal disease, low fertility, poor fruit quality and late ripening of *V. vinifera* cultivars. By contrast, a diverse range of native or open-pollinated *Vitis labrusca* L. are grown on backyard pergola systems or on redwood trees. These grapes have a "foxy" or musky flavour, thick "slip-skins" and a distinct aroma, and are consumed as table grapes, in marmalades and pickles, or as juice – according to local needs (Çelik et al., 2008). Several previous studies have shown *V. labrusca* grapes to be resistant to fungal diseases such as mildew and powdery mildew (Brown et al., 1999; Wan et al., 2007; Cadle-Davidson, 2008; Köse, 2014).

Raisin grape production

Turkey is the second most important raisin grape producer after USA, and its production of *Vitis vinifera* 'Sultana' was 286,575 t (Kara, 2014). Seedless 'Yuvarlak Çekirdeksiz' and 'Sultani' are the main cultivars used for raisins. Seedless raisins are grown especially in the Aegean region of Turkey, which has very fertile land, plenty of sunshine and abundant water supplies (Figure 4). The original name of the famous seedless Turkish raisins, 'Sultana', 'Sultanna', or 'Sultanine', comes from the fact that they were served at the Ottoman sultans' magnificent tables during the times of the Ottoman Empire. About 60% of the total production in this region is seedless. Depending on export market demand, the tendency in Turkey is towards more production without reducing quality. This has been realized by both increasing plantings throughout the country and utilizing modern viticulture techniques to increase productivity. Raisin production in Turkey accounts for nearly 23% of total world raisin production (www.nutfruit.org). About 20-30% of Turkey's raisins are marketed domestically, and the remainder are exported to different countries. Raisin export values of the top eight countries in 2014 were: Turkey (506.5 million $US), USA (402.7 million $US), Iran (272.5 million $US), Chile (167.2 million $US), China (104.5 million $US), Greece (73.7 million $US), South Africa (40.2 million $US), and Uzbekistan (27.5 million $US) (Faostat, 2014).

Some other raisin grape cultivars, such as 'Besni', 'Antep Karası', 'Rumi', 'Dımışkı', 'Kerküş' and 'Sergi Karası', are also grown in Eastern and Southeastern Anatolia regions. In addition to these regions, in Central Anatolia (Nevsehir and Konya provinces) some

Figure 5. A vineyard recently established using a trellis sytem.

raisin cultivars, such as 'Ekşi Kara' and 'Kara Dimrit', are also grown. These cultivars are different to those in the Aegean region because all of them are seeded cultivars (Söylemezoğlu et al., 2015).

Wine history and production in Turkey

Wine historians and ampelographers believe that the southeastern part of Turkey was the origin of grape domestication, dating back to 9,000 BC (http://vinorai.com). The first traces of viticulture and winemaking in Anatolia date back 7,000 years. Wine had an indispensable role in the social lives of the oldest civilizations of Anatolia, the Hattis and the Hittites. It was the primary libation offered to the gods during rituals attended by royalty and high governors. Provisions protecting viticulture in Hittite law, and the custom of celebrating each vintage with a holiday, suggest that wine was important to both ancient economies and ancient cultural practices. Later still, Turkish tribes arrived in Anatolia from Central Asia and they also drank wine.

During the long period of the Ottoman Empire (1299-1923), wine production and trade were carried out exclusively by non-Muslim minorities (Greeks, Armenians, Syrians, and others). Wine production reached record levels and alcohol prohibitions ceased during the second half of the 19th century, in an atmosphere of tolerance and freedom brought about by the Ottoman modernization movement. At the same time, European vineyards were being devastated by an epidemic of phylloxera (a vine-attacking insect), dramatically reducing their wine production. In order to meet the resulting surge in European demand, the Ottoman Empire's wine exports increased substantially, reaching 340 million litres in 1904. Thus, there was a considerable amount of wine production in Turkey before World War I and the War of Independence of Turkey. But these wars affected production negatively, especially in the Thrace and Aegean regions.

In 1927 the production of all alcoholic beverages was brought under the control of a government monopoly, with the exception of wine, for which private production and the development of vineyards was still permitted. This was specifically done to develop and protect wine production. In 1946, there were 28 small-sized wineries all around Turkey that were exploring the potential for high quality wine production by experimenting with different cultivars and terroirs under the government monopoly. In the 1950s, the government initiated the planting of French grape cultivars in the Aegean and Thrace regions. 'Semillon', 'Clairette', 'Sylvaner', 'Gamay', 'Cinsaut', 'Pinot Noir' and 'Cabernet Sauvignon' were among the cultivars planted and investigated during these dates. The subsequent decrease in quality began with the non-implementation of the "controlled wine regions" regulation as well as political changes in the 1960s. Private producers stayed in the market throughout this period, but remained relatively small in size.

By the late 1980s, the Turkish economy began to integrate with other global economies and deregulation became more prevalent. In addition, the tourism sector began to develop. These factors substantially boosted wine sales. This was the impetus for wineries to invest in the latest technology and machinery to develop their wineries, begin investment in their vineyards and plant international and local grape cultivars with international quality standards (http://www.winesofturkey.org). The largest winery of Turkey was operated by TEKEL, which started as a state-owned monopoly. TTA/TEKEL alcoholic beverages section was privatized by a block sale of 100% of shares in 2004. Other notable wineries include "Sarafin" on the Gallipoli peninsula in Thrace, which was Turkey's first privately owned "boutique winery"; "Doluca" of Thrace, and "Kavaklıdere" of Ankara. Sevilen Winery produces ten million bottles of wine per year. They have a full brand new reception (double sorting table), and their pre-fermentation process respects the integrity of the grapes, which are all hand-harvested. Newest in the Aegean area is LA Organik, which makes wine from organic grapes and in their first year they won international acclaim (http://en.wikipedia.org/wiki/Turkish_wine). Today, Turkey is experiencing a wine renaissance with rising quality, production capacity and export capability. As Turkey's wine industry blossoms, winemakers in Turkey continue to discover new indigenous cultivars and are focusing on reviving some that are nearly extinct. They are still exploring the possible contribution of these indigenous grapes (http://vinorai.com).

Table grape production

World fresh consumption of grapes increased from 15.2 million t in 2000 to 22.3 million t in 2011 (BKWine Magazine, 2016). China (6.07 million t), India (2.26 million t), Turkey (1.83 million t), Iran (1.51 million t), and Italy (1.25 million t) are the top producing countries (OIV, 2012).

The global export value of table grapes reached 7.026 million $US in 2013 (Faostat, 2013). Table grapes are consumed mainly in producer countries. In addition, the export market is expanding. The top exporters are Chile, Italy, USA, The Netherlands, Turkey and South Africa, supplying 22, 13, 10, 7, 6 and 6% of the total export volumes, respectively, together representing 64% of total exports (Faostat, 2013). In Turkey, vineyards are being modernised, including adoption of new trellis systems and netting (Figure 5).

Different table grape cultivars are grown in each region, many of which have been developed in Turkish breeding programs (Figures 6 and 7). Mid- and late-season cultivars ('Alfons', 'Red Globe', 'Razaki' and others) are widely grown in the Marmara region (Region 1). Mainly seedless cultivars ('Sultanina', 'Crimson', 'Superior' and others) are grown in the Aegean region (Region 2). Early cultivars ('Yalova İncisi', 'Trakya İlkeren', 'Victoria' and others) are grown in South Anatolia (Region 5). Also, some early cultivars are grown in greenhouses, but currently in limited quantities.

Cultivar germplasm collections

The Vitis International Variety Catalogue, developed at the Julius Kuhn-Institut-Federal Research Centre for Cultivated Plants in Geilweilerhof, Germany, contains 19,539 registered cultivars from all around the world (http://www.vivc.de). Turkey has contributed to this catalogue with 808 cultivars, which comprise 4.14% of the total listed cultivars. Turkey is preceded by France, Italy, USA and

Figure 6. 'Yalova İncisi', a table grape cultivar released through a breeding program implemented by Yalova Atatürk Central Horticultural Research Institute.

Germany in terms of the number of cultivars contributed to the catalogue. Efforts to establish a cultivar germplasm collection in Turkey started in 1965 at the Viticulture Research Institute in Tekirdağ, with approximately 1200 cultivars collected from all regions of Turkey. Over time, there have been some genotypes added to or, regrettably, lost from the collection. In 2006, a comprehensive research project was launched, with the financial support of TUBITAK. This project was undertaken by the Biotechnology Institute of Ankara University, in cooperation with the Ministry of Agriculture and Rural Affairs (currently, the Ministry of Food, Agriculture and Livestock), in order to genetically identify all grapevine accessions in the National Grapevine Germplasm Collection at the Viticulture Research Institute, Tekirdağ, Turkey. The project has now been completed. A total of 1150 cultivars were screened with 21 microsatellites and 850 cultivars identified as unique genotypes (Gökbayrak and Söylemezoğlu, 2010). An additional germplasm collection was started in the grounds of the Viticultural Research Institute of Manisa in 2004 and it has now around 174 local grape cultivars grown mainly in the Aegean region of Turkey (Sağlam et al., 2009).

Organic and sustainable viticulture

Turkey is one of the leading countries with potential for a large organic agricultural sector. Organic agricultural activities were started in 1985 in response to a demand for organic raisins by consumers in many European countries. In 2013, 1.5% of total organic agricultural production in Turkey (24,355 t) was in organic grapes. A significant portion of organic grape production is raisin grape, and the main cultivar is, again, 'Sultanina'. Nearly all organic raisin production takes place in Manisa (16,678 t) and in İzmir (2,877 t).

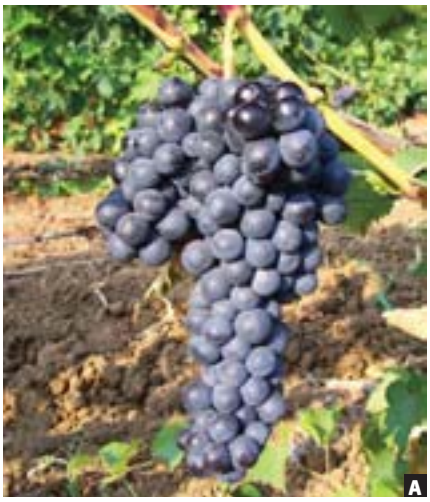


Figure 7. A) 'Trakya İlkeren', a table grape cultivar released through a breeding program implemented by Tekirdağ Viticulture Research Institute, B) 'Atasarısı', C) 'Pembe 77', D) 'Atak 77', table grape cultivars released through a breeding program implemented by Yalova Atatürk Central Horticultural Research Institute.

In 2012, good agricultural practices (GAP) had been adopted in 47 provinces, by 3,676 growers, and applied to 83,717 ha in Turkey. The majority of fresh fruit and vegetable production follows GAP, including fresh grapes. Overall, a total of 44 different agricultural products in Turkey have been documented to have GAP certification and grapes were 9th in terms of production, with the certification of 32,831 t (Söylemezoğlu et al., 2015).

Conclusions

Anatolia has a long history of cultivation of many agriculturally-important crops. One of these is viticulture, which is still very important. Grapes, and especially wine, have played a significant role throughout Turkey's history. Most of the production has been for table and raisin grapes, but in recent years there has been an increasing interest in wine cultivars. Also, the demand for healthy food has been increasing in recent years, and organic and sustainable production have both been increasing. Turkey also has potential to utilise different *Vitis* species, especially *Vitis vinifera*, *Vitis sylvestris*, *Vitis labrusca*, and *Vitis labruscana*. They will be used as genetic material for improving grapevines in breeding studies, mainly to resist biotic and abiotic stress factors. Wild genotypes must be collected in germplasm collection vineyards to ensure the germplasm is not lost, and later they can be used in different research programs. However, resistance breeding studies are still very limited in Turkey. It is hoped that these types of research studies will increase in the near future.

The cost of investment in vineyards is constantly increasing in response to changing climatic conditions and risk factors. If the product price in the market does not increase at the same rate as increasing investment costs, growers will face financial difficulties. Therefore, different support policies to overcome these difficulties are being researched.

References

BKWine Magazine. (2016). http://www.bkwine.com.

Brown, M.V., Moore, J.N., McNew, R.W., and Fenn, P. (1999). Inheritance of downy mildew resistance in table grapes. J. Am. Soc. Hortic. Sci. *124* (*3*), 262–267.

Cadle-Davidson, L. (2008). Variation within and between *Vitis* spp. for foliar resistance to the downy mildew pathogen *Plasmopara viticola*. Plant Disease *92* (*11*), 1577–1584.

Cangi, R., Çelik, H., and Köse, B. (2006). Determination of ampelographic characters of some natural foxy grape (*Vitis labrusca* L.) types grown in Northern Turkey (Ordu and Giresun Province). Int. J. Bot. *2*, 171–176.

Çelik, H., Köse, B., and Cangi, R. (2008). Determination of foxy grape genotypes (*Vitis labrusca* L.) grown in Northeastern Anatolia. Hortic. Sci. *4* (*35*), 162–170.

Ergül, A., and Ağaoğlu, Y.S. (2001). Molecular similarity analysis of some grapevine rootstocks from different nurseries in Turkey. J. Agric. Sci. *7*, 141–143.

Ergül, A., Marasalı, B., and Ağaoğlu, Y.S. (2002). Molecular discrimination and identification of some Turkish grape cultivars (*Vitis vinifera* L.) by RAPD markers. Vitis *41*, 159–160.

Faostat. (2013). http://www.faostat.com.

Faostat. (2014). http://www.faostat.com.

Gökbayrak, Z., and Söylemezoğlu, G. (2010). Grapevine throughout the history of Anatolia. International Journal of Botany *6* (*4*), 465–472.

Kara, Z. (2014). Sustainable development in viticulture industry in Turkey. Australian Journal of Biology and Environmental Research, Dubai International Conference Proceedings *1*, 43–48.

Köse, B. (2014). Phenology and ripening of *Vitis vinifera* L. and *Vitis labrusca* L. varieties in the maritime climate of Samsun in Turkey's Black Sea region. S. Afr. J. Enol. Vitic. *35* (*1*), 91–102.

OIV. (2012). www.oiv.int.

Sağlam, H., Sağlam, Ö.Ç., Yağcı, A., Merken, O., Ünal, A., and Sağlam, M.S. (2009). Grapevine germplasm in the Aegean region. Paper presented at: 7th National Vitic. and Tech. Symposium (Manisa, Turkey).

Söylemezoğlu, G., Kunter, B., Akkurt, M., Sağlam, M., Ünal, A., Buzrul, S., and Tahmaz, H. (2015). Production targets and developing methods of viticulture. Paper presented at: 8th Technical Congress of Turkish Agricultural Engineering (Ankara, Turkey).

TUIK. (2014). www.tuik.gov.tr.

Uzun, I., and Bayır, A. (2008). Viticulture in Turkey. Paper presented at: 7th International Symposium, Prospects for the 3rd Millennium Agriculture Sections Horticulture and Forestry; Economics and Management; Miscellaneous (Cluj-Napoca, Romania).

Uzun, I., and Bayır, A. (2010). Distribution of wild and cultivated grapes in Turkey. Not Sci Biol *2* (*4*), 83–87

Wan, Y., Schwaninger, H., He, P., and Wang, Y. (2007). Comparison of resistance to powdery mildew and downy mildew in Chinese wild grapes. Vitis *46* (*3*), 132–136.

› Gökhan Söylemezoğlu

› Arif Atak

› Yılmaz Boz

› Akay Unal

› Mehmet Sağlam

About the authors

Dr. Gökhan Söylemezoğlu is a full professor at Ankara University, Faculty of Agriculture, Department of Horticulture. Also, he is the Dean of the Ankara University, Faculty of Agriculture. His research interests focus on viticulture and plant biotechnology, especially postharvest, phenolic compounds, clonal selection, molecular characterization and marker assisted selection studies. Dr. Söylemezoğlu has many scientific publications covering different aspects of viticulture. He has been a consultant to nurseries, the wine sector and various companies as they establish new big vineyard plantations. E-mail: soylemez@agri.ankara.edu.tr, gsoylemezoglu@gmail.com

Dr. Arif Atak is the Head of the Viticulture Department in Yalova Atatürk Central Horticultural Research Institute in Turkey. His research interests focus on viticulture, kiwifruit and plant biotechnology, especially marker assisted selection studies. He has also carried out long term breeding studies with table grapes. He has registered six new table grape cultivars as a result of his breeding studies. He has also worked on kiwifruit cultivation and breeding studies for many years. In recent years, he has started to study fungal disease resistance breeding with *Vitis* species and is the leader of an international cooperation project on this topic. E-mail: arif.atak@gthb.gov.tr, atakarif@gmail.com

Dr. Yılmaz Boz is the Director of the Yalova Atatürk Central Horticultural Research Institute. His research interests focus on viticulture and breeding studies. He also has interests in ampelografic studies, phenolic compounds, clonal selection, grape germplasm collection and organic viticulture. Dr. Boz has many publications related to different aspects of viticulture. E-mail: yilmaz.boz@gthb.gov.tr, yilmaz_boz@hotmail.com

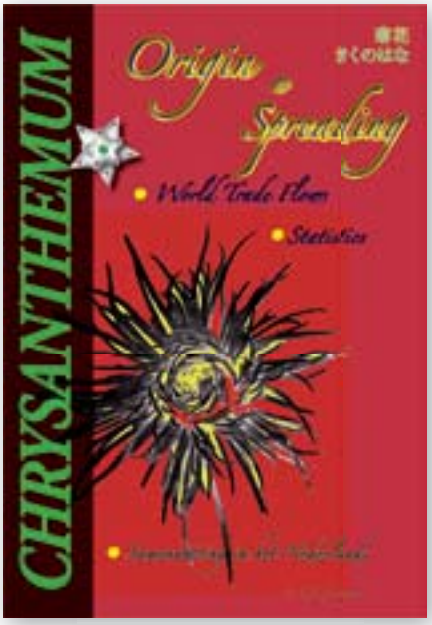
Akay Unal, MSc., is an agricultural engineer, and is the Director of the Manisa Viticultural Research Institute in Turkey. His research interests focus on agricultural structures and irrigation techniques, especially growing techniques in viticulture. He has also carried out many studies related to different viticultural activities. In recent years, he has also taken on an administrative role. E-mail: akay.unal@gthb.gov.tr

Mehmet Sağlam, MSc., is an agricultural engineer, and is the Director of the Tekirdağ Viticultural Research Institute in Turkey. His research interests focus on agricultural structures and irrigation techniques, especially growing techniques in viticulture. He has also carried out many studies related to different viticultural activities. E-mail: saglammehmet@gthb.gov.tr

› 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



Spaargaren, J.J. (2015). Origin and Spreading of the Cultivated Chrysanthemum (The Hague, The Netherlands: Cataloguing In Publication (CIP) Royal Library), pp.204. ISBN 978-90-803929-2-2. € 40. www.irjjspaargaren.nl

Reading this book made me feel very small. It is the definitive reference book on chrysanthemums for the foreseeable future. Even better, it is not particularly long and is organized into helpful sections. It is written with commendable clarity and parsimony. Minor lapses in English are completely unimportant. The first half deals with floriculture and floral commerce in the modern world. The second half covers the long and complex history of this beautiful flower in both Asia and the Western hemisphere.

The only problem is that Mr. Spaargaren is so modest that one needs a microscope to see his name at the bottom of the title page. His website indicates that he has a very strong background in horticulture, history and plant genetics.

The history and background of modern cut flowers and how they appeared in all their dazzling variety has interested me for many years. One can walk into an ordinary American supermarket and find six different cultivars of a flower like the chrysanthemum. This may seem unremarkable, but it is in fact extraordinary. Like the wallpaper, no one even thinks about it.

One of the late Richard Gorer's books first drew my attention to this topic. In "The Development of Garden Flowers" (1970) he paid tribute to Victor Lemoine for his legacy of hundreds of new cultivars which now provide the basis of modern floral commerce. This was a new name. I had never seen it before, but the fact that Lemoine had bred more than 400 cultivars of lilac focused my concentration powerfully.

The next remarkable thing I found was that no one had ever written anything about Lemoine. The sole biography is a doctoral thesis by a pharmaceutical student at the University of Nancy, the town in which Lemoine worked for most of his life. That was it, nothing else. The absence of any interest in such a man was appalling and incomprehensible. Without having to work too hard it became apparent that there were many others in that golden age of heroic horticulture such as Louis Van Houtte.

Just restricting oneself to the chrysanthemum revealed a legion of men who prospered and were internationally famous and are now forgotten. Spaargaren also elucidates in careful detail the enormous contribution of the ancient Chinese and Japanese masters to the development of the fragile and exotic cultivars of the flower which almost overwhelmed Western society when they first appeared.

'Mrs Alpheus Hardy' is a perfect example of that. In this jaded age, it is hard to imagine the level of excitement that the frilly and birdlike flower created, possibly now only rivaled by the appearance of Beyoncé on a concert stage. It bore almost no resemblance to the small unobtrusive plant known as *Matricaria* in the 17th century.

The growth of an international market in horticulture and floriculture also did not happen by itself. Here, too, Mr. Spaargaren traces the movement of floral markets around the world. He uses colored charts and tables to drive home his points. Alas, I was allowed only 500 words so must cease now but I think the reader gets the idea.

Reviewed by Judith M. Taylor, MD, author of four books on horticultural history (see www.horthistoria.com). She published an article on the development of the modern chrysanthemum in Chronica Horticulturae 53 (1), 20–26

› New titles

Harveson, R.M., Markell, S.G., Block, C.C., and Gulya, T.J., eds. 2016. Compendium of Sunflower Diseases and Pests (St. Paul, MN, USA: APS Press), pp.140. ISBN 978-0-89054-507-2 (softcover). $139.00. www.shopapspress.org

Wilcox, W.F., Gubler, W.D. and Uyemoto, J.K., eds. (2015). Compendium of Grape Diseases, Disorders, and Pests, 2nd edn (St. Paul, MN, USA: APS Press), pp.232. ISBN 978-0-89054-479-2 (softcover). $119. www.shopapspress.org

› 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

International Master in Plant Breeding (21st edition), 26 September 2016 – 9 June 2017 and September 2017 – June 2018, Zaragoza, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida Montañana 1005, 50059 Zaragoza, Spain, Phone: +34 976 716000, Fax: +34 976 716001, E-mail: iamz@iamz.ciheam.org, Web: www.iamz.ciheam.org

Postharvest Technology Course, 11-14 October 2016, Wageningen, The Netherlands. Info: Monique Tulp MSc, Programme manager Wageningen Academy, Phone: +31 317 48 22 98, E-mail: monique.tulp@wur.nl, Web: http://bit.ly/21zQXrK

The Food Factor I Barcelona Conference, 2-4 November 2016, Barcelona, Spain. Info: A. Méndez-Vilas, Formatex Research Center, Zurbaran 1, 2nd floor, office 1, Badajoz, Badajoz 06002, Spain, E-mail: conference@foodfactor.org, Web: www.foodfactor.org

Symposia and Workshops

VIII International Symposium on New Ornamental Crops, XII International Protea Research Symposium and XVII International Protea Association Conference

Section Ornamental Plants #ishs_seop
Commission Landscape and Urban Horticulture #ishs_cmuh
Commission Plant Genetic Resources #ishs_cmgr

Held in Perth, Australia, in August 2015, the combined symposia attracted almost 90 participants from 14 countries (Australia, Chile, Colombia, Israel, Japan, Mexico, New Caledonia, New Zealand, Oman, Philippines, Portugal, South Africa, UK, and USA). Conveners were Associate Professor Robyn McConchie, University of Sydney, NSW, Australia, and Bettina Gollnow, Flora Advisory Services Pty Ltd and WildFlowers Australia Ltd, Sydney, NSW, Australia.

Against the backdrop of Western Australia's unique flora, and coinciding with the 50th anniversary of the world-renowned Kings Park and Botanic Garden, speakers from around the globe spoke about new ornamental species, and their breeding, cultivation, postharvest handling, and marketing, and also discussed exciting new developments in the *Proteaceae* and Australian wildflower industries.

Combining symposia of two ISHS Working Groups, namely Protea and New Ornamentals, significantly expanded the diversity of research and opportunities for learning and networking. The program also included the International Protea Association Conference, which highlighted trends in the protea industry around the world. Five keynote presentations allowed highly regarded industry experts to share their in-depth knowledge on new plant innovation – trends, opportunities and consumer expectations for new woody plant introductions (Mr. Pete Kruger, Ball Horticultural Co., USA); origins, development and future prospects of the protea industry (Dr. Gerhard Malan, Fynflor, South Africa); evolution and conservation of biodiversity in the world's oldest landscapes of SW Western Australia (Prof. Stephen D. Hopper, University of Western Australia, WA, Australia); a new 5-season model for southern Australia's seasons (Prof. Timothy J. Entwisle, Royal Botanic Gardens, Melbourne, Vic., Australia); and the development of kangaroo paws as cut flower and ornamental plants (Mr. Angus Stewart, New World Plants, Australia).

› A selection of hybrid *Grevillea* seedlings developed through a breeding program (photo courtesy Digby Growns and Kings Park and Botanic garden).

› Umbrella fern (*Sticherus* spp.) being developed as a commercial cut foliage crop (photo courtesy Premium Greens Australia).

The key symposia themes were:

1. Biodiversity and its potential for the commercial *Proteaceae* and new ornamental plant industries. In addressing the challenges of developing and utilising local species from many different countries, speakers considered their economic potential as cut flower or foliage products, or as pot or landscape plants. A mathematical formula, to estimate 'ornamental potential', was developed by one researcher, to assess whether or not a plant that has been identified in the wild, really has potential as a new floricultural crop. This allows a more considered decision to be made at the start of the domestication process, saving time and money and giving greater assurance of an economic return. Specific plants assessed for development included ornamental species endemic to Macaronesia, several species native to Oman, *Lavandula pinnata* and umbrella fern (*Sticherus* spp.). Results of long-term breeding programs to develop ornamental *Eucalyptus* hybrids were also presented.

2. Development of completely new plants by using novel technologies to produce new hybrids that cannot arise in nature. Reflecting advances in scientific techniques, researchers have used protoplast fusion to develop new *Chamelaucium* hybrids, and interspecific hybridisation to develop novel *Eustoma* and *Cordyline* hybrids and to increase disease tolerance in *Anigozanthos* sp.

3. Propagation and production research. Research determined the photoperiod responses of various specialty cut flowers to allow growers to achieve minimum harvest stem lengths, and tissue culture techniques have been developed to propagate *Persoonia* and *Eustoma* species. Technical and business advantages of implementing a quality assurance program at a commercial propagation nursery were discussed.

4. Postharvest research. Researchers in Israel and Pakistan assessed commercial potential of local ornamental species by first determining

› Delegates visited the world's largest waxflower (*Chamelaucium*) flower farm (photo courtesy Bettina Gollnow).

their postharvest attributes. Research into the highly decorative *Iris oncocyclus* has extended flowering and postharvest life, and developed sea freight protocols to ship cut flowers and potted plants to distant markets. Postharvest treatments developed for new foliage products optimise quality and allow successful sea freight. Research spanning 13 years assessed commercial hydration and holding solutions to optimise vase life of 42 cut flower cultivars.

5. Specific issues affecting *Proteaceae* crops. The latest developments included use of leaf analysis to improve plant nutrition and canopy management to increase yields. Techniques to increase stem length and overcome postharvest disorders like involucral bract browning and leaf blackening were described.

6. Market trends, market demand, and protecting new cultivars. Several speakers considered the challenges of understanding and surviving in the competitive cut flower and ornamental plant market. They presented information about market trends and consumer demands, and discussed strategies for promotion and legal protection of new plant cultivars.

The third and fourth days of the program were devoted to visiting a commercial wildflower farm, an award-winning plant nursery and a leading wildflower exporter. Local flora was enjoyed along the way, as was a guided tour of Kings Park and Botanic Garden to view their nursery and research programs.

Twenty two delegates participated in the optional 4-day pre-conference tour that included technical visits to a nursery (to learn about propagation and growing of Australian species), a commercial seed harvesting company and the world's only complete arboretum of *Banksia* spp. and related plants.

The organisers acknowledge the generosity of the following sponsors: the Rural Industries Research and Development Corporation, the International Society for Horticultural Science, the International Protea Association, Proteaflora, East Coast Wildflowers, Perth Convention Bureau, Tourism Western Australia, Rendezvous Hotel Perth Scarborough, the Flower Association of Queensland, University of Hawai'i Press, Ball Australia and WAFEX.

The proceedings of the VIII International Symposium on New Ornamental Crops and XII International Protea Research Symposium were published in September 2015 as *Acta Horticulturae* 1097.

We hope to see you at the XIII International Protea Research Symposium, which will take place in Stellenbosch, South Africa on 3-6 September 2017, and the IX International Symposium on New Ornamental Crops, scheduled for 2019 in Guadalajara, Jalisco, Mexico.

Bettina Gollnow

› Contact

Bettina Gollnow, Flora Advisory Services Pty Ltd and WildFlowers Australia Ltd, 51 Griffiths Ave, Camden South, NSW 2570, Australia, e-mail: bettinagollnow@iprimus.com.au

› International Symposium on Succulents and Other Ornamentals

Section Ornamental Plants #ishs_seop

A four day International Symposium on Succulents and Other Ornamentals was organized jointly by the International Society for Horticultural Science (ISHS) and Kerala Agricultural University (KAU). In connection with Pooppoli 2016 – Global Flori-Fest at the Regional Agricultural Research Station (RARS), Ambalavayal, Wayanad, Kerala, India, the symposium was held from 24 to 27 January, 2016. The Global Flori-Fest and the symposium were designed to offer a platform for free interaction of various researchers and other stakeholders actively involved in global tourism as well as floriculture research, production and export. The main sponsors of the event were the National Bank for Agriculture and Rural Development (NABARD) and Hill Area Development Agency (HADA), Kerala.

The economic importance of ornamentals has been growing in many countries, and international demand has markedly increased. In world flower trade, cut flowers represent the largest segment of the industry followed by flowering pot plants, tree and nursery crops, and flower bulbs. The most important plants are orchids, succulents (cacti and euphorbias), insectivorous plants, cycads, bulbous species, etc. However, exploitation from natural habitats is still excessive, endangering many species. India is one of the largest producers of horticultural crops worldwide and many of their horticultural scientists are renowned for their research on a range of horticultural crops, including ornamental species. The state of Kerala has extensive resources that could be utilized to accelerate the floriculture and agri-tourism sector in the region. Development of the floricultural sector would not only improve the livelihood of farmers, but also play a great role in sustaining the ecosystem.

Prof. Dr. K.V. Peter, Former Vice Chancellor, KAU, and Director, World Noni Research Foundation, Chennai, inaugurated the symposium. Prof. Dr. Sisir Kumar Mitra, ISHS representative, gave a briefing on ISHS.

› Prof. Dr. Gert Groening (Garden Culture and Open Space Development Institute, Berlin), Dr. Tim Briercliffe (Secretary General, AIPH), Sri. Sreeram Sambasiva Rao IAS (Sub Collector, Wayanad), Dr. P.B. Pushpalatha (Director of Extension, KAU), Dr. P. Rajendran (Associate Director of Research, RARS, Ambalavayal), Sri. Joby Varghese (Staff, RARS, Ambalavayal), Dr. S.K. Mitra (Chair, ISHS Section Tropical and Subtropical Fruits), Dr. N. Anil Kumar (Director, Biodiversity, M.S. Swaminathan Research Foundation, Wayanad), Dr. A.K. Singh (Managing Director, National Horticulture Board, India), Dr. K.V. Peter (Former Vice Chancellor, KAU and Director, World Noni Foundation, Chennai).

› Speech of Dr. Tim Briercliffe, Secretary General, AIPH.

› ISHS representative, Dr. Sisir K. Mitra honouring symposium Convener, Dr. P. Rajendran.

Themes of the symposium were,

- Recent trends and techniques for commercial production and utilization of ornamentals;
- Biodiversity, conservation and utilization of succulents and other ornamentals;
- Bulbous ornamentals: commercial potential, production techniques and crop improvement;
- Molecular approaches for crop improvement in succulents and other ornamentals.

Dr. Tim Briercliffe, Secretary General, International Association of Horticultural Producers (AIPH), pointed out that, “In the past the production and marketing of ornamentals has been focused around servicing demand in developed countries. The associated trading and logistics infrastructure has developed around this model. For many years, the industry has been expanding production in developing countries (with lower production costs) but still with a market focus on the traditional market, particularly Northern Europe and North America. In these cases, the majority of product exported from developing countries has been cut flowers, rather than potted plants, due to transport costs. The dynamic of this market is changing as economic growth takes off in a number of developing countries. Ornamental producers face challenges in relation to environmental sustainability, social welfare and competition. The industry needs to identify new ways to grow this new market into the future and meet the needs of an ever changing consumer. In an increasingly technological world there is a need to promote the real benefits of plants (environmental, social, health and economic), to drive the greening of cities and people’s lives, using ornamentals to address the challenges that cities and individuals face. Ornamentals are not just ‘ornamental’. They both can and must play a key role in the future development of our cities and societies”.

› Participants crowd into the conference hall.

Prof. Dr. Gert D. Groening, Garden Culture and Open Space Development Institute for History and Theory of Design, Berlin University of the Arts, Germany, gave a fascinating lead presentation on “Urban Horticulture”. There were talks on ornamentals for greening, orchid-centric floriculture development

› Field visit.

in Kerala, exploring gladiolus for color evolution in India, quality flower production of goldenrod (*Solidago canadensis* L.) through growth regulation, selection of foliage plants suitable for different indoor light intensities and conditions, strategic planning for orchid farming as a profitable enterprise and possible agri-tourism components, insect pest problems of rose at RARS, Ambalavayal, Wayanad, and the significance of ex situ conservation of *Exacum bicolor* Roxb. in Kerala.

Posters were presented on topics such as the effect of precooling and holding solutions on the keeping quality of cut flower *Anthurium andrianum* 'White King', newer molecules for the management of leaf miner *Liriomyza trifolii* (Burgess) in gerbera, maintenance of compact growth form suitable for pot culture in foliage plants using growth retardants, potential of different species/cultivars of philodendrons as cut foliage, conservation of orchids in the Western Ghats region of Kerala, genetic variability studies in gladiolus (*Gladiolus hybridus* Hort.), effect of plant growth regulators and cow urine on vegetative growth, flowering and corm production in gladiolus, analysis of genetic parameters in commercially important monopodial orchid genotypes, in vitro propagation of *Rosa hybrida* 'Golden Fairy' through nodal explants, a study on in vitro shoot morphogenesis in orchid *Dendrobium* induced by steroid plant growth regulator '28-homobrassinolide', and Mahalanobis D^2 analysis of genetic diversity in anthurium (*Anthurium andreanum* Lind.).

Interaction session

This session focused mainly on the development of the horticultural sector in the Wayanad district. All delegates shared their views and opinions on this topic.

Dr. Gert D. Groening opened the discussion by congratulating the RARS team on the success of the symposium and also stated that Wayanad is full of potential with plenty of scope for continued development. Sri. Kesavendra Kumar, Indian Administrative Service, District Collector, Wayanad, proposed a plan for developing adventure tourism in the Ambalavayal region. Also, he suggested the need to promote floriculture in Wayanad, which would provide livelihoods for the tribal population. The participants proposed establishing in situ conservation of orchids in forests. The gathering also identified the need for assured markets for ornamental plants and it was considered that floriculture could be made successful in Wayanad through a cluster approach of cultivation.

The International Symposium on Succulents and Other Ornamentals, held under the auspices of ISHS, was well-timed and served as a perfect platform to bring together scientists, students and stakeholders associated with this industry to facilitate sharing and exchange of knowledge and experience, while also enhancing the likelihood of collaborative endeavors. The discussions and presentations offered at the symposium will contribute markedly to the progress in developing new generic solutions to surmount the hurdles that threaten this sector.

Wayanad tour

On the fourth day of the symposium, the delegates were taken for a tour to various mesmerizing locations around Wayanad. The trip gave the delegates the opportunity to see and feel what Wayanad is famed for – nature. Jungles, wildlife, hills, lakes, dams and historical sites were all part of the tour thoroughly enjoyed by the participants.

Pangath Rajendran, Smitha Revi, Vishnu Savanth and Rajees Potta Chola

› Contact

Dr. P. Rajendran, Associate Director of Research, Regional Agricultural Research Station, Kerala Agricultural University, Ambalavayal, Wayanad, Kerala, 673 593, India, e-mail: adramb@kau.in

› First International Symposium on Tropical and Subtropical Ornamentals

Section Ornamental Plants **#ishs_seop**
Commission Quality and Postharvest Horticulture **#ishs_cmph**

The First International Symposium on Tropical and Subtropical Ornamentals (TSO 2016) was successfully held on 7-9 March, 2016 in Krabi Province, Thailand. The symposium was organized by the Department of Plant Science, Faculty of Science, Mahidol University, under the auspices of the International Society for Horticultural Science (ISHS) and with the support of the Department of Agricultural Extension and the Department of Agriculture, Ministry of Agriculture and Cooperatives, Kasetsart University, Suratthani Rajabhat University, Agricultural Research Development Agency (Public Organization), Queen Sirikit Botanical Garden and Thailand Convention & Exhibition Bureau.

The symposium attracted 132 participants, which included presenters, accompany-

› Participants of the symposium.

› Participants visiting the 'Mard-Daeng' *Paphiopedilum* Orchid Nursery, Krabi Province.

ing people, staff, sponsors, local growers and government agents from 15 countries around the world (China, Denmark, Germany, Hong Kong, India, Indonesia, Japan, Mauritius, Mexico, Pakistan, Russia, Taiwan, Thailand, USA and United Kingdom), who shared their knowledge and experience on a wide range of topics on tropical and subtropical ornamental plants.

The symposium was opened by Assoc. Prof. Dr. Kanchit Thammasiri, Symposium Convener, Assist. Prof. Dr. Ngarmnij Chuenboonngarm, the Deputy Head of Department of Plant Science, and Mr. Somkhuan Khanngern, the Deputy Governor of Krabi, and was followed by a welcome address and ISHS presentation by Prof. Dr. Margrethe Serek, ISHS representative and Chair of Section Ornamental Plants, the presentation of an ISHS

› Participants at the 'Mak Noi' island, the Andaman Sea, Krabi Province.

› Prof. Dr. Margrethe Serek, ISHS representative and Chair of Section Ornamental Plants, presenting the ISHS certificate and medal to Symposium Convener Assoc. Prof. Dr. Kanchit Thammasiri.

certificate and medal to the Symposium Convener by Prof. Dr. Margrethe Serek, the presentation of souvenirs to the symposium sponsors by Mr. Somkhuan Khanngern and group photographs.

There were two days (March 7 and 8) of scientific program, which was divided into four sessions: Cryopreservation and Micropropagation; Breeding and Selection Tools; Ornamentals for Landscape; and Ornamentals in Business. There were six keynote and invited presentations, 22 oral presentations and 51 posters. The keynote and invited speakers were: Prof. Dr. Hugh W. Pritchard, Royal Botanic Gardens, Kew, United Kingdom; Prof. Dr. Richard A. Criley, University of Hawaii, USA; Dr. Setapong Lekawatana, Department of Agricultural Extension, Thailand; Prof. Dr. Seiichi Fukai, Kagawa University, Japan; Prof. Dr. Fure-Chyi Chen, National Pingtung University of Science and Technology, Taiwan; and Prof. Dr. Chunlin Long, Minzu University and Kunming Institute of Botany, China. All sessions were of interest to the participants, who responded with questions, suggestions and discussion. Further discussions occurred during the breaks, lunches, welcome dinner and excursion, which encouraged the participants to exchange research ideas, projects and common interests, as they renewed friendships and established new ones.

The social program of the symposium included a welcome dinner and cultural show in the venue hotel and an excursion tour. The participants enjoyed Thai food and were entertained by a cultural show related to a Southern novel. Many photos were taken and participants also enjoyed talking to one another.

At the end of the second day, a business meeting was arranged by Prof. Dr. Mar-

grethe Serek. Prof. Serek presented an ISHS Student Award certificate to Mr. Sutthinut Soonthornkalump, Ph.D. candidate from the Department of Biology, Faculty of Science, Prince Songkla University, Thailand, for the best student poster presentation. Subsequently, it was decided to hold the Second International Symposium on Tropical and Subtropical Ornamentals in Indonesia in 2020. The convener of the next symposium will be Dr. Syarifah Lis Aisyah, Director of the Institute Peranian Bogor in Java. At the end of the symposium, Assoc. Prof. Dr. Kanchit Thammasiri expressed his appreciation to all participants, to sponsors of the symposium and to all members of the Organizing Committee for their efforts and contributions.

The last day (March 9) was entirely dedicated to an excursion. The symposium participants visited the 'Mard-Daeng' *Paphiopedilum* Orchid Nursery, where they learnt how to grow paphiopedilums as well as how to do propagation, conservation, hybridization and selection. This was followed by sight-seeing along the Andaman Sea to observe mangrove forests and the local vegetation, especially *Paphiopedilum* species growing in their natural habitats. Lunch was served amidst the vegetation on the beautiful 'Mak Noi' island. The participants relaxed and enjoyed themselves, took lots of pictures, and stood outside the shade of the boats to have a closer look at the beautiful tropical atmosphere along the Andaman Sea. The last stop was the Krabi Andaman Flora Festival 2016 organized by the Department of Agricultural Extension. Highlights included viewing anthurium growing in the greenhouse, a lotus collection, ornamental plant show and contests, plant sales, local product sales, etc. The book of abstracts is available at the symposium website: www.sc.mahidol.ac.th/scpl/tso2016. The proceedings of the symposium will be published as a volume of *Acta Horticulturae* after editorial review.

Kanchit Thammasiri

› Contact

Assoc. Prof. Dr. Kanchit Thammasiri, Symposium Convener, Department of Plant Science, Faculty of Science, Mahidol University, Rama VI Road, Phayathai, Bangkok 10400, Thailand, e-mail: kanchitthammasiri@gmail.com

› XVI International Symposium on Apricot Breeding and Culture

Section Pome and Stone Fruits #ishs_sefr

› Participants of the symposium.

The XVI International Symposium on Apricot Breeding and Culture, organized by the Chinese Society for Horticultural Science (CSHS), the Liaoning Society for Horticultural Science (LSHS), the Liaoning Academy of Agricultural Sciences (LAAS) and the Shenyang City Forestry Bureau and under the auspices of the International Society for Horticultural Science (ISHS), was held from the 29th June to the 3rd July, 2015, in Shenyang City, Liaoning Province, China. A total of 37 international delegates from 13 countries (Armenia, Czech Republic, Finland, France, Italy, New Zealand, Russia, Serbia, Slovak Republic, Spain, Sweden, Switzerland and Turkey) and 88 Chinese delegates attended the symposium. The XV National Symposium on Plum and Apricot was held concurrently.

The International Symposium on Apricot Breeding and Culture is held every four years, and this was the first time that it had been held in Asia. China has a long apricot cultivation history, a wide cultivation area, rich germplasm resources, profound cultural deposits, an active communication platform, remarkable research achievements and great development potential, all of which deeply impressed the foreign delegates. This symposium achieved the goals of connecting apricot research, teaching and production, enhancing understanding and friendship and promoting cooperation internationally. Chinese apricot researchers were able to learn of advanced ideas, technologies and experiences from other countries that will further improve their capacity to innovate and support the industry. The symposium was an opportunity to extend international academic influence and to promote sustainable development of apricot and other special forest fruit industries in China and the world.

In China, fresh apricots are produced on about 269,000 ha, apricots for kernel production are grown on 255,000 ha and *P. sibirica* is produced on 1.55 million ha. The cultivation area of *P. sibirica* has increased year by year and it has been the largest and fastest growing ecological economic forest tree in some areas, with an increase of about 160,000 ha per year. Apricot fruit is juicy and

› Opening ceremony.

› Keynote presentation by Dr. Jill Stanley.

› Mid symposium tour to the Shadigou apricot orchard.

› Post symposium tour to the Chinese National Germplasm Repository for Plums and Apricots.

of high nutritional value, and apricot trees are cold resistant, drought tolerant and barren resistant. Apricot production has played an important role in increasing the income of farmers, improving national nutrition and health levels and improving and rebuilding the environment.

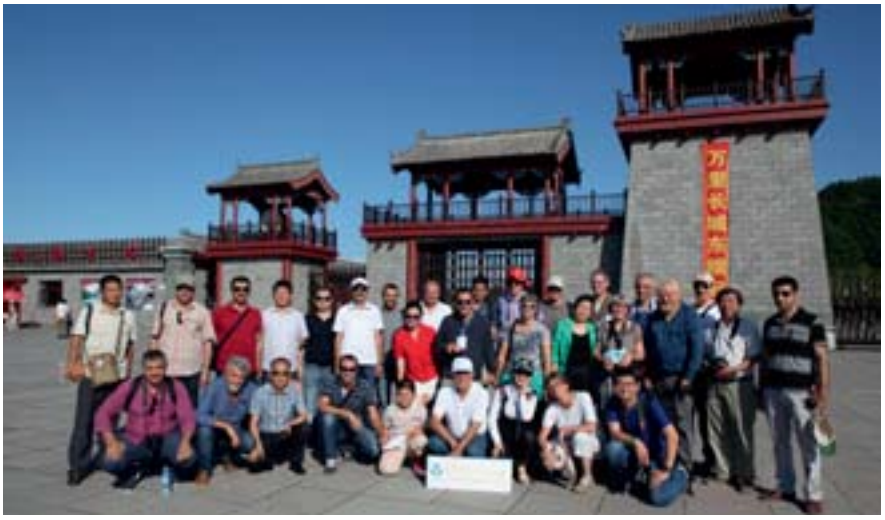
The opening ceremony of the symposium was chaired by Mr. Zhanxiang Sun (vice president of LAAS), who was accompanied by Mr. Zhigang Bing (vice governor of Liaoning Province), Mr. Tianyu Liu (vice director of Foreign Affairs Office of Liaoning Provincial People's Goverment), Mr. Botao Sha (vice mayor of Shenyang City), Prof. Dr. Daniele Bassi (former Chair of ISHS Working Group Apricot Breeding and Culture and professor at the University of Milan), Prof. Zhenhai Han (vice president of CSHS and professor at China Agricultural University), Prof. Tianlai Li (executive director of CSHS and vice president of Shenyang Agricultural University), Dr. Chengguang Tao (president of Plum & Apricot section, CSHS and president of LAAS), Mr. Guomin Sui (vice president of LAAS), Mrs. Xin Wang (director of General Office of LAAS), Mr. Jingwen An (director of Scientific Research Management Division of LAAS), Mr. Nianli Zhao (director of International Center of LAAS) and Mr. Bingyu Zhang (director of Liaoning Institute of Pomology). Dr. Chengguang Tao delivered a welcoming address, which was followed by opening speeches given by Prof. Dr. Daniele Bassi, Prof. Zhenhai Han and Mr. Zhigang Bing.

The symposium included oral presentations and poster displays on apricot and plum, an evaluation of processed apricot products, and visits to large-scale local apricot orchards. The oral presentation sessions were chaired by Prof. Weisheng Liu from the Liaoning Institute of Pomoloy, China, Prof. Guglielmo Costa from the University of Bologna, Italy, Dr. Jill Stanley from the New Zealand Institute for Plant & Food Research, Dr. Jean-Marc Audergon from the Unité Génétique et Amélioration des Fruits et Légumes, INRA, France, Dr. Federico Dicenta from the Spanish National Research Council (CSIC), Dr. Boris Krška from Mendel University in Brno, Czech Republic, Prof. Daniela Benedikova from the Slovak Nation Food and Agriculture Center and Prof. Sezai Ercisli from Ataturk University, Turkey. During the oral presentations, Dr. Jill Stanley from Plant & Food Research, New Zealand, Prof. Zhongshan Gao from Zhejiang University, China, and Prof. Yuzhu Wang, director of the Beijing Academy of Agriculture and Forestry Sciences, China, gave keynote presentations. Twenty-two delegates gave oral presentations on germplasm resources, botany, physiology, ecology, molecular biology, genetics, breeding, pest/disease control, tree training/pruning, fertilization/irrigation, soil management, postharvest handling, processing, and nutritional/health qualities of apricot and mume (Japanese apricot).

In addition, 60 posters were displayed during the symposium. Posters from Mr. Shuo Liu (Liaoning Institute of Pomology, China), Mr. Hailong Sun (Nanjing Agricultural University, China), Mr. Cristos Xiloyannis (Università degli Studi della Basilicata, Italy), Mr. Cemil Ernim (Apricot Research Institute, Malatya, Turkey) and Ms. Xiaomin Xue (Shandong Institute of Pomology, China) were selected as the best posters by experts from the ISHS Working Group Apricot Breeding and Culture.

Twenty-two processed apricot products produced by six Chinese companies (Shanxi Bailaoda Food Co., Ltd., Henan Xingfuyuan Biological Sci & Tech Co., Ltd., Xinjiang Deyuan Agriculture and Forest Sci & Tech Co., Ltd., Dalian Xinghuashanzhuang Agricultural Development Co., Ltd., Gushan Orchard Management Committee, and Sanmenxia Tianrui Sci & Tech Co., Ltd.) were evaluated during the symposium. Five processed apricot products including 'Xingfuyuan' apricot juice,

'Dagushanxingmei' apricot wine, 'Yamanzi' sweet apricot oil, 'Bailaoda' spiced apricot kernels and 'Xinghua shanzhuang' canned apricots were presented with gold awards by experts from the ISHS Working Group Apricot Breeding and Culture according to specified selection criteria.
All delegates visited the Shadigou apricot orchard in Shenyang City and LAAS during the symposium, and after the symposium 22 foreign delegates visited the eastern starting point of the Chinese Great Wall on Tiger Mountain of Dandong City, Dalian Xinghuashanzhuang Agricultural Development Co., Ltd., Gushandaxingmei Production Base, and the Chinese National Germplasm Repository for Plums and Apricots.



› Post symposium tour to the eastern starting point of the Chinese Great Wall on Tiger Mountain of Dandong City, Liaoning.

During the ISHS business meeting, Turkey was elected to host the next International Symposium on Apricot Breeding and Culture in July 2019, with Dr. Sezai Ercisli as symposium convener. Prof. Dr. Weisheng Liu, vice director of Liaoning Institute of Pomology, was elected as the new Chair of the ISHS Working Group Apricot Breeding and Culture. A memorandum of understanding was signed to work towards the establishment of the International Joint Laboratory for Research on Apricot (IJLRA) by the New Zealand Institute for Plant & Food Research, the French National Institute for Agricultural Research (INRA) and LAAS.
The attendees agreed that the symposium was a great success.

Weisheng Liu

› Contact

Prof. Dr. Weisheng Liu, Liaoning Institute of Pomology, Xiongyue Town, Yingkou City, Liaoning 115009, China, e-mail: weishengliu@aliyun.com

› XIV International Symposium on Processing Tomato

Section Vegetables, Quality Production Systems, Leafy Green and Non-Root Vegetables #ishs_sevq

The XIV International Symposium on Processing Tomato: "Innovation for next challenges" was held alongside the XII World Processing Tomato Congress on 6-9 March, 2016 in Santiago de Chile, Chile. The symposium was jointly organized by ISHS in collaboration with the World Processing Tomato Council (WPTC) and ChileAlimentos as the local organizer. This was a unique situation in that the ISHS scientific symposium has been held simultaneously with the industry sector congress on ten occasions. Since the creation of WPTC in 1998 at Pamplona (Spain), congresses have taken place regularly every two years in a different WPTC member country. In this edition, three scientists worked together as Co-conveners, Mª Teresa Pino (INIA, Chile), Cosme Argerich (INTA, Argentina) and Montaña Cámara (University Complutense of Madrid, Spain).
The "multi-disciplinary and participative" spirit of the previous meetings is still alive.

› Mª Teresa Pino, Chile (right), Cosme Argerich, Argentina (center), and Montaña Cámara, Spain (left), Co-conveners of the symposium.

On this occasion, the goal was to bring together science and industry, to share cur-

› Jacques Miklichansky, founder of WPTC and organizer of the first tomato congress in Avignon in 1989, presenting the "Bernard Bièche Memorial Award" to Dr. José Ignacio Macua (Spain) in the presence of Co-conveners Dr. Cosme Argerich and Dra. Montaña Cámara.

rent state-of-the-art knowledge about tomato processing, focused on three main topics:
1. Crop production: "Increasing productivity with sustainability"
2. Processing: "Efficiency: coping with cost increments"
3. Products: "Satisfying more and more consumer demands"
Forty-nine abstracts from 18 different countries were submitted to the symposium, indicating the widespread involvement of the international scientific community in tomato research. During the symposium, there were four scientific sessions, with 26 oral presentations and 23 posters.
The symposium started with Session 1: Processing efficiency coping with cost increments, where invited speaker Dr. Ricardo Amon (University of California, Davis, USA) talked about "Improving resource efficiency in tomato processing". Session 2 focused on "Breeding as a tool for optimizing productivity and fruit quality", where invited speaker Dr. David Francis (Ohio State University, USA) evaluated whether the challenges of climate-induced yield reduction can be met with new breeding technology. The main topic of Session 3 was related to the optimization of plant nutrition and water management. In this session, invited speaker Dr. Tim Hartz (University of California, Davis, USA) addressed the challenge of nutrition management of processing tomatoes in an era of rising yield expectations. Session 4 was devoted to planning and IPM management in which four oral presentations were discussed.
In addition to the topics mentioned above, other important issues, such as tomato crop pest management, technological process optimization, new analytical techniques to be used in tomato product quality control, tomato and health, and consumer science and tomato product acceptance were addressed.
The third "Bernard Bièche Memorial Award" was given to José Ignacio Macua (Spain) for his involvement in tomato research and the excellence of his contributions during previous ISHS tomato symposia.
To encourage the participation of promising young scientists working on tomato research, the Kagome Japanese Company offered two grants to Dr. Cleber Rocco from Unicamp, Brazil and Dr. Patricia Silva from Embrapa, Brazil, and Bayer CropScience offered a grant to Dr. Pablo Asprelli from INTA La Consulta, Argentina.
Our goal was to bring together the world's academics, researchers, students, growers and businessmen involved in processing tomato, to share the current state-of-the-art knowledge about this important industry. For all of us, the symposium was an excellent opportunity to network with leading scientists as well as tomato industry representatives from around the world, and we are sure that the scientific papers to be published in *Acta Horticulturae* will be of great value to everybody involved in tomato research.
With this edition we celebrated 27 years of fruitful collaboration (1982-2016) between science and industry. Looking to the future, we are already working on the next symposium, which will take place in Greece in June 2018.

Cosme A. Argerich, Montaña Cámara Hurtado and María-Teresa Pino

› Contact

Agr. Eng. M.Sc. Cosme A. Argerich, EEA INTA La Consulta, Mendoza, Argentina, e-mail: argerich.cosme@inta.gob.ar
Dra. Montaña Cámara Hurtado, Universidad Complutense de Madrid, Spain, e-mail: mcamara@ucm.es
In. Agr. PhD María-Teresa Pino, Instituto de Investigaciones Agropecuarias (INIA), Santiago, Chile, e-mail: mtpino@inia.cl

› IX International Symposium on In Vitro Culture and Horticultural Breeding

Commission Molecular Biology and In Vitro Culture #ishs_cmmv

The Convener, Prof. Dr. Adel A. Abul-Soad from the Horticulture Research Institute (HRI), Agricultural Research Center (ARC), Egypt, greeted over 140 people at the Opening Session, including the 65 registered participants from 30 different countries, who were attending the IX International Symposium on In Vitro Culture and Horticultural Breeding. This symposium was held from 13 to 17 March, 2016, in the Auditorium Hall of HRI in Giza city, just a few kilometers from the ancient Egyptian pyramids.
The symposium program covered numerous topics of in vitro culture, with special attention on the development of effective protocols for micropropagation of different plant species through the optimization of media components (e.g. mineral formulation,

› A partial view of the opening session of the IX International Symposium on In Vitro Culture and Horticultural Breeding at the Auditorium Hall of the Regional Center for Food and Feed, Agricultural Research Center, Giza, Egypt. In the front row are from left to right: Prof. S. Shalaby, Prof. M.A. Germanà, and Prof. T. Winkelmann.

plant growth regulators, gelling agents) and culture conditions. Other pivotal topics in the program included innovative approaches using liquid culture, in vitro techniques for the long-term conservation of rare and endangered genetic resources, induction of salt tolerant strains, production of transgenic plants, and in vitro culture strategies for horticultural breeding.

Throughout four intensive days, eight excellent keynote lectures, 33 oral presentations, and 18 posters were presented during the seven scientific sessions composing the symposium program. Attending delegates from private companies and nurseries enriched the general discussion, underlining the importance of pursuing the practical application of in vitro techniques to plant propagation and breeding.

The symposium was opened by Prof. Dr. Kameel Mitias, Vice-President of the Agricultural Research Center (host institution) for Research, and Prof. Dr. Saeed Shalaby, Vice-President of the Academy of Science and Research Technology of Egypt.

The opening session started with the keynote lecture "What can we learn from seeds? Somatic versus zygotic embryogenesis" delivered by Traud Winkelmann, prominent scientist of the Leibniz Universität Hannover, Germany. The lecture, greatly appreciated by the participants, highlighted some crucial points of the somatic embryogenesis process that could lead to reproduction of recalcitrant plant species. The other keynote lectures were: (i) "Innovation in tissue culture by means of novel plant growth regulators", given by Danny Geelen of Ghent University, Belgium, and Chair of the ISHS Working Group on In Vitro Culture. In his speech, he highlighted some alternative chemicals that have recently been identified to enhance plant organogenesis, such as phenylalanine, a compound that can be used as an alternative to cytokinins. (ii) "Importance of in vitro culture for developing cryopreservation strategies of woody plants" by Maurizio Lambardi of the National Research Council of Italy, and Chair of the ISHS Commission Molecular Biology and In Vitro Culture. He showed that recent advances in tissue culture-based cryopreservation technology have paved the way to an innovative approach to the long-term preservation of woody plant genetic resources, complementary to the traditional ex situ conservation of trees in clonal orchards. (iii) "An overview on in vitro culture industry in Egypt" by Adel Abul-Soad from the Horticulture Research Institute of Cairo. The lecture focused on the micropropagation of economically-important species in Egypt, such as banana, strawberry, potatoes, and date palm, and described how to use floral buds to reproduce superior genotypes of date palm within a short period of time. (iv) "Microspore embryogenesis in *Citrus* and in other fruit crops" delivered by Maria Antonietta Germanà of the University of Palermo, Italy. This extremely interesting lecture provided some background, recent advances and a future prospective on the employment of microspore embryogenesis as a powerful tool to support plant breeding in fruit crops, particularly in *Citrus*. (v) "Induced mutations and transgenic approach for horticultural crop improvement" by Mohan Jain of the University of Helsinki, Finland. He discussed how mutations are induced in vitro and provided several examples of important crop improvements that have resulted from tissue culture-based genetic transformation. (vi) "Bioreactors and smart vessels for large scale propagation" by Jeffrey Adelberg of Clemson University, USA. He presented an overview of the past and present of liquid culture technology, and the future expectations from innovative bioreactors. (vii) "Genetic transformation: Egyptian experience" by Taymour Nasr El Din of the Agricultural Genetic Engineering Research Institute, Egypt. In his lecture, El Din highlighted the efforts of the institute to develop new potential plant cultivars, genetically modified to resist different biological stress factors.

As a result of a new initiative by ISHS to encourage the involvement of students in symposia, Zienab Ahmed from Egypt was awarded the best oral presentation under the title "Hormone-like action of a natural lipid, lysophosphatidylethanolamine: a com-

› Maurizio Lambardi, Chair of ISHS Commission Molecular Biology and In Vitro Culture (on the left) presenting the ISHS certificate and medal to the Convener Adel A. Abul-Soad (on the right) during the closing ceremony.

› Dr. Mohamed M. Abd El-Gilil, Director HRI, presenting the ISHS student awards to A) Zienab Ahmed from Egypt for the best student oral presentation, B) Inês Ferreira from Portugal for the best student poster presentation.

› A group of participants during the technical visit to PICO, a commercial micropropagation company at Cairo-Alexandria desert road, Egypt.

› Some of the participants gathered beneath the pyramids of Giza. Note that many are keeping their arms crossed in the typical position of Egyptian pharaohs.

parison with auxin". The award for the best poster went to Inês Ferreira from Portugal for her innovative piece of research, "Greenhouse gas emissions life cycle assessment of an in vitro plant production system in *Lavandula multifida*".

The symposium program combined scientific sessions with spectacular evening sightseeing, during which the participants experienced the warm hospitality of Egyptians. Post-session tours were organized to the Egyptian Museum, the repository of the old civilization of Egypt, in downtown Cairo, with a walk in Tahrir Square, and a wonderful night cruise, during which the participants experienced the fascinating atmosphere of a dinner with dances along the Nile River.

A technical tour to PICO, a commercial tissue culture company on the Cairo-Alexandria desert road, was arranged immediately after the closing ceremony and certificate presentations. The different stages of work within the laboratory to produce 3-5 million high-quality micropropagated plants (mainly banana, deciduous fruit rootstocks and date palm) were displayed. The technical advisor of the company, Mr. Mahmoud Refaat, explained the system for providing nutrients to the growing plants in the greenhouse, as well as the technology to produce cut flowers and indoor plants.

Finally, it was impossible for the participants to leave Egypt without saying "hi" to the Giza pyramids, one of the seven wonders of the ancient world.

The Convener wishes to express his deep gratitude to all who contributed to the symposium, including the host institute, who looked after the logistics of the symposium, the Scientific Committee for assisting with the final symposium program, and all the excellent keynote speakers. Special thanks goes to Dr. Maurizio Lambardi, Chair of ISHS Commission Molecular Biology and In Vitro Culture, for his kind help in selecting invited speakers and encouraging abstract submission, the International Society for Horticultural Science, the sponsors for their financial support and, especially, all the participants who contributed to making this a memorable symposium in the series of In Vitro Culture and Horticultural Breeding. Finally, I would like to thank Dr. Abd El-Moneum El-Banna, the President of the Agriculture Research Center, and Dr. Mohamed M. Abd El-Gilil, the current Director of the Horticulture Research Institute.

Adel A. Abul-Soad

› Contact

Prof. Dr. Adel A. Abul-Soad, Agricultural Research Center, Horticultural Research Institute (HRI), 9 Cairo University Street, Orman, 12619, Giza, Egypt, e-mail: adelaboelsoaud@gmail.com

› III International Conference on Fresh-Cut Produce: Maintaining Quality and Safety

Commission Quality and Postharvest Horticulture #ishs_cmph

This international conference, called 'Fresh-cut2015' for short (http://www.ishs.org/symposium/392), was held at the UC Davis Conference Center from 13-16 September, 2015, with an optional technical tour from 17-18 September. The conference was organized around the same topics presented in the annual fresh-cut workshop held at UC Davis (http://postharvest.ucdavis.edu/Education/), and with the same over-arching theme, 'maintaining the quality and safety'. The III International Conference on Fresh-Cut

Produce was organized under the banner of ISHS and the Fresh Cut Produce Working Group under the Commission Quality and Postharvest Horticulture. Conference organization was done by the staff of the Postharvest Technology Center at UC Davis, and abstract and manuscript reviews were conducted by a 20-member international scientific and editorial committee. There were 150 attendees from 27 countries, and about one-third of the attendees were from the private sector. Nine attendees were graduate students.

The conference was inaugurated by Helene Dillard, Dean of the College of Agricultural and Environmental Sciences at UC Davis, and Elizabeth Mitcham, Director of the Postharvest Technology Center at UC Davis. The conference was comprised of keynotes, 'cutting edge' presentations, short orals, e-posters, and an industry-academia panel. Keynote presentations covered the recently completed European Quafety project (Giancarlo Colelli, University of Foggia, Italy), fresh-cut processing lines and equipment (Rudi Groppe, Heinzen Manufacturing International, USA, and Alexandro Turatti, Turatti, North America/Italy), preharvest factors and quality of leafy greens (Maria Isabel Gil, CEBAS-CSIC, Spain), tropical fruit fresh-cut processing challenges (Latifah Mohd Nor, MARDI, Malaysia), preparation and handling of fresh-cut root vegetables (Merete Edelenbos, Aarhus University, Denmark), packaging of fresh-cut products (Jeff Brandenburg, JSB Group, USA), preventative controls for food safety (Trevor Suslow, UC Davis, USA), pathogen transfer in fresh-cut operations (Elliot Ryser, Michigan State University, USA), sensory evaluation (Anne Plotto, USDA, USA), aroma and off-odor biology (Charles Forney, Agri-Food Canada, Canada), temperature and fresh-cut product quality (Jeff Brecht, University of Florida, USA), nutritional quality of fresh-cuts (Gustavo González-Aguilar, CIAD, Mexico), and fresh-cut marketing trends (Roberta Cook, UC Davis, USA).

The 'cutting edge' presentations dealt with fresh-cut biology and the wound response (Mikal Saltveit, UC Davis, USA, and Luis Cisneros, Texas A&M, USA), new fresh-cut processing technologies (Deirdre Holcroft, Holcroft Postharvest Consulting, USA, and Steve Lacasse, Fresh Appeal, New Zealand), and breeding lettuces for fresh-cut (Ryan Hayes, USDA, USA), among other topics. There were 20 short oral and 37 e-poster presentations. The e-posters were formally presented on monitors with 5-minute oral summaries. Most poster presenters liked not having to print their posters, and pdf files of many posters were later added to the conference website. The conference also had a small 10-company exhibitor area that was well attended during breaks and lunch periods. A 9-member 'Industry-Academia Panel' was well organized by Susanne Klose of Fresh Express and stimulated good participation from conference attendees. There was considerable discussion on the need for better understanding and appreciation of the different cultures that drive industry and academic work.

At the business meeting there was discussion about whether a Working Group and a conference on this topic are needed, as research on fresh-cut produce is presented at numerous other ISHS postharvest symposia and events. However, it was concluded that the specific research needs of fresh-cut produce continue to expand. In addition, these value-added products are still relatively new in many countries. Previous ISHS-sponsored fresh-cut conferences were held in Thailand (2007) and Italy (2011). The business meeting concluded with a unanimous vote to hold the IV International Conference on Fresh-Cut Produce in 2019 in China, with Dr. Qingguo Wang of Shandong Agricultural University as convener.

A very enjoyable gala dinner was held on the second day at the historic California State Railroad Museum in Old Sacramento. Besides a special tour of the museum, Gold Rush period music was played during the dinner that was served along with California wines of course!

Fifty conference attendees also went on a 2-day technical tour to the Salinas Valley, often referred to as the 'salad bowl' of the U.S. The four visits were to Heinzen Manufacturing International in Gilroy to observe construction, design and innovations in processing plant equipment, Ocean Mist Farms in Castroville to see a medium-scale spinach processing line equipped with wash water sanitation controls by Pulse Instruments, Fresh Express field operations for harvest and preparation of romaine lettuce and fields of small specialty lettuces, and the Dole Fresh Vegetables processing plant in Soledad to view a large-scale fresh-cut lettuce processing line and also discuss raw material quality. In addition to the technical tour stops, participants also visited the historic Mission in San Juan Bautista and stayed overnight in the city of Monterey on the coast of California.

› Group photo at UC Davis Conference Center taken by Christian Koszka.

Marita Cantwell

› Lettuce harvest, Salinas Valley. Photo taken by Lee Dean.

› Contact

Dr. Marita Cantwell, Conference Convener, Former Chair ISHS Working Group on Fresh Cut Produce, Dept. Plant Sciences, UC Davis, USA, e-mail: micantwell@ucdavis.edu

From the Secretariat

› New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Argentina: Carlos Enrique Cardoso Prieto, Dr. Georgina Paula Garcia Inza; **Australia:** Mr. Muhammad Umair Ahsan, Dr. Mobashwer Alam, Dr. Karine Chenu, Ms. Shulang Fei, Veronique Froelich, Mr. Edward Howell, Mr. Michael Hughes, Mr. Julian Lane, Prof. Behdad Moghtaderi, Ms. Khamla Mott, Mr. Satend Nandan, Ms. Katie O'Connor, Dr. Prabhakaran T Sambasivam, Lyndell Taranto, Mr. Simon Watt, Mr. Matthew Weinert, Mr. Shaun Windrim; **Belgium:** Chadi Berhal, Niels Bessemans, Ms. Eline Braet, Mr. Jonas Coussement, Tim De Clercq, Dr. Barbara De Coninck, Assoc. Prof. Sebastien Massart, Ms. Martien Rutten; **Benin:** Dr. Ginette Azandeme Hounmalon, Dr. lies huizink, Mr. Eugène Kassa; **Bosnia and Herzegovina:** Assist. Prof. Mirjana Radovic; **Brazil:** Leticia Baptista, Dr. Florence Castelan, Dr. Otniel Freitas-Silva, Dr. Michele Reis, Prof. Dr. Breno Silva; **Brunei Darussalam:** Mr. Takiyaudin Mohmad; **Bulgaria:** Mr. Krasen Krastev; **Cameroon:** Dr. Jean-claude Bidogeza; **Canada:** Keith Brown, Dr. Claire Depardieu, Mr. Claude Dubois, Mr. Eden Dubuc, Mr. Alex K.S. Fan, Ms. Laurence Gendron, Dr. S. Norman Goodyear, Mr. Louis Gosselin, Dr. Richard Hogue, Ms. Stephanie Patenaude, Mr. Stephane Perreault, Dr. Parminderjit Sandhu, Mr. Guillaume Sauvageau, Marc Schurman, Mr. Robert Spivock, Dr. Jazeem Wahab; **Chile:** Patricio Antoni Fernandez Gutierrez, Prof. Gabino Reginato, Dr. Juan Salazar, Mr. Sebastián Valdés; **China:** Dr. Zhaojun Ban, Prof. Cheng-xin He, Wen-ming Huang, Assoc. Prof. Yinghua Ji, Sheng Jia, Rijian Li, Prof. Dian-peng Li, Ms. Yangziye Lu, Mr. Ting Dong Ma, Prof. Dr. Hongxia QU, Xiu-lan Xie, Assoc. Prof. Lixin Xu, Yin Xu, AiDi Zhang, Sijun Zheng; **Chinese Taipei:** Dr. Rishi Ram Burlakoti, Dr. Denise Yi-Tan Fang, Ms. Jing-Yi Li, Dr. Hsueh-Shih Lin, Dr. Pepijn Schreinemachers, Dr. Marco Wopereis, Ms. Yi-Chin Wu, Mr. Kuang Yeh; **Colombia:** Mr. German Andres Calberto Sanchez, Assist. Prof. Marcela Castro-Benitez; **Congo:** Assoc. Prof. Joseph Adheka Giria, Dr. Dowiya Nzawele; **Costa Rica:** Dr. Ruben Ortiz; **Croatia:** Dr. Karolina Brkic Bubola, Mr. Tvrtko Jelacic, Ime Marcelic, Ms. Barbara Soldo, Dr. Elda Vitanovic; **Czech Republic:** Nambe Jababu; **Dominican Republic:** Domingo Rengifo; **Ecuador:** Myriam Arias, Rosa Corozo; **Egypt:** Dr. Mohamed Abdelwahed, Amal El-Awady, Dr. mohammad El-denary, Ms. Mona Sayed; **Ethiopia:** Awetahegn Nigus Beyene, Dr. Akalu Teshome; **Finland:** Mr. Jorma Järvinen, Ms. Hanna Mononen, Anna Toljamo; **France:** Raphael Achard, Justine Barthod, Dr. Zouhair Bouhsina, Dr. Dominique Carval, Dr. Jean-Marie Codron, Prof. Paul-Henry Cournede, Dr. Sylvain Depigny, Ms. Silvia Di Cesare, Dr. Pauline Feschet, Ms. Claire Guillermet, Dr. Bouchaib Khadari, Mr. Denis Loeillet, Assoc. Prof. Pasquale Lubello, Ms. Aurore Méry, Mr. Urbain Niangoran, Ms. Charlotte Poeydebat, Mr. Francis Renault, Ms. Elisabeth Rosalie, Dr. Philippe Tixier; **Germany:** Dr. Jochen Dürr, Ms. Marie-Therese Hölscher, Dr. Jafargholi Imani, Ms. Jana Käthner, Prof. Dr. Rainer Matyssek, Ms. Inga Matzner, Mr. Marco Meixner, Dr. Sarah Nischalke, Mr. Dieter Oellerich, Ms. Yi-Chen Pao, Dr. Tundra Ramirez, Regina Ronoh, Dr. Christian Scheer, Dr. Thomas Schwend, Ms. Jana Stallmann, Johanna Stammler, Ms. Martina Tomasella, Sofia Vio Michaelis, Dr. Carel W. Windt; **Ghana:** Dr. Abdul-Halim Abubakari, Mr. Richard Agyare, Mr. Yakubu Balma Issaka; **Greece:** Assist. Prof. Katerina Biniari, Dr. Panagiotis Madesis, Dr. Georgia Ntatsi, Assist. Prof. Konstantinos Vlachonasios, Dr. Antonios Zambounis; **Guadeloupe:** Irina Comte, Dr. Gaëlle Damour, Dr. Marc Dorel, Dr. Jean-Claude Govindin, Mr. hoa tran quoc; **India:** Md Shamsher Ahmad, Sanjay Chavaradar, Dr. Bikash Das, Dr. Neelima Garg, Dr. Karan Bir Singh Gill, Dr. Remany Gopalakrishnan, Dr. Kumari Karuna, Dr. Bharati Killadi, Mr. Manoj Kumar, Sameer Muhamed, Dr. Vishal Nath, Dr. Parag Pandit, Dr. Alemwati Pongener, Dr. Muneshwar Prasad, Mr. Abdul Rahim, Mr. Rajeeb Kumar Roy; **Indonesia:** Erliana Ginting, Dr. Rokhani Hasbullah, Mr. Husien Jahja, Indra Wilis; **Iran:** Abdolhossein Aboutalebi, Dr. Zahra Nourmohammadi, Reza Salarkia, Ms. Nehleh Taghvaeefard; **Ireland:** Ms. Regina Cleary, Tara Duggan; **Israel:** Dr. Amnon Bustan, Dr. Shmulik Friedman; **Italy:** Alberto Algarra Alarcón, Dr. Nicola Bernabini, Mr. Marco Rosario Butera, Dr. Ottavio Cacioppo, Dr. Marco Campus, Valentina Gobbi, Dr. Thomas Letschka, Dr. Giorgia Liguori, Dr. Enrico Maria Lodolini, Mr. Pierluigi Lucchi, Dr. Antonio Lupini, Dr. Paolo Martinatti, Dr. Alessandro Matese, Dr. Luca Mazzoni, Dr. Cinzia Montemurro, Prof. Franco Nigro, Mr. andrea pergher, Francesco Pica, Dr. Maria Saponari, Assoc. Prof. Marco Saracchi, Riccardo Scotti, Prof. Maurizio Servili, Dr. Giacomo Squeo; **Japan:** Yoshihiro Ban, Mr. Oscar Witere Mitalo, Yuki Sago, Dr. Kagari Shikata-Yasuoka, Mr. Kornlawat Tantivit; **Jordan:** Dr. Mounir Louhaichi, Dr. Sireen Naoum, Dr. Manar Talhouni; **Kenya:** Temitope Jekayinoluwa, Dr. Stepha McMullin, Dr. Dennis Ochieno, Dr. Subramanian Sevgan; **Korea (Republic of):** Ms. Somin Ahn, Mr. Se Woong An, Prof. Won Kyong Cho, Ms. Ge Guo, Jaewook Kim, Ms. Minji Kwon, Dr. Kyung Hwan Moon, Mr. Fahad Ramzan, Mr. Donghoon Seo, Prof. Dr. Wonmo Yang, Dr. Mohammad Zahirul Islam; **Kuwait:** Mr. Fouzi Sultan; **Latvia:** Dr. Gunta Cekstere; **Lebanon:** Dr. Milad El Riachy; **Liberia:** Ms. Emma Jao; **Malaysia:** Prof. Dr. Siti Nor Abdullah, Prof. Dr. Desa Ahmad, Prof. Dr. Azrina Azlan, Ms. Hafizah Mohd Johar, Dr. Joon Sheong Tan, Dr. Saiful Irwan Zubairi; **Mali:** Dr. Takemore Chagomoka; **Mauritius:** Ms. Yogeeta Devi Luchoomun; **Mexico:** Dr. Jacqueline Capataz-Tafur, Prof. Dr. Abelardo Nuñez-Barrios, Prof. Dr. Guadalupe Olivas; **Montenegro:** Mr. Cazim Alkovic, Dr. Biljana Lazovic, Dr. Tatjana Perovic; **Morocco:** Prof. Saïd Khabba, Mr. Hamid Maloui, Ms. Sara Oulbi; **Netherlands:** Pelin Kocaturk; **New Zealand:** Dr. Jenny Aitken, Dr. Ross Bicknell, Dr. Carol Elliott, Mr. Greg Prendergast, Ms. Harina Warbrick; **Nigeria:** Ms. Eunice Adeyemi, Mr. Orevaoghene Aliku, Prof. Paul Baiyeri, Prof. Isaac Daniel, Omolola Etukudo, Dr. Ayodele Fajinmi, Dr. Rotimi Ipinmoroti, Dr. Olusimbo Kenneth-Obosi, Dr. Olufisayo Kolade, Dr. Lava Kumar, Mr. Kabiru Muhammad Na'Allah, Dr. Adeyela Okunlola, Dr. Abayomi Olaniyan, Dr. Amudalat Olaniyan, Mr. Amos A. Oloyede, Mr. Adelani Olusegun, Uterdzua Orkpeh, Dr. Himanshu Saini, Dr. Ayobola Sakpere, Dr. Vincent Umeh; **Pakistan:** Dr. Babar Bajwa, Mr. Muhammad Sohail Waqas; **Peru:** Mr. Andres Cardenas, Ms. Elizabeth Idrogo Cabezas, Juan Carlos Rojas, Mary Carmen Yamamoto; **Philippines:** Ms. Christy Marie Alsado, Ms. Phoebe Galeon, Dr. Nelda R. Gonzaga, Mathew Tan, Assist. Prof. Vilma Zacal; **Poland:** Dr. Maria Grzegorzewska, Dr. Agnieszka Masny; **Portugal:** Isabel Ferreira, Dr. Rui Oliveira, Prof. Dr. Francisco Santos; **Romania:** Dr. Maria Brinza, Assoc. Prof. Elena Liliana Chelariu, Dr. Mirela Cojocariu, Dr. Daniela Veringa, Dr. Marian Vintila; **Russian Federation:** Prof. Dr. Zinaida Klimenko, Ms. Tatiana Sidorova; **Saudi Arabia:** Mr. Nayef Alshammari; **Serbia:** Dr. Nebojsa Milosevic, Dr. Branko Popovic; **Singapore:** Ms. Qing Sarah Lim, Mr. Pablo Peralta Quesada; **Slovenia:** Maja Podgornik; **South Africa:** Mr. Pierre Du Plooy, Dr. Olaniyi Fawole, Ms. Jenifer Koen; **Spain:** Jose Antonio Alburquerque, Dr. Gabriel Beltran Maza, M. Del Rocio Jimenez, Inés López Cano, Dr. Ascensión Martínez Sánchez, Mr. Antonio Miranda-Fuentes, Ms. Natalia Moratalla, Mr. Jose Navas, Dr. Francisco M. Padilla, Dr. José M Peña, María Isabel Requejo Mariscal, Asunción Roig GarcíaFerrández, Dr. Josep Rufat, Maria Sánchez García, Rafael Ruben Sola-Guirado, Maria Solé Bundó; **Sri Lanka:** Nipuna Perera, Mr. Samudra Rajapakshe; **Sweden:** Emina Mulaosmanovic, Victoria Tönnberg; **Switzerland:** Prof. Dr. Ranka Junge; **Tanzania:** Mr. Maneno Chidege; **Thailand:** Ms. Sylvie Desilles, Assist. Prof. Supat Isarangkool Na Ayutthaya, Mr. Nakarin Jeeatid, Ms. Nantha Pengnet, Dr. Ratchuporn Suksathan, Assist. Prof. Thammasak Thongket; **Turkey:** Assist. Prof. Arda Akçal,

Dr. Nilüfer Aksu Uslu, Mr. Lokman Altinkaya, Ms. Büsra Atamer Balkan, Mr. Recep Balkic, Assist. Prof. Engin Gür, Dr. Melek Gurbuz Veral, Assist. Prof. Özgür Kahraman, Mr. Ibrahim Kahramanoglu, Assoc. Prof. Cevriye Mert, Assoc. Prof. Ayse Tulin OZ, Mr. Murat ozaltas, Gizem Özinanç, Dr. Nilgün Pehlivan Gürkan, Dr. Aysegul Yildirim Kumral; **Uganda:** Ms. susan Ajambo, Dr. Bonaventure Omondi Aman Oduor, Anne Rietveld, Mr. Allan Waniale; **United Arab Emirates:** Dr. Sangeeta Kutty Mullath; **United Kingdom:** Mr. George Anderson, Dr. Minshad Ansari, Mr. Daniel de Vega Perez, Ms. Sarah Donaldson, Ms. Jenny Harding, Ms. Abi Johnson, Dr. Alessandra Lillo, Mr. Robert Lillywhite, Natasha Mortimer, Dr. Daniel Sargent, Chibi Takaya; **United States of America:** Prof. Carlos Aguila, Saul Alarcon, Mr. Stephen Albaugh, Diego Alcazar, Mr. Jaser Aljaser, Ms. Andrea Ayala, Jim Bagdasarian, Mr. Chris Barbey, Assoc. Prof. Pamela Bennett, Mr. Jeremy Blackwell, Mr. Edward Blanchard, Jennifer Boldt, Dr. Bhaskar Bondada, Dr. Kenneth Boote, Kevin Brooks, Tim Bruner, Mario Cabezas, Rafael Cambra, Dr. Colin Campbell, Prof. Dr. Danesha Carley, Ms. Cassandra Chryssakis, Louise Comas, Lauren Crawford, Robert Driver, Ms. Nancy Fowler-Johnson, Mr. Robert Gabriel, Mr. Craig Gaines, Prof. David Handley, Scott C. Hicks, Mr. Harrison Higaki, Mr. David Holden, Mr. Jonathan Horton, Mr. Ed Ishida, Rodrigo Iturrieta, Vicente Ivars, Dr. Raymond Jacobs, Prof. Jerry Kliewer, Prof. Steven Knapp, Mr. Johnny Loff, Janel L. Martin, Dr. Marta Matvienko, Mr. Gitau Mbure, Mr. Douglas McCann, Leonora Meier, Mr. George Melton, Dr. Phuong Nguyen, Nick Pinkerton, Todd Plummer, Jayne Roberts, Ms. Carolina Sarmiento, Scott Scholer, James Scruggs, Dr. Felix Serquen, jaime serrato, Rebecca Sideman, Dr. James Sproul, Mr. Keith Starke, Travis Stegmeir, Jen Stiles, Dr. Alto Straughn, Dr. Mark Walton, Vaughn Walton, John Watson, Dr. Tharindu Weeraratne, Christopher Winterbottom, Dr. William Wintermantel, Cody Wong, Dr. Melanie Yelton, Dr. Huihui Zhang; **Uruguay:** Dr. Marta Chiappe, Paula Conde; **Vanuatu:** Dr. Vincent Lebot; **Vietnam:** Dr. Dinh Thi Tran

› In memoriam

They don't make them like this anymore...

Dr. Norman E. Looney (1938-2016)

It is with great sadness that I learned about Norm Looney's passing away last March. Even though I knew he was ill, his death came as a shock to me and to all ISHS members. Norm Looney, let me call him Norm, was one of a kind. While preparing this tribute and seeking advice and memories from people who knew him, one thing struck me and came back as a leitmotiv: we were fortunate and privileged to have met this exceptional person. "*They don't make them like this anymore*" commented Judith Francis, Senior Programme Coordinator for Science & Technology Policy of the CTA (Technical Center for Agricultural and Rural Cooperation), a statement that expresses how unique he was for many of us.

Norm could have been my father, but he considered me as a friend, and I considered him as my mentor. While I cannot say that I knew him closely, I certainly felt like I was a part of his intimate circle. Norm had this capacity to go towards people and make them feel important. I first got to know him well when he appointed me as the Chair of the Science Program Task Force of IHC2002 in Toronto. While I could dwell for many pages on his scientific accomplishments at Agriculture and Agri-Food Canada and on his impressive service record within ISHS, I would rather give you a personal account of what Norm represented to me and what he stood for. By doing so I hope I will be able to convey his love of horticulture, his love of people and most importantly, his love of life.

Norm was a true humanist. He believed in human freedom and in the capacity of people to progress. Mostly, he believed he could make a difference in the livelihood and well-being of people. He was an altruist and was deeply concerned for the welfare of others. He was convinced that horticulture was a means of reaching out to others and improving their quality of life.

Norm Looney had a sharp intelligence. He was curious and attentive to others, as well as being affable and having a great rapport with everyone. This openness was a key attribute and became an asset in his role as President of the ISHS. He was indeed instrumental in the expansion of ISHS, in inviting many countries to join in the activities of the Society. Under his auspices, ISHS reached out to East-European, African, and Asian countries. He cherished the multicultural diversity of the ISHS and saw it as a strength of the Society.

Norm was eloquent. I always envied his capacity to stand up and improvise a speech which was always pertinent and touching. This apparent fluency was not fortuitous as he was always well prepared. His speeches were articulate mostly because he had something to say. I was always proud of him and how he represented ISHS on all occasions.

Despite the fact that he was easy-going and open-minded, Norm could also be strong-minded and even stubborn if he believed his cause was the right one. He despised careerism and hated those who used their position to advance themselves. Norm was a man of principles and he stood strong for them. For instance, he emigrated to Canada in protest against the Vietnam War. He became a proud Canadian citizen and a passionate advocate of the values of his adopted country.

Norm was a true liberal with great ambitions for the ISHS. He had a well-planned agenda when he became President of the Society; he wanted horticulture to be considered an ines-

The Garden of Life

Official hymn of IHC2002
Written by Patrick Rose

We're here, sowing the seeds
As we fill the needs of each land
We know the garden of life
That we hold in our hand

We have the power to grow
The power to know our worth
We'll find the harvest for all
That lives within the earth

For the dream is there
As we hear each nation call
And we can share
As the seeds we sow, as the waters flow
Let our garden grow for all

Artistry in life
Art and science for life
Light the flame. Let it burn bright and free
Artistry in life
Art and science for life
Let it shine for all to see, all to see

We have the vision, we have the light
And the strength to lead the way
Bring us together give us hope
For a new and brighter day

Artistry in life
Art and science for life
Art and science for life
Hear the call!
Artistry in life
Art and science for life
Let the seeds we sow as the waters flow
Let our garden grow for all
Grow for all.

capable discipline for the well-being of people. He worked hard during his presidency to have horticulture recognized by world international research and development agencies. One of his great ambitions was to see a horticulturist winning the World Food Prize. He thus lobbied intensively for the advancement and recognition of our profession's essential role in the development of humankind.

Norm was a great ambassador of the ISHS and of horticulture worldwide. He was a dreamer but transformed his aspirations into concrete achievements. For instance, he embraced the concept of "Horticulture for Development" during his campaign for ISHS presidency and joined alongside visionary people like Tom Lumpkin from AVRDC and Jacky Ganry from CIRAD, to create the Global Horticulture Initiative, an organization dedicated to promoting horticulture as a tool to advance sustainable development. He was a tactician playing his cards judiciously to yield results. For example, he pushed hard to persuade Dr. Ismaël Serageldin, then Chairman of the Consultative Group on International Agricultural Research (CGIAR) and Vice-president of the World Bank, to deliver the keynote lecture at the IHC2002 Congress in Toronto, knowing that it would open doors for ISHS and place our Society at the forefront of the international development agenda.

Norm had a broad cultural background. He was a true epicurean in many ways. He would have starved for days if he had the promise of a good meal to come. He enjoyed good wine and good company. His home, overlooking Okanagan Lake and his peach orchard, was a welcoming oasis. It was the lifetime project of both Norm and Norah, his loving wife. Many, like John Possingham and myself, considered his place to be "heaven on earth". This was a safe and hospitable retreat for him to think ahead and move forward. Former ISHS Board members were enlightened by the spirit of this place when they outlined their first ISHS strategic plan, paving the way of his 8-year presidency of the ISHS.

Norm had many talents, one of which was music. He was a gifted multi-instrument player, but particularly enjoyed the simplest and purest form of music: singing. It was a ritual for him to sing with the Penticton Choir. He shared in this activity, which he considered a communion of senses and purpose. Norm was faithful to his friends and did not keep his friendships secret. Those who had the chance of meeting him in Summerland know of Theo's restaurant, his second "family" where he would bring his close friends. He had a special relationship with Greece where his daughter lives.

Norm was a refined man and knew that image counts, particularly when you are President of a Society like the ISHS. With the good taste of Norah, he always dressed to make a statement of the importance of his status and the status of the ISHS.

In reflecting on and remembering Norm, the epitome of his life, philosophy, and aspirations were embedded in the lyrics of the song he commissioned for the opening of IHC2002 (www.ishs.org/garden-life). This song is a hymn to all the values he stood and fought for and is a tribute to horticulture as a way of life.

Norm will always remain in our hearts.

Yves Desjardins, ISHS Board Member Responsible for Publications, Québec, Canada

Prof. Dr. Dieter Treutter (1956-2016)

It is with great sadness that we must announce that our friend and colleague, Professor Dieter Treutter, passed away on May 7, 2016. He was Head of the Associate Professorship of Fruit Science at the Technical University of Munich in Freising-Weihenstephan. The department has lost its long-standing head, his colleagues their caring superior, many doctoral students their judicious advisor, and countless students their dedicated lecturer. The wider science community has lost a profiled mastermind, one who never followed the mainstream but was instead tenaciously committed to the issues which, through his scientific expertise, he recognised as pertinent.

Dieter Treutter studied Horticultural Science at the Technical University of Munich from 1976-1982. Following these studies, he completed a doctorate at the Chair of Fruit Science under supervision from the former head, Walter Feucht, on the topic of grafting incompatibility in sweet cherry. In 1992, he gained the venia legendi on the subject of Fruit Science through his postdoctoral qualification on the topic of polyphenols and their significance to fruit growers and consumers. After a period working in Spain, he was appointed Head of the Associate Professorship of Fruit Science at the Technical University of Munich in 1999. The establishment of the masters programme in 'Horticultural Sciences', which runs in co-operation with a number of renowned European universities, can essentially be credited to his hard work. He was involved in numerous national and international scientific organisations, as a member or as the chairman, and was awarded an honorary doctorate from the Corvinus University in Budapest. He was one of the Conveners of the XI International Symposium on Plum and Prune Genetics, Breeding and Pomology that will be held in Freising-Weihenstephan, Germany, in July 2016.

There was hardly a scientist who was as comfortable in both the world of scientific research and that of the practical field of fruit growing as Dieter Treutter. It was the connection between the physiology of fruit trees and the requirements of fruit growers that made his lectures both challenging and informative. He kept much of his work and many of his achievements quiet. Humility was one of his virtues. Dieter Treutter was passionate about his career and what he could still achieve.

We are thankful as we look back on the years in which we had the pleasure of working with Dieter Treutter. We will honour his memory and draw on those things which he both professionally and personally imparted to us. His dedication to fruit sciences has set an example that we will take with us into the future.

Johannes Hadersdorfer, Technische Universität München, Germany
Michael Neumüller, Bavarian Centre of Pomology and Fruit Breeding, Germany

Associate Prof. Dr. Colin James Birch (1952-2016)

Colin James Birch was born on 30 June, 1952 in Kingaroy, Queensland, the heart of Australia's peanut and navy bean industry, located 210 km north-west of Brisbane.

Colin began his career working for Incitec (now Incitec Pivot), then worked for the Queensland Agricultural College, Gatton, as a Lecturer in Agronomy. During his term there the college was assimilated by his Alma Mater, the University of Queensland (UQ), and by 1990, Colin was promoted to Senior Lecturer in Agronomy, a position he occupied for 18 years until 2008, both teaching agronomy and conducting research into maize. Not having learnt from what must have been a hardship undertaking a Masters degree while working, Colin, and this is a testament to his capability, then completed a PhD (UQ) in crop modelling of maize from 1992 to 1997. His dedication to the maize industry was recognised when he was awarded the Ian Hamparsum Memorial Award for Outstanding Service to the Australian Maize Industry in 2003. While having a substantive position as Senior Lecturer, in 2003 Colin was appointed as the Director of Studies, Faculty of Natural Resources, Agriculture and Veterinary Science (NRAVS).

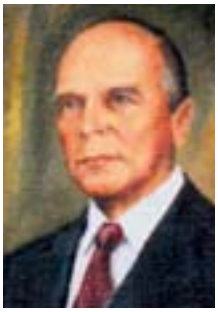
Colin arrived at the Tasmanian Institute of Agriculture (TIA), University of Tasmania, in 2008, where he had been appointed to the newly created position of Centre Leader, Vegetables, as an Associate Professor. During his tenure with the institute, Colin established a solid foundation that allowed his staff to deliver significant applied research outcomes to the local vegetable industry. Colin was a compassionate and kind man, and on reflection, must have had a compelling desire to help those living in developing countries. While with TIA he ran a large Australian Centre for International Agricultural Research (ACIAR) project, focussed on developing vegetable supply chains to the capital city of Papua New Guinea (PNG), Port Moresby. The political and socio-cultural issues in PNG are complex, and I and other project members admired his ability as a statesman, demonstrated by his capacity to negotiate with all parties involved to reach a respectable outcome. His compassion for people was also evidenced by the way he took time to mentor staff from project partner agencies, some of whom have gone on to higher degree research. In 2014, Australia had the privilege of hosting the International Horticultural Congress in Brisbane, and Colin's role in running a symposium was duly recognised with an ISHS medal. Colin stayed with us for 6 years and 5 months before semi-retiring with his family in their newly built house at Top Camp, Toowoomba, in Queensland.

In his 'retirement', Colin continued in his role as Honorary Reader, School of Agriculture and Food Sciences (UQ) to which he had been appointed to in 2008, and closer to Top Camp, as an Associate Professor, Agricultural Systems at the University of Southern Queensland. Until his passing Colin continued to be actively involved in an ACIAR project addressing vegetable production in Laos and Cambodia. This telling has only recounted some of Colin's achievements, which were many, and a full reportage can still be found on his Linked-In page.

The metaphor 'dwarfs standing on the shoulder of giants (*nanos gigantum humeris insidentes*)' was made famous by Isaac Newton (and Google), who is quoted as saying, 'if I have seen further, it is by standing on the shoulder of giants'. Colin's contribution to agricultural science has helped us see further, but I can't help thinking that a person's true legacy is the impact on people we touch as we travel life's journey. I am sure, and many people around the globe would agree, that in this respect, Colin left a fortune behind.

And herewith all I bid thee farewell,
and doe not forget me. Vale.
Thomas Shelton, 1612

Mark Boersma,
University of Tasmania, Australia



Prof. em. Johan Efraim (Hannu) Hårdh (1917-2014)

The following information has reached the ISHS Secretariat about the passing of Prof. em. Johan Efraim (Hannu) Hårdh in 2014. We wish to inform our members (although with a delay). Prof. Hårdh died at the age of almost 97 years in Kangasala (Finland). He was the first Chair of the ISHS Section Vegetables, serving a full term (1961-1966).

His scientific development as an agronomist was interrupted in 1942 by military service and resumed later with scientific work at the Agricultural Research Institute in Tikkurila. In 1959, he was appointed Professor of Horticulture at the University of Helsinki. After gaining great merit in various fields of horticultural science, Prof. Hårdh specialized in vegetables. He worked on a range of research topics, including comparing contamination levels, especially heavy metals, in vegetables and soils from industrial countries, e.g. Germany, with the much less contaminated soils of Finland. With the death of Prof. Hårdh, we recognise the loss of one of the important contributors to the development of ISHS. He will always be remembered.

We acknowledge the input from former ISHS President, Prof. em. Dr. Dr. h.c. D. Fritz.

Prof. Innocenza Chessa

Professor Innocenza Chessa passed away a few months ago. She served as Chair of the ISHS Working Group on Cactus Pear and Cochineal and was Co-Convener of the last International Congress on Cactus Pear and Cochineal held in Palermo (Italy) during October 2013. Enza was full professor of Horticulture at the University of Sassari in Sardinia (Italy). She was a very active scientist with sound experience in postharvest management of Mediterranean fruits and, most particularly, in the evaluation, preservation and use of the biodiversity of Mediterranean species such as citrus, fig, and cactus pear, among others. She made an important contribution to the evaluation of cactus pear cultivars worldwide. She was beloved by her colleagues also because of her friendly and elegant attitude and her ability to participate in international research groups. The FAO-ICARDA Cactusnet network will include a dedication to her in the next FAO Book on 'Agroecology, Cultivation and Uses of *Opuntia* sp.'

Paolo Inglese, Coordinator European Network of Horticultural Societies

Dr. Edward Carroll Sisler (1930-2016)

With the death of Dr. Edward Carroll Sisler, February 12th, 2016, the scientific community lost a leading intellect and scientist. We mourn the passing of an outstanding colleague, productive scholar and generous friend. A native of Maryland, Edward lived in Raleigh for many years. He received his B.Sc. and M.Sc. from The University of Maryland, and his Ph.D. in Plant Physiology from North Carolina State University (NCSU). Edward was a biochemistry professor at NCSU for many years.

In 1992, Edward's research resulted in the discovery of 1-MCP, and in 1996 he was awarded his second of many patents. The subsequent commercialization of 1-MCP revolutionized the handling of agricultural and horticultural commodities bringing him world-renowned recognition. Throughout the scientific community he is known as "The Father of 1-MCP".

Edward was an extremely bright and hard-working researcher. He published extensively, and enjoyed sharing knowledge personally with scientists worldwide. In addition, he was a very kind and generous colleague, who was always willing to share all that he knew. Those who had the privilege to know him closely appreciated his encyclopedic knowledge of history, classic music and literature. He had a dry, almost brusque humor and a love for animals and nature. He enjoyed taking care of his rabbits, collecting coins and solving the puzzles that Mother Nature created for him and others like him. For decades, Edward came to his laboratory at NCSU every day before dawn while the campus was empty and the aroma of flowers floated in the air. There were so many things that he wanted to explore, try and discover. He never ceased to wonder, thus never ceased to discover.

Margrethe Serek, Leibniz University Hannover, Germany

› 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 2016

- July 17-21, 2016, Freising and Hallbergmoos (Germany): **XI International Symposium on Plum and Prune Genetics, Breeding and Pomology.** Info: Dr. Michael Neumüller, Bayerisches Obstzentrum, Am Süßbach 1, 85399 Hallbergmoos, Germany. Phone: (49)8119933558, Fax: (49)8119933656, E-mail: nm@obstzentrum.de Web: http://plum2016.bayoz.de
- August 2-5, 2016, Minneapolis, MN (United States of America): **III International Symposium on Woody Ornamentals of the Temperate Zone.** Info: Dr. Stan C. Hokanson, Univ. of Minnesota, Dept. Of Horticulture, Breeding & Genetics, Woody Landscape Plants, 258 Alderman Hall, 1970 Folwell Ave., St. Paul, MN 55108, United States of America. Phone: (1)6126241203, Fax: (1)6126244941, E-mail: hokan017@umn.edu Web: http://www.woodyornamentals2016.org/
- August 7-12, 2016, Ibadan (Nigeria): **III All Africa Horticultural Congress.** Info: Prof. Dr. Isaac Ore Aiyelaagbe, Department of Horticulture, University of Agriculture, PMB 2240 Abeokuta, Ogun State, Nigeria. Phone: (234)8033815606, Fax: (234)39243045, E-mail: ola_olu57@yahoo.com E-mail symposium: aahc2016@yahoo.com Web: http://afrohort.org
- August 8-12, 2016, Atlanta, GA (United States of America): **II International Symposium on Germplasm of Ornamentals.** Info: Prof. Dr. Donglin Zhang, University of Georgia, Dept. Of Horticulture, 1111 Plant Science Building, Athens, GA 30602-7273, United States of America. Phone: (1)7065420776, Fax: (1)7065420624, E-mail: donglin@uga.edu or Prof. Dr. Zhang Qixiang, Nat'l Engineering Res.Center Floriculture, Beijing Forestry University, No.35, Qinghua East Road-Haidian Dist., Beijing 100083, China. Phone: (86)1062338005, Fax: (86)1062336321, E-mail: zqx@bjfu.edu.cn or Prof. Dr. Byoung Ryong Jeong, Department of Horticulture, 501 Jinjudaero, Gyeongsang National University, Jinju, Gyeongnam 660-701, Korea (Republic of). Phone: (82)55-772-1913, Fax: (82)55-757-7542, E-mail: brjeong@gmail.com Web: http://woodies.uga.edu/conference.html
- August 13-17, 2016, Québec City (Canada): **VIII International Strawberry Symposium.** Info: Prof. Dr. Yves Desjardins, Horticulture Research Center/INAF, Faculty of Agriculture and Food, 2440, Blvd. Hochelaga, # 2736, Laval Univ. Québec, QC G1V 0A6, Canada. Phone: (1)418-656-2131x2359, Fax: (1)418-656-3515, E-mail: yves.desjardins@fsaa.ulaval.ca or Prof. André Gosselin, Université Laval, Pavillon ENVIROTRON, Ste-Foy (Quebec), G1K 7P4, Canada. Phone: (1)4186562131ext2068, Fax: (1)4186567871, E-mail: andre.gosselin@fsaa.ulaval.ca E-mail symposium: iss2016@conferium.com Web: http://www.iss2016-quebec.org
- August 23-25, 2016, Kuala Lumpur (Malaysia): **III International Conference on Agricultural and Food Engineering.** Info: Dr. Samsuzana Abd Aziz, Dept. of Biological Agricultural Eng., Faculty of Engineering, 43400 Selangor UPM, Serdang, Malaysia. Phone: (60)3 89464455, Fax: (60)3 89466425, E-mail: samsuzana@upm.edu.my E-mail symposium: eng.cafei2016@upm.edu.my Web: http://www.cafei.upm.edu.my
- August 28 - September 2, 2016, Bologna (Italy): **XI International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems.** Info: Prof. Dr. Luca Corelli-Grappadelli, Department of Agricultural Sciences, Università di Bologna, Via Fanin 46, 40127 Bologna, Italy. Phone: (39)0512096400, Fax: (39)0512096401, E-mail: luca.corelli@unibo.it E-mail symposium: convener@orchardsystems2016.org Web: http://www.orchardsystems2016.org
- NEW September 11-14, 2016, Midrand (South Africa): **VII International Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops - SEST2016.** Info: Prof. Dr. Puffy Soundy, PO Box 99476, Garsfontein, 0042, South Africa. Phone: (27)123825335, Fax: (27)123825869, E-mail: soundyp@tut.ac.za E-mail symposium: kathy@sest2016.co.za Web: http://www.sest2016.co.za
- September 19-22, 2016, Avignon (France): **HortiModel2016: V International Symposium on Models for Plant Growth, Environment Control and Farming Management in Protected Cultivation.** Info: Dr. Nadia Bertin, UR 1115 PSH, INRA, Domaine St Paul, 228 route de l'aérodrome, Site Agroparc, 84914 Avignon, France. Phone: (33)0432722324, E-mail: nadia.bertin@avignon.inra.fr or Dr. Valentina Baldazzi, UR 1115 PSH, INRA, Domaine St Paul, 228 route de l'aérodrome, Site Agroparc, 84914 Avignon, France. Phone: (33)0432722447, E-mail: valentina.baldazzi@avignon.inra.fr E-mail symposium: hortimodel2016@paca.inra.fr Web: https://colloque.inra.fr/hortimodel2016/
- September 26-30, 2016, Mendoza (Argentina): **IX International Congress on Cactus Pear and Cochineal.** Info: Dr. Juan Carlos Guevara, Argentine Institute for Arid Land Research, (IADIZA), Adrian Ruiz Leal s/n, Parque General San Martín, 5500 Mendoza, Argentina. Phone: (54)02615244103, Fax: (54)02615244101, E-mail: jguevara@mendoza-conicet.gob.ar or Prof. Maria Ochoa, Delibano Chazarreta 544, Santiago del Estero 4200, Argentina. Phone: 54 385-4315885, E-mail: mariajudith8a@gmail.com or Ms. Josefina Grünwaldt, Argentine Institute for Arid Land Research, (IADIZA), Adrian Ruiz Leal s/n, Parque General San Martín, 5500 Mendoza, Argentina. Phone: (54)02615244103, Fax: (54)02615244101, E-mail: jgrunwaldt@mendoza-conicet.gob.ar E-mail symposium: cactus2016@mendoza-conicet.gob.ar Web: http://cactus2016.mendoza-conicet.gob.ar/index.php/homeingles
- September 26-28, 2016, Chengdu City (China): **II Asian Horticultural Congress - AHC2016.** Info: Prof. Dr. Yongchen Du, Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sci., 12 Zhongguancun Nandajie, Beijing 100081, China. Phone: (86)1068919515, Fax: (86)1062174123, E-mail: duyongchen@caas.cn Web: http://ciccst.org.cn/ahc2016
- September 26-28, 2016, Kafr El-Sheikh (Egypt): **VI International Symposium on Tropical and Subtropical Fruits.** Info: Dr. Ali R. El-Shereif, Horticulture Department, Faculty of Agriculture, Kafrelsheikh University, 33516 Kafr El-Sheikh, Egypt. Phone: (20)473254315, Fax: (20)479102930, E-mail: aelshereif@agr.kfs.edu.eg Web: http://www.kfs.edu.eg/intersociety/display.aspx?topic=26108
- October 2-7, 2016, Antalya (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://chestnut2016.org/
- October 5-7, 2016, Potsdam (Germany): **International Symposium on Sensing Plant Water Status - Methods and Applications in Horticultural Science.** Info: Dr. Werner B. Herppich, Leibniz-Inst. Agricult. Eng. Potsdam-Bornim, Max-Eyth-Allee 100, 14469 Potsdam, Germany. E-mail: wherppich@atb-potsdam.de or Prof. Dr. Manuela Zude-Sasse, Leibniz Institute for Agric. Engineering, Potsdam-Bornim, Max-Eyth-Allee 100, 14469 Potsdam-Bornim, Germany. Phone: (49)331-5699-612, Fax: (49)3315699849, E-mail: zude@atb-potsdam.de E-mail symposium: spws2016@atb-potsdam.de Web: http://www.spws2016.atb-potsdam.de/
- October 10-16, 2016, Yangling, Shaanxi (China): **I International Apple Symposium.** Info: Prof. Dr. Zhen-Hai Han, Institute for Horticultural

Plants, China Agricultural University, No. 2 Yuanmingyuanxilu, 100193 Beijing, China. Phone: (86)1062732467, Fax: (86)1062734391, E-mail: rschan@cau.edu.cn or Prof. Fengwang Ma, 3 Taicheng Road, College of Horticulture, Northwest AF University, Yangling, Shaanxi Province, 712100, China. Phone: +8613572076386, E-mail: fwm64@nwsuaf.edu.cn or Dr. Stuart Tustin, Hawke's Bay Research Centre, Plant & Food Research Ltd, Private Bag 1401, Havelock North, New Zealand. Phone: (64)69758968, E-mail: stuart.tustin@plantandfood.co.nz E-mail symposium: firstias@hotmail.com Web: http://ias.nwsuaf.edu.cn/

- October 10-14, 2016, Split (Croatia): **VIII International Olive Symposium.** Info: Dr. Slavko Perica, Director, Institute for Adriatic Crops, Put Duilova 11, 21000 Split, Croatia. Phone: (385) 21 434434, Fax: (385) 21 316584, E-mail: slavko@krs.hr E-mail symposium: ios2016-info@krs.hr Web: http://ios2016.krs.hr/
- October 10-14, 2016, Montpellier (France): **X International Symposium on Banana: ISHS-ProMusa Symposium on Agroecological Approaches to Promote Innovative Banana Production Systems.** Info: Dr. Jean-Michel Risede, CIRAD, RU GECO, Persyst Department, Boulevard de la Lironde, TA B26/PS4, 34398 Montpellier, France. Phone: +33(0)467617152, E-mail: jean-michel.risede@cirad.fr or 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. 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: symposium@promusa.org Web: http://ishs-promusa2016.cirad.fr/
- October 16-20, 2016, Valencia (Spain): **VI International Symposium on Persimmon.** Info: 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: convener@persimmonsymposium.es Web: http://www.persimmonsymposium2016.es/
- October 17-21, 2016, Chania, Crete (Greece): **III International Symposium on Horticulture in Europe - SHE2016.** Info: 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 or Prof. George Manganaris, Anexartisias 33, P.O. Box 50329, 3603 Lemesos, Cyprus. Phone: (357)25002307, Fax: (357)25002804, E-mail: george.manganaris@cut.ac.cy Web: http://she2016.org/
- October 24-29, 2016, Antalya (Turkey): **VIII International Symposium on Mineral Nutrition of Fruit Crops.** Info: Prof. Dr. Bekir Erol Ak, University of Harran, Faculty of Agriculture, 63200 Sanliurfa, Turkey. Phone: (90)4143183698, Fax: (90)4143183682, E-mail: beak@harran.edu.tr Web: http://www.mnutrition2016.org
- NEW November 10-12, 2016, Montevideo (Uruguay): **XIII International People Plant Symposium: Plants, Cultures and Healthy Communities.** Info: Dr. S. Norman Goodyear, 15 Parsons Rd, St. John's NL A1A 2H8, Canada. Phone: (1)7098642076, E-mail: norman.goodyear@mun.ca or Dr. Marta Chiappe, Garzón 780 CP 12900, Montevideo, Uruguay. E-mail: marbechiappe@gmail.com E-mail symposium: ipps2016@ipps2016.org Web: http://ipps2016.org/
- November 20-25, 2016, Cairns, Queensland (Australia): **International Symposia on Tropical and Temperate Horticulture.** Info: Prof. Dr. Roderick A. Drew, Griffith Sciences, Logan Campus, Griffith University, University Drive, Meadowbrook, QLD 4131, Australia. Phone: (61)733821291, Fax: (61)737357618, E-mail: r.drew@griffith.edu.au or Dr. Robin Elaine Roberts, Griffith Asia Institute, Griffith University, 170 Kessels Road, Nathan Qld 4111, Australia. Phone: (61)7 373 57885, E-mail: robin.roberts@griffith.edu.au E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Urban Landscapes in Tropical Cities.** Info: Prof. Dr. Gert D. Groening, Universitaet der Kuenste Berlin Institut GTG, Gartenkultur und Freiraumentwicklung, Postfach 12 05 44, 10595 Berlin, Germany. Phone: (49)3031852278, Fax: (49)3031852499, E-mail: groening@udk-berlin.de or Prof. Patrícia Paiva, Universidade Federal de Lavras, Depto de Agricultura, campus universitario, Lavras-MG, 37200-000, Brazil. Phone: (55)35 38291786, Fax: (55)35 38291301, E-mail: patriciapaiva@dag.ufla.br E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-urban-landscapes-tropical-cities/
- November 20-25, 2016, Cairns, Queensland (Australia): **IV International Symposium on Guava and Other Myrtaceae.** Info: Prof. Dr. Sisir Kumar Mitra, B-12/48, Kalyani, Nadia, West Bengal 741235, India. Phone: (91)3325823017, Fax: (91)3325828460, E-mail: sisirm55@gmail.com or Andrew East, Massey University, Private Bag 11222, Palmerston North, New Zealand. E-mail: a.r.east@massey.ac.nz E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-guava-other-myrtaceae/
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Tropical Plant Breeding.** Info: Dr. M.R Dinesh, Principal Scientist, Division of Fruit Crops, Sadashivanagar - IIHR, Bangalore, Karnataka, 560089, India. Phone: (91)80- 23611198, Fax: (91)80-28466291, E-mail: drmrdinesh@gmail.com or Dr. Wen-Li Lee, Taiwan Agricultural Research Institute, No.530, Wenlong E.Rd., Fengshan Dist., 83052 Kaohsiung City, Chinese Taipei. E-mail: leewenli@fthes-tari.gov.tw or Dr. Songpol Somsri, Senior Advisory in Plant Production, Department of Agriculture, Chatuchak, Bangkok 10900, Thailand. Phone: (66)25790574, Fax: (66)29405472, E-mail: songpolsom@yahoo.com E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-tropical-plant-breeding/
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Vegetative Propagation and In Vitro Culture of Tropical Plants.** 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 Prof. Dr. Renato Paiva, Alameda dos Flamboyants 103, Condominio Jardim das Palmeiras, 372000-000 Lavras-Minas Gerais, Brazil. Phone: (55)3538291359, Fax: (55)3538291100, E-mail: renpaiva@dbi.ufla.br E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/international-symposium-on-vegetative-propagation-and-in-vitro-culture-of-tropical-plants/
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Beverage Crops.** Info: Prof. Dr. Roderick A. Drew, Griffith Sciences, Logan Campus, Griffith University, University Drive, Meadowbrook, QLD 4131, Australia. Phone: (61)733821291, Fax: (61)737357618, E-mail: r.drew@griffith.edu.au 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 Prof. Dr. Renato Paiva, Alameda dos Flamboyants 103, Condominio Jardim das Palmeiras, 372000-000 Lavras-Minas Gerais, Brazil. Phone: (55)3538291359, Fax: (55)3538291100, E-mail: renpaiva@dbi.ufla.br or Prof. Dr. Yves Desjardins, Horticulture Research Center/INAF, Faculty of Agriculture and Food, 2440, Blvd. Hochelaga, # 2736, Laval Univ. Québec, QC G1V 0A6, Canada. Phone: (1)418-656-2131x2359, Fax: (1)418-656-3515, E-mail: yves.desjardins@fsaa.ulaval.ca E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-beverage-crops/
- November 20-25, 2016, Cairns, Queensland (Australia): **II International Symposium on Tropical Horticulture: Now is the Era for Tropical Horticulture.** Info: Prof. Dr. Roderick A. Drew, Griffith Sciences, Logan Campus, Griffith University, University Drive, Meadowbrook, QLD 4131, Australia. Phone: (61)733821291, Fax: (61)737357618, E-mail: r.drew@griffith.edu.au or Prof. Dr. Robert E. Paull, Dept. Tropic Plant & Soil Sci., University of Hawaii, 3190 Maile Way, Honolulu, HI 96822-2279, United States of America. Phone: (1)808-956-7369, Fax: (1)808-956-3894, E-mail: paull@hawaii.edu or Dr. Alain Rival, CIRAD Resident Regional Director, Southeast Asian Island Countries, Graha Kapital 1 - Jl. Kemang Raya #

4, 12730 Jakarta, Indonesia. Phone: (62)217198641, Fax: (62)2171794652, E-mail: alain.rival@cirad.fr E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-tropical-horticulture/

- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Tropical Plant Genomes.** Info: Dr. Natalie Dillon, DAFF, 28 Peters Street, Mareeba QLD 4880, Australia. E-mail: natalie.dillon@daf.qld.gov.au E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-tropical-plant-genomes/
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Poverty, Hidden Hunger and Horticulture & VI International Symposium on Improving the Performance of Supply Chains in the Transitional Economies.** Info: Dr. Detlef Virchow, GlobalHort, co Center for Development Research ZEF, Walter-Flex-Str. 3, 53113 Bonn, Germany. Phone: (49)228-734476, Fax: (49)228-731889, E-mail: dvirchow@globalhort.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 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: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-poverty-hidden-hunger-horticulture/
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Protected Cultivation in Tropical and Temperate Climates & X International Symposium on Protected Cultivation in Mild Winter Climates.** Info: Prof. Dr. Gordon Rogers, University of Sydney, Biomedical Building 1 Central Ave, Eveleigh, NSW 2015, Australia. Phone: (61) 2 8627 1040, Fax: (61) 2 9544 3782, E-mail: gordon@ahr.com.au or Dr. Sophie Parks, Industry NSW, Locked Bag 26, Gosford, NSW 2250, Australia. Phone: (61)243481914, Fax: (61)243481910, E-mail: sophie.parks@dpi.nsw.gov.au 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 E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-protected-cultivation-tropical-temperate-mild-winter-climates/
- November 20-25, 2016, Cairns, Queensland (Australia): **I International Symposium on Tropical Plantation Crops.** Info: Prof. Dr. Sisir Kumar Mitra, B-12/48, Kalyani, Nadia, West Bengal 741235, India. Phone: (91)3325823017, Fax: (91)3325828460, E-mail: sisirm55@gmail.com or Valerie S. Tuia, Secretariat of the Pacific Community, Suva Regional Office, Private Mail Bag, Suva, Fiji. Phone: (679)3379274, Fax: (679)3370021, E-mail: valeriet@spc.int or Dr. Luseane Taufa, Senior Plant Pathologist, Ministry Agric., Food, Forests & Fisheries, P.O Box 14, Nuku'alofa, Tonga. Phone: (676) 23038, Fax: (676) 24271, E-mail: luseane.taufa@mafff.gov.to E-mail symposium: istth2016@griffith.edu.au Web: http://www.istth2016.org/science/int-sym-tropical-plantation-crops/
- NEW November 23-26, 2016, Agadir (Morocco): **V International Symposium on Saffron Biology and Technology: Advances in Biology, Technologies, Uses and Market.** Info: Prof. Mohammed Badraoui, Institut National de Recherche Agronomique, Avenue Ennasr, BP 415 Rabat, Morocco. Phone: (212)537772654, Fax: (212)537770049, E-mail: mohamedbadraoui@gmail.com E-mail symposium: saffronsymposium@gmail.com Web: http://www.vsaffronsymposium.com

Year 2017

- March 7-10, 2017, Napier (New Zealand): **IV International Symposium on Molecular Markers in Horticulture.** Info: Dr. Vincent Gerardus Maria Bus, Plant and Food Research, Private Bag 1401, Havelock North 4157, New Zealand. Phone: (64)69758946, Fax: (64)69758881, E-mail: vincent.bus@plantandfood.co.nz E-mail symposium: Yvonne.McDiarmid@plantandfood.co.nz Web: http://www.molecularmarkers.co.nz
- March 27-31, 2017, Antalya (Turkey): **III International Symposium on Biotechnology of Fruit Species.** Info: Prof. Dr. Ahmet Naci Onus, Department of Horticulture, Faculty of Agriculture, Akdeniz University, 07059 Antalya, Turkey. Phone: (90) 242-3102441, Fax: (90) 242- 2274564, E-mail: onus@akdeniz.edu.tr E-mail symposium: fruitbiotech@gmail.com Web: http://fruitbiotech2016.org
- March 28-31, 2017, Santiago (Chile): **III International Symposium on Bacterial Canker of Kiwifruit (Psa).** Info: Paulina Sepulveda, INIA-LA Platina Chile, Zurich 221 Depto 101, Santiago, Chile. Phone: (56)225779147, E-mail: pssr2009@gmail.com E-mail symposium: symposium.psa2017@gmail.com Web: http://www.psa2017.cl
- April 6-8, 2017, Amaya Hills, Kandy (Sri Lanka): **IV International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions.** Info: Dr. Chalinda Beneragama, Department of Crop Science, Faculty of Agriculture, University of Peradeniya, 20400 Sri Lanka Peradeniya, Sri Lanka. Phone: (94)812-395127), E-mail: chalindab@gmail.com E-mail symposium: pqmhp.ishs2017@gmail.com
- April 24-28, 2017, Lavras, Minas Gerais (Brazil): **VII International Symposium on Production and Establishment of Micropropagated Plants.** Info: Prof. Dr. Renato Paiva, Alameda dos Flamboyants 103, Condominio Jardim das Palmeiras, 372000-000 Lavras-Minas Gerais, Brazil. Phone: (55)3538291359, Fax: (55)3538291100, E-mail: renpaiva@dbi.ufla.br or Dr. Diogo Pedrosa Corrêa da Silva, Rua América de Moura Maia, 57, apto 02, Lavras, Brazil. E-mail: pedrosacorrea@yahoo.com.br or Dr. Michele Reis, R. Misseno de Padua, 296 apt. 202, Centro, 37200–00 Lavras-Minas Gerais, Brazil. Phone: (55)035 38291619, E-mail: mvreis@yahoo.com.br
- NEW May 1-4, 2017, Ramsar (Iran): **International Symposium on Wild Flowers and Native Ornamental Plants.** Info: Dr. Pejman Azadi, National Institute of Ornamental Plants, PO Box 37815-137, Mahallat, Iran. E-mail: azadip22@gmail.com E-mail symposium: info@wildflowers2017.com Web: http://wildflowers2017.com/
- May 8-11, 2017, Antalya (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 Web: http://www.carob2016.org
- NEW May 22-26, 2017, Fullerton, CA (United States of America): **X International Workshop on Sap Flow**. Info: Prof. Dr. H. Jochen Schenk, Department of Biological Science, California State University Fullerton, PO Box 6850, Fullerton, CA 92834-6850, United States of America. Phone: (1)6572783678, E-mail: jschenk@fullerton.edu
- May 23-26, 2017, Pontevedra (Spain): **VII International Symposium on Brassicas.** Info: Elena Cartea, CSIC, PO BOX 28, 36080 Pontevedra, Spain. Phone: (34)986854800, E-mail: ecartea@mbg.csic.es or Pablo Velasco, Misión Biológica de Galicia (CSIC), Apartado 28, 36080 Pontevedra, Spain. Phone: 34 986854800, E-mail: pvelasco@mbg.csic.es or Pilar Soengas, Misión Biológica de Galicia (CSIC), Apartado 28, 36080 Pontevedra, Spain. Phone: (34)986854800, E-mail: psoengas@mbg.csic.es or Dr. Victor Rodriguez, Mision Biologica de Galicia, Palacio de Salcedo, Carballeira, 8 (Salcedo), 36143 Pontevedra, Spain. Phone: (34)986854800, E-mail: vmrodriguez@mbg.csic.es E-mail symposium: brassica2017@csic.es
- June 5-9, 2017, Yamagata (Japan): **VIII International Cherry Symposium.** Info: Prof. Dr. Satoshi Taira, Lab. of Pomology, Fac. of Agr., Yamagata University, Tsuruoka, Yamagata 997-8555, Japan. Phone: (81)235-282829, Fax: (81)235-282832, E-mail: staira@tds1.tr.yamagata-u.ac.jp or Prof. Dr. Ryutaro Tao, Lab. Pomology, Fac. Agric., Kyoto University, Kitashirakawa Oiwake-cho, Sakyo-ku Kyoto 606-8502, Japan. Phone: (81)757536053, Fax: (81)757536497, E-mail: rtao@kais.kyoto-u.ac.jp or Hideki Murayama, Faculty of Agriculture, Yamagata University, 1-23 Wakabamachi Tsuruoka, Yamagata 997-8555, Japan. Phone: (81)235282887, Fax: (81)235282812, E-mail: mhideki@tds1.tr.yamagata-u.ac.jp Web: http://cherry2017.jshs.jp

For updates logon to www.ishs.org/symposia

› Available issues of *Acta Horticulturae*

Available numbers of *Acta Horticulturae* (in print). These as well as all other titles are also available in *ActaHort CD-rom* format. For detailed information on price and availability, including tables of content, or to download an *Acta Horticulturae* order form, please check out the 'publications' page at www.ishs.org or go to www.actahort.org

Acta Number	Acta Title	Price (EUR)
1134	VIII International Symposium on Light in Horticulture	105
1133	XI International Rubus and Ribes Symposium	118
1132	XVIII International Symposium on Horticultural Economics and Management	60
1117	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): II International Berry Fruit Symposium: Interactions! Local and Global Berry Research and Innovation	92
1116	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): III International Jujube Symposium	57
1115	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IV International Symposium on Tropical Wines and International Symposium on Grape and Wine Production in Diverse Regions	74
1114	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IX International Symposium on Banana: ISHS-ProMusa Symposium on Unravelling the Banana's Genomic Potential	77
1113	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Micropropagation and In Vitro Techniques	75
1112	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposia on Water, Eco-Efficiency and Transformation of Organic Waste in Horticultural Production	109
1111	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IV International Symposium on Papaya, VIII International Pineapple Symposium, and International Symposium on Mango	92
1110	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Molecular Biology in Horticulture	67
1109	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Nut Crops	76
1108	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): V International Conference on Landscape and Urban Horticulture and International Symposium on Sustainable Management in the Urban Forest	90
1107	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Innovation and New Technologies in Protected Cropping	82
1106	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): VI International Symposium on Human Health Effects of Fruits and Vegetables (FAVHEALTH 2014)	68
1105	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposia on Innovative Plant Protection in Horticulture, Biosecurity, Quarantine Pests, and Market Access	98
1104	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Ornamental Horticulture in the Global Greenhouse	112
1103	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): XVII International Symposium on Horticultural Economics and Management and V International Symposium on Improving the Performance of Supply	75
1102	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): International Symposium on Promoting the Future of Indigenous Vegetables Worldwide	76
1101	XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IV International Symposium on Plant Genetic Resources	65
1100	III International Symposium on Molecular Markers in Horticulture	60
1099	II International Symposium on Horticulture in Europe	201
1098	International Symposium on Medicinal Plants and Natural Products	55
1097	VIII International Symposium on New Ornamental Crops and XII International Protea Research Symposium	71
1096	VIII International Symposium on Kiwifruit	109
1095	I International Symposium on Bacterial Canker of Kiwifruit	59
1094	XII International Pear Symposium	127
1093	XI International People Plant Symposium on Diversity: Towards a New Vision of Nature	59
1092	IV International Symposium on Loquat	75
1091	VI International Conference on Managing Quality in Chains	83
1090	I International Symposium on Horticulture Economics, Marketing and Consumer Research	36
1089	III International Symposium on Pomegranate and Minor Mediterranean Fruits	108
1088	II Southeast Asia Symposium on Quality Management in Postharvest Systems	134
1087	XXV International EUCARPIA Symposium Section Ornamentals: Crossing Borders	111
1086	I International Symposium on Vegetable Grafting	76
1085	Proceedings of the 2014 Annual Meeting of the International Plant Propagators Society	119
1084	VIII International Peach Symposium	174
1083	VIII International Symposium on In Vitro Culture and Horticultural Breeding	126
1082	XI International Conference on Grapevine Breeding and Genetics	91
1081	XIII International Symposium on Processing Tomato	83
1080	I International Symposium on Cashew Nut	104
1079	V International Conference Postharvest Unlimited	149
1078	II International Orchid Symposium	61
1077	I International Symposium on Ornamentals in Africa	55
1076	II International Symposium on Organic Matter Management and Compost Use in Horticulture	69

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