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ISHS

Chronica Horticulturae

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Cover photograph: The scientific community is mobilized to fight against PSA which threatens the kiwi industry. See article p. 4.

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ISHS

Contents

Use and Abuse of the Impact Factor: Scientists Rebel!

Yves Desjardins, ISHS Board Member Responsible for Publications

Yves Desjardins

For many years, horticulture scientists have expressed doubts and dissatisfaction with the use of the impact factor (IF) as a criterion for their promotion and the evaluation of the quality of their research. Dr. Jules Janick, former Board member and ISHS editor, wrote appropriately about the "Tyranny of the impact factor" and the misuse of this bibliometric parameter for assessing the impact of research (Janick, 2008). It seems that horticulturists are not alone anymore in rejecting the concept of IF and its use and abuse. Actually, the entire scientific community may be on the verge of a small rebellion against IF. The echoes of this uprising come from San Francisco.

Before talking about San Francisco, let's backtrack. The IF was conceived by Eugene Garfield in the 1970s as a tool intended for research libraries to judge the relative merit of scientific journals to intelligently spend their limited and shrinking subscription budgets. This index was, and still is, a measure of the number of citations an article receives over the total number of articles published in that journal during the two preceding years. It is considered a measure of the overall journal quality, but is **not** a measure of the quality of individual papers. Indeed, Seglen (1992) reported that only 15% of the articles in scientific journals account for more than 50% of the citations, and 90% of papers have fewer citations than the average!!! Over the years, use of the IF has drifted from its original purpose. Now, international scientists are ranked by the weight conferred by the IF of the journal in which they publish. This conceptual shift is absurd. The IF has been appropriately criticized for many years. Rating papers on the average ranking of the journal in which they were published is inappropriate.

Indeed the IF concept has been denounced by many scientific organizations for its shortcomings and lack of objectivity. For one, the index is discipline dependent. In other words, it is largely influenced by the size of the community in a specific field of science. Thus, small scientific communities have limited opportunities to cite a paper. IF is also affected by the speed at which a paper is published and by the vitality of the domain. For example, a paper on AIDS stands more chance of being cited than a paper on the effect of nitrogen on postharvest storage of mangosteen. Thomson Reuters recommends not to compare IF between disciplines but unfortunately there are many universities and organizations simply ignoring this basic rule.

The IF can be tricked and manipulated by an aggressive editorial policy whereby a large number of review articles that receive higher citations are published, the number of articles published is restricted (e.g. Nature and Science with acceptation rates of less than 10%), higher impact papers are published early in the year, so they can be cited over a longer time, or a coercive policy of self-citations is applied. IF has also been blamed for promoting "me-too" science and discouraging high risk and potentially ground-breaking work because of fear of not being cited or being cited by too few persons.

It's in this context that many scientists (+ 8800) and reputable science organizations (+ 350) have signed the San Francisco Declaration of Research Assessment (DORA, 2012), as an outcome of the last meeting of the American Society for Cell Biology in December 2012. The declaration aims to correct the distortions in the evaluation of scientific research quality and to stop the use of the IF for this purpose altogether!!!

San Francisco DORA
Declaration on Research Assessment

The declaration, which has sent shockwaves through the science community, calls for 1) a ban on the use of journal-based metrics such as journal IF in funding, appointments and promotion considerations; 2) judgement of research on its own merit rather than on the basis of the journal where it is published; and 3) use of the new opportunities conferred by on-line publication to loosen limits on specific length, number of words, figures and references in articles, while exploring new indicators of research significance and merit.

Many recommendations of the 18 listed in the declaration stand out and are of direct relevance to us in academia. For instance, *"when involved in committees making decisions about funding, hiring, tenure or promotion, researchers should make their assessment based on scientific content rather than publication metrics and should challenge research assessment practices that rely inappropriately on journal IF"*. Scientists should be aware and use a range of article-based metrics ("altmetrics") when available for assessing the quality of research output. Publishers are also invited to *"limit their emphasis on IF as a promotional tool and make available a range of article-based metrics"*. Other recommendations are made to funding agencies and institutions to be explicit about the criteria they use to evaluate scientific productivity.

During its last meeting in Matera, Italy, the ISHS Board enthusiastically signed the DORA, a declaration that conforms to what the Society has been claiming for years: the IF does not properly assess the scientific significance of papers published in the field of horticulture science, e.g., the low IF of most horticultural journals (< 1.5). This is particularly important for the recognition of *Acta Horticulturae*®, which is not considered by ISI-Thomson Reuters' Web-of-Knowledge® as a scientific journal, even if it is fully refereed in the ISI conference database. *Acta* is referenced by Scopus and thus used in the calculation of the H-Index (the set of a scientist's most cited papers divided by the number of citations that they have received in other publications) and altmetrics.

The recent decisions by the ISHS Board to provide a digital object identifier (DOI) to each published *Acta Horticulturae*® article, to invest in the infrastructure to fully cross-reference articles and bibliographies and to provide the capacity for on-line publication of articles are opening new opportunities to comply with the San Francisco's DORA declaration. Opening the door to the WEB 2.0 into PubHort will allow the generation of new altmetrics, including conventional ones like the number of times an article is viewed, downloaded and cited, but also new ones such as the use of social media (Twitter, Facebook and LinkedIn), online reference managers (CiteULike, Zotero and Mendeley), collaborative encyclopedias (Wikipedia), Blogs (both scholarly and general-audience), and scholarly social networks (ResearchGate or Academia.edu). At this stage, we are ready to provide the number of Twitter tweets generated by an *Acta Horticulturae*® article (the so-called Twimpact Factor), a reflection of the "buzz" generated by an article in the scientific community and the

media, a metric that is gaining popularity as a prediction of the impact of a paper in the community at large.

As the ISHS Board member responsible for publications, and on behalf of the Board, I stand and promote the publication of quality research. Articles in *Acta Horticulturae*® and other horticultural publications will be better recognized through the use of the H-index and altmetrics than with IF. We support the DORA and so should you. I invite you to read the "Declaration" and sign it in support.

ISHS does not want to play the IF game anymore and is taking steps to use altmetrics when and wherever possible.

We hear the echo of San Francisco DORA… and retweet it!

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Postcard

I had the opportunity to attend the excellent 1st World Congress on the Use of Biostimulants in Agriculture, which was organized by New AG International in collaboration with the ISHS. This meeting had a very high attendance, perfect organization and world class invited speakers. However, I also know of other industry meetings flawlessly organising and attracting a high number of participants that could benefit from a better scientific content. These meetings could be enhanced by the participation of internationally recognised scientists and from the presentation of appropriate oral and poster contributions. Industry-related organisations could benefit from the capacity of ISHS members to contribute to the scientific program of their meetings and to publish the proceedings in a traceable series like *Acta Horticulturae*. There are great opportunities for collaboration and exchange of multidisciplinary knowledge. However, industry people usually make quick decisions. The rather complex decision making structure of ISHS needs to be more reactive in order to provide a timely reply when our Society receives concrete proposals.

António Monteiro, President of ISHS

Issues

Adapting to a Virulent Bacterial Canker in Kiwifruit

Alistair Mowat, Greg Clark, Mary Black, Jayson Benge, Bryan Parkes, Stuart Kay and David Tanner

INTRODUCTION

Prior to November 2010, the New Zealand kiwifruit industry had a high economic growth rate. Kiwifruit (both Hayward 'Green' and Hort16A 'Gold') was the largest horticultural export from New Zealand, with sales of approximately $NZ1.1 billion per year, and an 8.2% annual growth rate from 1984 to 2009 (Bano and Scrimgeour, 2012); and this industry was setting its sights even higher. As part of a global kiwifruit industry with combined estimated production of two million metric tonnes (0.2% of globally produced fruit), the opportunities for growth in this category, at the time, were significant.

With the incursion of *Pseudomonas syringae* pv. *actinidiae*, this impressive growth rate slowed. *P. syringae* pv. *actinidiae* (more commonly known as Psa) is the causal agent of bacterial canker of kiwifruit. First recorded in Japan in 1984, the bacterial disease has had a serious economic impact on kiwifruit production. The virulent form of Psa, known as Psa-V, has severely affected kiwifruit orchards in Europe, New Zealand, Chile and China. The haplotype, or form, found in New Zealand is genetically similar to the European haplotype, but genetically distinct from the form responsible for damage in Japan and Korea in the 1980s and 90s (Vanneste et al., 2011).

Affected vines exhibit leaf spots (Fig. 1A), cane wilting (Fig. 1B), cane die-back, and cankers, which are sometimes associated with copious production of a red exudate (Fig. 1C). This red exudate can also be produced from apparently healthy tissues. Although production of this exudate is one of the symptoms of bacterial canker, the pathogen is not easily isolated from this red exudate. In contrast, Psa is readily isolated as a pure culture from a milky white exudate, which is also sometimes produced by affected tissues (Fig. 1D). When the conditions are favourable for the development of the disease, Psa can kill a vine within a few months.

Figure 1. Some of the many characteristic symptoms of *Pseudomonas syringae* pv. *actinidiae*: A. leaf spotting; B. shoot/cane wilting; C. red exudate; D. white, bacteria-laden exudate.

Today it is the most destructive disease known to kiwifruit.

The arrival and formal identification of Psa in New Zealand in late 2010 (Everett et al., 2011) has transformed how kiwifruit will be grown in this country. The economic impact from the pathogen over the next ten years has been estimated to cost between NZ$500 and NZ$600 million (Greer and Saunders, 2012). Adaption of the New Zealand kiwifruit sector to the disease is underway as the industry uses a fundamental understanding of the pathogen, the kiwifruit host and the environment, in conjunction with management, to map a pathway forward.

An important aspect of the New Zealand research programme has been its linkages with a wide range of research providers both locally and offshore. Collaboration between organisations, industries and research agencies, both nationally and internationally, has been critical to the progress made so far. In particular, Plant & Food Research Limited, Landcare Research Limited and the Ministry for Primary Industries have played a significant role in the New Zealand research efforts, with all committing significant funding.

Rapid and free transfer of knowledge between growers and researchers alike has been important for the two-way transfer of knowledge and learnings between the field and lab. There is an on-going flow of information from the Psa research program that keeps stakeholders updated on what projects are being contracted, progress being made, final reporting and uptake (e.g. www.kvh.org.nz).

The New Zealand Psa research and development programme was able to be established relatively quickly in response to the New Zealand outbreak due to the industry's large existing research programme and research networks. Existing resources and research providers responded rapidly and were able to re-task to address the new needs of the New Zealand kiwifruit industry. The research and development programme has quickly expanded to over 30 research providers on 70 projects across four countries, targeted to address the new challenges from a Psa outbreak in New Zealand.

The scope of the programme is continually increasing in depth and breadth as existing research providers, growers and other researchers and outside parties bring new ideas to consider and explore further. The complex nature of the threat dictates that for every step forward taken in understanding Psa, there will inevitably be a slight stumble backwards as the disease throws up new questions and challenges.

The Psa R&D programme has experienced just such a pattern of ups and downs since it began. However, a view across the length of the programme shows the Psa knowledge curve is on the increase and that the technical programmes are delivering this knowledge, either directly or through tools and techniques to the grower.

The research programme has been structured around five broad themes. The first, detection and genomics, is focused on field or lab-based tools for the identification and characterisation of Psa pathovars and inoculum load. The second theme, epidemiology, aims to understand the pathogen, host, environment and management interactions associated with Psa. The third theme, chemical/biological control, aims to identify and deliver chemical and biological control options for Psa. The fourth theme, management, is targeted at the delivery of tools, growing methods and production systems that are resilient to Psa. Finally, a major

Figure 2. The Kiwifruit Vine Health (KVH) website – KVH was set up by the New Zealand Kiwifruit Industry to manage the incursion of *P. syringae* pv. *actinidiae* on behalf of all stakeholders.

Figure 3. The pathogen – *Pseudomonas syringae* pv. *actinidiae*. A flagellated, gram-negative bacterium that causes the bacterial canker of kiwifruit.

effort has commenced on breeding new fruiting cultivars, rootstocks and pollinisers that are tolerant to Psa. Research activities span the short (< 3 years), medium (< 7 years) and long (< 15 years) term. The delivery of effective decision support tools for growers is the main priority for the short term, whereas integrated control options are being pursued over the medium term and tolerant cultivars over the longer term.

DETECTION & GENOMICS

Multilocus sequence analysis of global *P. syringae* pv. *actinidiae* populations has shown similarities in the strain causing secondary symptoms that include canker formation, exudate production and dieback in Italy, New Zealand and Chile (Chapman et al., 2012). Recent genomic sequencing work on *P. syringae* pv. *actinidiae* accessions that were available for sequencing suggest that the *P. syringae* pv. *actinidiae* biovar responsible for the 2008 outbreak in Italy that subsequently spread to other parts of Europe, could have arrived directly from China (Mazzaglia et al., 2012). Further genomic analysis supports a hypothesis for an independent origin for both the recent Italian and the New Zealand outbreaks of *P. syringae* pv. *actinidiae* (Butler et al., 2013).

Genomic studies suggest that all *P. syringae* pv. *actinidiae* biovars share the genetic potential for copper and antibiotic resistance (Marcelletti et al., 2011). However, the recent *P. syringae* pv. *actinidiae* found in Italy and New Zealand is inhibited in vitro by copper-based compounds and antibiotics, unlike strains from Korea and Japan (Ferrante and Scortichini, 2010).

Within New Zealand, two biovars of *P. syringae* pv. *actinidiae* that differ in virulence have been identified (Vanneste et al., 2012). One biovar results in angular leaf spots and secondary symptoms occurring in infected orchards (Psa-V), whereas the other biovar shows no symptoms beyond leaf spotting (known as Psa-LV; low virulence). The low virulence biovar appears to have been present in New Zealand prior to the arrival of the virulent biovar. Detection systems, based around PCR technology, have been developed to allow efficient detection of Psa, and classification as to what strain of Psa has been detected. Control measures have focused on the biovar that causes cankers and other secondary symptoms.

Actinidia species and cultivars vary in tolerance to the virulent *P. syringae* pv. *actinidiae* biovar responsible for the current outbreak in Europe and New Zealand. In Italy, orchards containing *A. chinensis* cultivars, particularly 'Hort16A', were associated with the highest disease incidence (Balestra et al., 2009). Similarly, in New Zealand, 'Hort16A' has been shown to be more susceptible to the pathogen than 'Hayward', an *A. deliciosa* cultivar. Another separate virulent biovar of *P. syringae* pv. *actinidiae* from Jeyu Island, Korea, that causes cankers in 'Hayward' was found to be more damaging on 'Hort16A' vines (Koh et al., 2010). *P. syringae* pv. *actinidiae* can also be isolated from asymptomatic leaves, suggesting the pathogen can survive as an epiphyte on kiwifruit host plants (Mucini et al., 2011).

EPIDEMIOLOGY

Prediction of risk of infection is a critical part of an integrated control program. Controlled studies have shown that the optimal temperature for growth of *P. syringae* pv. *actinidiae* on inoculated new growth canes is 10-18°C, with growth suppression occurring as the temperature rose (Serizawa and Ichikawa, 1993). Temperature of the host plant may also influence susceptibility. For example, application of the pathogen to auxiliary buds and lenticels on kiwifruit canes from summer to winter did not result in disease symptoms the following spring, but damaged areas of canes exposed to inoculum during late autumn and early winter showed secondary symptoms in late winter and early spring (Serizawa et al., 1994). In part this response appears to be due to the interaction of temperature on bacterial growth and host plant wound responses, with wound response activity being lower at temperatures optimum for bacterial growth (Serizawa et al., 1994). Other factors such as humidity, rainfall and wind also play a significant role in the population growth of the pathogen and rate of infection (Serizawa, 1993). This type of data has been used to construct a *P. syringae* pv. *actinidiae* risk prediction model in New Zealand to provide growers with decision support in the application of sprays and other pathogen control activities. Current work is focused on understanding the fundamental interactions between the pathogen, kiwifruit vine and environmental conditions in order to optimise prediction, management and control programmes for the disease.

CHEMICAL AND BIOLOGICAL CONTROL

Historically, copper-based compounds have played an important role in the control of bacterial diseases on kiwifruit (Balestra and Varvaro, 1997). Efficacy in the reduction of epiphytic bacteria populations on kiwifruit leaves and canes has been shown to vary between the formulations of copper applied and the rate used (Balestra and Bovo, 2003). Application of copper sprays during leaf fall can be an effective way of reducing the risk of leaf scars as infection sites in the autumn (Young, 2012). Optimisation of formulations, rates and timing by industry and commercial companies is ongoing to ensure efficacy, while minimising any negative effects on plant phyto-toxicity and fruit size reduction.

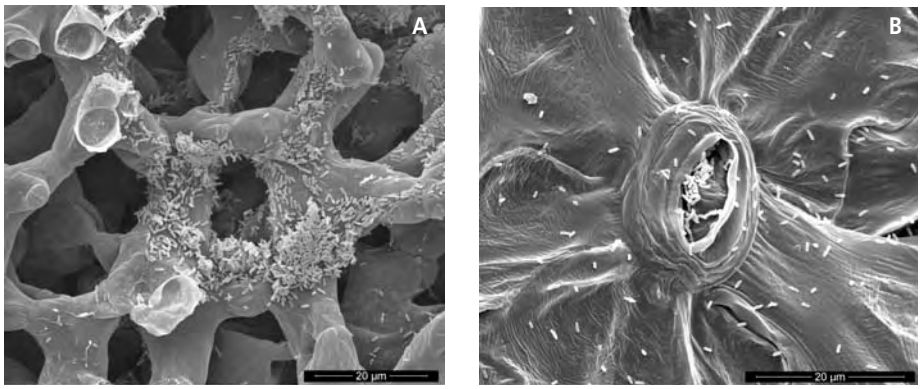
Antibiotics are another tool that has been used historically to control bacterial diseases on kiwifruit (Koh et al., 2003). Streptomycin has shown to be one of the most effective bacteriocides against *P. syringae* pv. *actinidiae* (Li et al., 2001). Due to market access restrictions, application of Streptomycin on kiwifruit in New Zealand is severely regulated to limit the number and timing of applications to ensure there is no risk of fruit residues (Vanneste, 2011). Bacterial resistance to copper-compounds and antibiotics are of concern. Monitoring is used to detect the emergence of resistance in *P. syringae* pv. *actinidiae* to both these groups of compounds.

A wide range of other protectant compounds for the epiphytic control of *P. syringae* pv. *actinidiae* have been evaluated by industry and companies in New Zealand (Reglinski et al., 2013). Where sufficient efficacy and safety data exist, application for registration can be made under the New Zealand Agricultural Compounds and Veterinary Medicines Legislation administered by the Ministry for Primary Industries (Ministry for Primary Industries, 2013). However, while these compounds may reduce epiphytic inoculum loads, albeit temporarily, in most cases they are not effective once the pathogen enters the plant tissue. Risk of fruit residues, efficacy, application method and emergence of bacterial resistance limit what products would be suitable for systemic activity against the pathogen.

Integration of plant-induced resistance into the control program for *P. syringae* pv. *actinidiae* could provide systemic protection of kiwifruit vines ahead of infection risk events. Based on greenhouse studies, Actibenzolar-S-methyl has been shown to be one of the most effective plant elicitors to improve the tolerance of kiwifruit plants to subsequent inoculation with *P. syringae* pv. *actinidiae* (Reglinski et al., 2013). Again, due to the risk of fruit residues, foliar application of this compound is restricted to times when fruit are not present on the vine.

Biological control agents may also contribute to an integrated control of *P. syringae* pv. *actinidiae*. Knowledge about their efficacy and

Figure 4. Kiwifruit leaf tissue naturally infected by *Pseudomonas syringae* pv. *actinidiae* (A) shows the accumulation of the bacterial cells on a stomata, (B) the outer surface of the leaf has been removed and the infection of the spongy mesophyll immediately underneath where a stomata was can be clearly seen. Pictures kindly provided by Paul Sutherland, Plant & Food Research Limited.



reliability under a range of environmental conditions is limited. Bacteriophages active against *P. syringae* pv. *actinidiae* are being isolated and developed for evaluation on kiwifruit (Frampton et al., 2012). Similarly work is in progress on other biological agents with various modes of action such as a plant elicitor response, pathogen competition or antimicrobial compounds production with specific activity against the pathogen. Published information on these approaches in kiwifruit is limited, but if successful, will form part of the future integrated control options.

MANAGEMENT

Management of the New Zealand incursion of the virulent strain of *P. syringae* pv. *actinidiae* has gone through several stages that are consistent with what has been used for citrus canker outbreaks in Florida (Graham et al., 2004). Firstly, the destruction of infected plant material from the orchards that initially showed signs of the pathogen was used as a means of trying to eradicate the pathogen. This was closely followed by the establishment of protocols for infected growing areas that restricted the movement of plant material and introduced hygiene practices designed to contain the spread of the pathogen. Previously, such an approach proved successful in the eradication of citrus canker from New Zealand (Sosnowski et al., 2009). However, in the case of kiwifruit bacterial canker, it is now recognised that due to the spread of the pathogen across the main growing areas it is not possible to eradicate Psa from New Zealand. Hence the focus has shifted to more integrated approaches for the prevention and management of the pathogen.

Integrated control of *P. syringae* pv. *actinidiae* in New Zealand is less than three years old. Control practices are still constantly evolving.

Figure 5. Wounding (either natural or man-made) has been shown to increase the susceptibility of the plant to bacterial canker.

Initially, the industry drew heavily on the existing control measures used in other kiwifruit growing countries infected with the pathogen. Learnings from the management of similar pathogens on other crops have also played an important role in the design of control practices. New management insights are also now being created through the significant investment in research and development that occurred soon after the pathogen was detected in New Zealand.

Orchard hygiene is expected to be an important part of any integrated management programme. The pathogen can readily overwinter on infected leaves and pruning on the orchard floor for up to 15 weeks (Tyson et al., 2012). Growers are experimenting with a range of practices to reduce inoculum risk from the orchard floor including the complete removal of fallen leaves and canes, mulching in situ, application of microbial amendments to aid litter breakdown, spraying anti-microbial compounds such as copper directly to the litter or any combination of these various treatments. Currently, no data has been published to quantify the effectiveness of managing litter to reduce *P. syringae* pv. *actinidia*e in kiwifruit orchards.

The protected culture of kiwifruit has shown benefits in reducing the amount of infection and crop loss associated with bacterial blossom blight of kiwifruit caused by *Pseudomonas syringae* (Koh et al., 2001). Trials are currently in progress examining this cultural method for the management of *P. syringae* pv. *actinidiae* under New Zealand conditions.

The role of plant nutrition and soil quality in the susceptibility of kiwifruit to bacterial canker is an area of particular interest to growers. Published literature on the role of plant nutrition in relation to kiwifruit susceptibility to the pathogen is very limited at present. In tobacco, it has been shown that the form of nitrogen affects resistance against *P. syringae* pv. *phaseolicola* (Gupta et al., 2012). In this case, nitrogen in the nitrate form enhances salicylic acid, nitric oxide and polyamine-mediated hypersensitivity response-linked defence, whereas these were compromised with ammonium. Validation of these findings on kiwifruit and other plant nutritional regimes are currently being investigated.

Vine metabolism may be an important factor in the susceptibility of kiwifruit plants to Psa. Differences in the metabolism or metabolic pathways between the different kiwifruit cultivars may even underpin the range in susceptibility or tolerance to Psa observed between the cultivars. The key metabolites appear to be associated with the phenylpropanoid and flavonoid pathways and are likely to be linked to polyamine metabolism.

In addition, observations from the field suggest a link between vine damage and the development of Psa symptoms beyond merely the wound site acting as a potential entry point

for bacteria. Is it possible the actual wound response and associated metabolic changes within the vine are somehow advancing the development of the disease?

As well as the potential for significant differences in metabolism between cultivars, the metabolic processes within a vine change throughout the year as the vine moves from a state of dormancy to vegetative and reproductive growth phases. These seasonal fluxes in vine metabolism and responses to wounding are not well understood in kiwifruit. Projects are underway to investigate the metabolite profiles of a range of cultivars to identify metabolic differences between the cultivars that may underpin Psa susceptibility.

Results to date reveal significant metabolic differences between cultivars. Measurable changes in response to girdling (indicative of a wound response) have also been recorded.

NEW CULTIVARS

Given the variation in susceptibility of *Actinidia* to virulent *P. syringae* pv. *actinidiae* strain, breeding new commercial cultivars with tolerance to this pathogen is a priority (Granger, 2011). Using 'Hayward' as a reference, it has been shown in a Chinese study that of 9 cultivars screened for tolerance to *P. syringae* pv. *actinidiae*, 6 were more tolerant and 2 less tolerant to the pathogen than 'Hayward' (Li et al., 2004). The New Zealand breeding programme has recently released 'Gold3', an *A. chinensis* cultivar with greater tolerance to bacterial canker, as a replacement for 'Hort16A'. This cultivar was originally selected to extend the marketing window for the "gold" kiwifruit category (Ferguson, 2010). Advances in the genomic knowledge of *Actinidia* will be valuable in future development of new cultivars (Datson and Ferguson, 2011).

THE 1ST ISHS INTERNATIONAL SYMPOSIUM ON BACTERIAL CANKER OF KIWIFRUIT (PSA)

November 19-22, 2013 will mark a milestone in the fight against Psa with the 1st International Symposium on Bacterial Canker of Kiwifruit (Psa). This will be the inaugural symposium in a series supported by the International Society for Horticultural Science – Commission Plant Protection, Section Pome and Stone Fruits and Working Group Bacterial Diseases of Kiwifruit – and will take place at ASB Baypark in Mount Maunganui, New Zealand.

The theme for the 3-day symposium is "Learning together means learning faster", highlighting in particular the most recent developments in the field, including the detection and understanding of Psa, management techniques, kiwifruit breeding and the impact of Psa on the supply chain. We look forward to welcoming you to New Zealand.

REFERENCES

Much of the research on Psa remains as yet unpublished due to the urgency of the response and the authors wish to acknowledge and thank all those that have contributed to advances in the understanding of Psa.

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HORTICULTURE DOWN UNDER

A number of *Chronica horticulturae* articles that feature Australian, New Zealand and Pacific Island horticulture and horticultural science may be found on the Media Centre homepage (**http://www.ihc2014.org/media_and_news.html**) on the IHC2014 website (**http://www.ihc2014.org/**) which includes information on a diversity of foods and lifestyle services across Oceania. If you are interested in reading on the different fruits and vegetables of Australia, New Zealand or the Pacific Islands or the more specific commodities like ginger, the macadamian nut, the pineapple, pyrethrum or turfgrass, then it's all available from the Media Centre. Poster material may also be downloaded from **http://www.ihc2014.org/publications.html**

Sensing Technologies in Horticulture: Options and Challenges

Nicolas Tremblay

INTRODUCTION

Intelligence is the name of the game. The more you can find out from a crop, using your eyes or other methods, the better you are able to manage it. This is what crop sensing is all about. A plant interacts with the sun's radiation in a way that depends on the plant's physiological status. Sensing may involve one or several wavebands in the ultraviolet (UV), visible or infrared part of the radiation spectrum. Crop sensing deals with the radiative budget of a leaf or canopy in a way that the human eye sometimes cannot see. In reality, how valuable is crop sensing for horticulture? What are the principles involved and the best technologies available? This article provides an overview of the topic and suggests key publications for more details.

REFLECTANCE AND TRANSMITTANCE

The radiation reaching a plant can come either from the sun, and therefore relate to "passive sensing," or from a man-made device, and therefore relate to "active sensing." Active sensing is performed from a position relatively close to the crop because of the energy required. When the radiation collected by the sensing device comes from the radiation reflected from the leaf, the sensing principle is based on "reflectance," which is pretty much what our eyes would see. However, a part of the incoming radiation is absorbed by the leaf (normally for the purpose of photosynthesis), and another part is transmitted through the leaf, where it can be collected from the other side to measure "transmittance." It is this transmittance feature that is exploited by the most common sensing device, the chlorophyll (Chl) meter. The meter is clamped onto a leaf, and light transmittance through the leaf is determined at wavelengths of 650 and 940 nm. The 650-nm wavelength coincides with the spectral region associated with maximum Chl activity, whereas the transmittance at 940 nm is used as a reference to compensate for factors such as leaf moisture content and thickness (Blackmer and Schepers, 1995). The measured value is an indication of the Chl concentration in the leaf and is often used for N fertilization management (Tremblay et al., 2009; Zhu et al., 2012).

The Multiplex fluorometer can be used for remote stress or fruit maturity determination.

Often, two wavelengths (or larger wavebands) are opposed to derive an indication of crop Chl status, either on a leaf basis, as with a Chl meter, or on a surface basis, when the measurement is taken from a distance. In the remote-sensing sector, this is known as multispectral measurement, since relatively few wavelengths or wavebands are used in the calculation of vegetation indices, for which there is a wealth of declinations, each with their pros and cons (Vincini and Frazzi, 2011). Hyperspectral approaches are also used, since some sensors can provide information from a multitude of narrow wavebands simultaneously (Haboudane et al., 2008). Multi- or hyperspectral radiometers can assess reflectance from a point whose size depends on the field of view of the sensor and the distance from the target. As well, some cameras allow an image with multi- or hyperspectral characteristics to be produced from a single shot.

THERMAL INFRARED

Infrared radiation from the sun is harmful to vegetation, and leaves have adapted to this threat by reflecting most of the infrared radiation that they receive. There is also a part of the infrared spectrum labelled "thermal" (10,400-12,500 nm) that can be emitted from vegetation, even at night. This thermal infrared radiation is a good indicator of temperature and, indirectly, of the capacity of a crop to regulate its own temperature by transpiration. This feature is therefore very helpful in identifying stress (lack of water, rooting limitations, or other biotic or abiotic stress) that can translate into stomatal closure (Moller et al., 2007). From a sensing point of view, thermal infrared is more stable at night, when the sun's irradiance does not fluctuate and create variations in measurements.

FLUORESCENCE

The Chl molecule generates fluorescence as a way to deal with the light that it receives. A relatively large fluorescence emission is characteristic of an inefficient photosynthesis process. When the photosynthetic apparatus is fully functional, a maximum proportion of the light energy is directed toward energy accumulation in sugars. But the level of incoming light is not

always equal and can sometimes fluctuate so much that the system has difficulty adapting. For example, if the system has stabilized to a low level of radiation, and suddenly a high level is received, some of the excess energy will have to be released quickly, or damage to thylakoids may occur. Fluorescence emission allows energy to be released quickly and acts as a safety valve for the plant. There is always a certain level of fluorescence emission from a leaf or canopy (Pedrós et al., 2010), in the order of 3% of the incoming light energy. The fluorescence emission emanating from the Chl a molecule is found in the red to far-red region of the spectrum (630-800 nm). When fluorescence from a surface is measured, it can be related directly to the presence of plants. Studying the signal in greater detail can even make it possible to estimate the efficiency of the photosynthesis process (Daumard et al., 2010) or the stress level (Baker and Rosenqvist, 2004; Buschmann, 2007; Lichtenthaler, 1996).

From a practical plant-sensing point of view, the proportion of "variable" fluorescence is evaluated using widely available and portable pulse amplitude modulation (PAM) fluorometers (Tartachnyk and Rademacher, 2003). This method is often used to assess the potential for CO_2 fixation, or photosynthetic capacity, and constitutes a handy and quick alternative to gas-exchange measurement procedures for stress evaluation (Lichtenthaler and Rinderle, 1988). These fluorometers work by sending a known amount of supplementary light to the plant target to perform their measurements and

UAV carrying a 6-bands multispectral camera and a thermal infrared camera.

thus fall into the category of "active" sensors. An alternative to active fluorescence sensing is passive fluorescence sensing, in which the source of light that generates fluorescence is the sun only. Instruments capable of distinguishing the tiny fraction of light coming from the canopy that is truly fluorescence are very sensitive (Liu et al., 2005; Zarco-Tejada et al., 2002).

Apart from pigments (mostly Chl), other products of plant metabolism, namely polyphenols, are evidence of the presence of stresses. Polyphenols are metabolites considered to be products of secondary metabolism and are produced by the plant in response to a number of stresses, particularly UV radiation. Polyphenols accumulate in the leaf epidermis, where they can screen out the short-wave radiation from the sun (UV) that can be harmful to the leaf structures.

The ability to measure stress-related polyphenol accumulation has emerged in the last couple of decades thanks to the development of active fluorescence technologies (Cerovic et al., 1999). When UV light reaches the Chl molecule, the light is re-emitted as fluorescence in the red to far-red part of the light spectrum. Instruments have been developed to instantaneously compare the fluorescence resulting from the action of two light sources: a source that is not screened by the polyphenols contained in the epidermis, and a UV source that is screened by the epidermis based on its polyphenol content. This measurement provides an assessment of the plant's stress level (Tremblay et al., 2012). Normally, as the Chl content goes down as a result of stress, the polyphenol content goes up. Dividing the Chl content by the polyphenol content provides a more sensitive indicator of plant stress status than using either of these two independent measurements separately. This is the basis of the N balance index (NBI). Some fluorescence-based instruments can estimate both the Chl and polyphenol contents simul-

Table 1. Summary of remote-sensing technologies suitable for horticulture, their principles of operation and key features, and examples of commercial products.

Technology	Principle	Instrument	Features	Commercial examples
Multi- and hyperspectral	Reflectance	Radiometer	Point measurement; global positioning system (GPS) needed to produce a map from a scan of individual points. Evaluation of crop biomass and chlorophyll level per unit area.	CropScan, GreenSeeker, CropCircle, Yara N-Sensor ALS
		Camera (flexibility for deployment: from unmanned aerial vehicles to planes to satellites)	Charge-coupled device detectors for imagery from a single shot. The higher the altitude, the more surface area covered. Evaluation of crop biomass and chlorophyll level per unit area.	Tetracam Mini-MCA, FluxData multispectral cameras, satellites
Thermal infrared	Emission	Camera	Same as for multi- and hyperspectral cameras. Variations in the signal in daylight conditions. Evaluation of crop temperature (mainly related to water stress).	FLIR infrared cameras
Fluorescence	Chlorophyll fluorescence	Fluorometer	Remote assessment of chlorophyll level; GPS needed to produce a map from a scan of individual points. Evaluation of chlorophyll level per unit leaf area.	FieldScout CM 1000 chlorophyll meter, Multiplex Research
	Polyphenols	Fluorometer	Remote assessment of polyphenol level (N status, fruit maturation, disease levels). Estimation of the N balance index (NBI); GPS needed to produce a map from a scan of individual points	Multiplex Research

The Dualex Scientific fluorometer is able to measure chlorophyll and leaf polyphenols simultaneously.

A 6-bands multispectral camera on a moving rail makes pictures that will be post-processed as a mosaic image of the greenhouse-grown crop.

taneously and rapidly (Cerovic et al., 2012). This technology can also be used to assess fruit properties (Ben Ghozlen et al., 2010).

NEED FOR ABSOLUTE OR RELATIVE CALIBRATION

Most remote-sensing devices will provide a measurement that, taken by itself, has little relevance for crop management. Even when a biophysical indicator such as leaf area index (LAI) or crop biomass per unit area is provided, the result does not translate into a requirement for a known level of an input (fertilizer, irrigation water, growth regulator, pesticide, etc.). Differences in growing conditions, crops, cultivars and management also influence the output of remote sensing and confound the results. For those reasons, remote sensing information may be somewhat misleading and can often produce disappointing results. The key to making valuable use of remote sensing is calibration. Successful calibrations generally account for species, cultivars and growth stages at the very least. The best example of the commercial application of absolute calibration is the Yara company's N-tester Chl meter on winter wheat and winter barley.

Because horticultural crops are much more diverse than field crops, it is a challenge to adapt crop sensing for vegetable, ornamental and fruit production (Gianquinto et al., 2006; Tremblay et al., 2011). An option to consider is the use of a relative, instead of absolute, assessment of the production factor that we want to manage. That is, we can compare (determine the ratio of) the measurements made on the crop to those made on reference plots within the production units that have been treated with a contrasting level of the input that we want to manage (Schroder et al., 2000; Samborski et al., 2009). This approach has been shown to stabilize the link between the input rate and the expected response. Reference plots can be made using sub-optimal levels (e.g. no fertilization) or high levels (e.g. saturated fertilization) of the input to be managed. There are currently attempts to aim for "natural" instead of "man-made" reference areas (Holland and Schepers, 2013).

PROXIMAL VS. REMOTE SENSING

A large number of instruments from various suppliers are available for research purposes. For large-scale crop management, however, the number of scientifically validated options is much smaller. For leaf-clip devices, only Chl meters, PAM fluorometers and Dualex meters are available. However, by definition, remote sensing is measurement "from a distance," whether that distance is in the order of centimetres, metres or even hundreds of kilometres. A sub-category of remote sensing, called proximal sensing, generally encompasses instruments that are placed on board agricultural machinery (on a tractor roof, a ramp or a trailer) and moved around in the field. When a global positioning system (GPS) is also used, the data points obtained can be positioned and interpolated to generate a comprehensive map of the crop's condition. Proximal sensing is a handy alternative to reliance on aircraft or satellite services for imagery. The most popular push-broom type devices are the GreenSeeker and CropCircle units. The Multiplex fluorescence sensor also features proximal sensing capacity. Yara's N-Sensor unit is a good example of a rooftop-based device.

Cameras, also called imagers, with single-, multi- or hyperspectral capabilities, are handy for quickly achieving a representation of an area such as a field. Because of field-of-view limitations, a camera has to be used as high off the ground as possible in a nadir (downward-looking) position to encompass the whole field or at least a significant portion of it. The nadir position helps ensure a straight image where every pixel (smallest point) represents the same surface area. When it is not possible to raise the camera high enough (because of flight regulations, for example), the alternative is to create a mosaic of overlapping shots and to assemble them in a post-processing step. This method is often necessary when an unmanned aerial vehicle (UAV) platform is used to carry the imaging system. Because they can be affordable and easy to deploy, UAVs (Lebourgeois et al., 2012; Zarco-Tejada et al., 2012) are becoming increasingly popular. In reality, however, successful operation of a UAV requires qualified personnel. Mosaicking a suite of small images is a challenge if the goal is to make sure that every image is at the exact place where it should be, given the instability of UAVs (GPS location, roll, pitch, etc.). This technique is also a challenge from a radiometric point of view. If even a small cloud passes over between the beginning and the end of the acquisition, the parameters of interest in the image will not be fully comparable from one point in the field to another. Ideally, image acquisitions should be done under a perfectly blue sky.

An unsuspected level of spatial variability generally exists in agricultural fields or greenhouses. This variability is not apparent, because we manage our production factors based on the area that will be the first to show a limitation. It follows that most of our production area receives too much of the production factors (fertilizers, pesticides, etc.) for the sake of maintaining uniformity throughout the entire area. Inefficiencies and pollution are the result. Remote sensing, together with GPS location and other newly developed tools, is an opportunity to do a better job in our production systems. Remote sensing is the key to the optimal positioning of production factors in locations where they will really make a difference

rather than where they are not required and are therefore wasted. The FARMSTAR product is a good example of a precision-farming application from a satellite platform (https://www.farmstar-conseil.fr/; in French only). Although crop sensing is suitable for greenhouses (López et al., 2012), attention needs to be paid to the many shadows created by the structural elements of the greenhouse. Shadows are likely to modify the physiology of the leaf when sensing is performed.

CONCLUSIONS

Remote sensing goes a long way in assessing crop variability, which in turn can be related to field history or local physico-chemical or environmental conditions. Hundreds of studies have demonstrated a relationship between remotely sensed parameters and crop status indicators. Yet, contrary to the field crop sector, very few commercial applications can be found in the horticultural sector. This issue can be addressed by the proper choice of technology and the standardization of procedures (absolute or relative calibration). Spatial variability is an inherent reality of agricultural and horticultural systems. Horticultural crops are managed intensively because of their high value, and they often do not show spatial variability levels as great as those found in more extensive crops. This low apparent variability is simply an indication that inputs are applied at a high intensity. High input levels tend to smooth out the natural variability that would show up with lower levels. As well, a better future lies in improved "reactive management," which accounts for the unique effects of seasonal features (temperature, rain, sequence of events, etc.). Therefore, remote sensing is likely the key to achieving more-sustainable performance in horticultural crop production.

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The Paradox of Horticulture in the Pacific Islands

Richard Markham

INTRODUCTION: SEAFARERS AND HORTICULTURISTS

When the ancestors of today's Polynesian and Melanesian people set out, probably from East and South-east Asia, to colonise the Pacific islands, these intrepid seafarers carried with them in their canoes the planting material of various crops that would ensure their subsequent survival. Among the significant crops were taro (*Colocasia esculenta*), plantains and cooking bananas (*Musa* sp., of various genome groups but especially AAB and ABB), yams (*Disocorea alata* and *D. esculenta*), breadfruit (*Artocarpus altilis*), giant taro (*Alocasia macrorrhizos*), and giant swamp taro (*Cyrtosperma merkusii*). As well as being master navigators and fisherfolk, these colonists were also accomplished cultivators, who established well-nourished, horticulture-based societies, as documented by early European navigators in the Pacific, such as British explorer and cartographer Captain James Cook (1728-1779), who arrived in the region in the mid-eighteenth Century.

Taro remains the preferred staple crop in several Pacific islands, notably Fiji and Samoa, as well as some islands of Hawaii, where sophisticated, gravity-fed irrigation systems were developed for its cultivation. However, following their contact with European seafarers and traders, Pacific islanders enthusiastically adopted a number of crops originating from the American tropics, which were compatible with traditional production systems. These include: sweet potato (*Ipomoea batatas*), which has become the dominant starchy staple in Papua New Guinea and Solomon Islands; cassava (*Manihot esculenta*), which is increasingly important as a cash crop and staple food in Melanesia; and tannia (*Xanthosoma sagittifolia*), which is becoming a substitute for taro throughout the region, wherever poor conditions make the traditional crop too hard to grow.

Recent social trends in the Pacific islands have included a rapid increase in total population, migration from the more remote islands to growing cities, along with rising food imports to supply new staple foods, such as rice and potatoes. However, the great majority of Pacific islanders, probably two-thirds of the total population, still live in rural communities, whose basic food security depends on locally grown horticultural crops.

The Pacific islands were first drawn into the global economy during colonial times as producers of commodities such as copra (produced from coconuts), sugar, coffee and cocoa. However, as Pacific islanders have made their own choices in making the transition from subsistence to a cash-based economy, they have naturally turned to various horticultural crops as a source of local livelihoods and export earnings. In Fiji, these include taro, papaya (*Carica papaya*) and ginger (*Zingiber officinale*), while in Tonga, watermelons (*Citrullus lanatus*) are of increasing importance, as is vanilla (from the orchid *Vanilla planifolia*), while Kabocha squash (*Cucurbita maxima*) is in decline. Taro used to be by far the most important export of Samoa, until the advent of taro leaf blight (caused by *Phytophthora colocasiae*). Now exports of 'finger' bananas, limes and breadfruit are being

Preparing taro for export from Fiji.

Traditional irrigated fields of taro in Hawaii.

Preparing ginger for export at Nabua, Fiji.

developed. Cook Islands currently exports papaya, watermelon and various tropical flowers.

PACIFIC ISLAND HORTICULTURE IN CRISIS

There is a most unfortunate paradox, however, in the status of horticulture in the Pacific islands today. Although the majority of smallholders in the Pacific islands are expert horticulturists, whose inherited skills have assured the food security of their communities over several thousand years (and continue to support the majority of the population today), almost all the 'commercial' horticultural industries in the region face some sort of crisis of sustainability, ecological or economical. Although the manifestation of the crisis may be different in each case – for instance expressed in terms of declining profitability or biosecurity issues – the underlying causes are usually pest or disease outbreaks and, beneath these again, declining soil health and fertility.

Exports of taro from Fiji have encountered increasing problems with nematodes (*Radopholus similis*) and 'root rots' (caused by *Erwinia chrysanthemi, Pythium* spp. and other pathogens). These have led to biosecurity penalties in New Zealand and Australia (the principal markets) that have threatened the viability of the industry. Meanwhile, the search for more fertile soils to counter problems of declining quality and productivity has led to record rates of deforestation on the 'garden island' of Taveuni, the main source of Fiji's taro exports. A similar syndrome has affected ginger, in which repeated cropping on the same land has led to a fall in soil fertility and the build-up of soil-borne pests and diseases, again principally nematodes (especially *R. similis*) and *Pythium* spp. This has led farmers to abandon the crop in one area as fast as it is taken up by their counterparts in another.

Invasive pests and diseases also pose major problems. Taro exports from Samoa were wiped out by taro leaf blight in the 1980s and, although blight-tolerant cultivars are now available, an adequate supply of taro cannot be secured to sustain the resumption of exports. Seeking alternatives, a new generation of exporters are struggling to find viable means to control scab moth (*Nacoleia octasema*) on banana and scale insects on limes that meet the organic standards that they have chosen to pursue in their search for higher-value markets. In Tonga, the squash export industry to Japan was already trapped in a spiral of escalating costs as producers battled to control powdery mildew, whitefly and spider mites, before competition from Mexico dealt the fatal blow to the industry. Throughout the Pacific islands, local producers of 'Western' vegetables – tomatoes, peppers, cabbage, lettuce – face difficulties meeting the quality standards of supermarkets and of the burgeoning tourist and hospitality sector, and are turning increasingly to pesticides to provide the security of supply and the unblemished product that such consumers demand. With smallholders lacking an adequate understanding of the risks of pesticides, and operating in a largely unregulated environment, inappropriate use of pesticides constitutes an urgent threat to both human health and the environment.

A HOSTILE CLIMATE FOR HORTICULTURE

The climate of the Pacific islands is also not as favourable for horticulture as a casual visitor might suppose. While average temperatures and rainfall suggest a benign environment, at least for tropical vegetables, these figures conceal both temporal and spatial extremes. The alternating cycles of El Niño and La Niña weather patterns tend to bring periods of drought or excessive rainfall, which can last several years, to island countries that have few reserves of food and finance to carry them through such extended periods of unfavourable weather. Entire atoll islands may become short of fresh water over an extended drought. This was the case in Tuvalu, where a state of emergency was declared in late September 2011 and drinking water had to be flown in from New Zealand and Fiji.

Rod Drew, IHC2014 Co-President, inspects root rots destroying papaya plantations in Fiji after severe floods in 2012.

Atolls may also suffer long-term problems as the 'lens' of fresh water below the island is depleted and incursions of sea water contaminate it, rendering the water unsuitable for irrigating crops in the future and eventually even for human consumption. On the other hand, 'high islands' (i.e. those with mountains of volcanic origin) tend to have a side exposed

Atolls, such as the island of Tarawa, Kiribati, are especially vulnerable to depletion and contamination of the freshwater 'lens' beneath.

Differences in cloud- and forest-cover accentuate the contrast between the wetter and drier sides of 'high islands' in the Pacific (Viti Levu, Fiji).

Stink lily, formerly used as a 'famine reserve' food, can still be found in bush fallow (Vanua Levu, Fiji).

to the prevailing trade winds that is too wet for most horticultural crops and a side that is in a 'rain shadow' and is too dry, at least for rain-fed production.

The 'normal' vagaries of Pacific island climates are then often exacerbated by extreme climatic events. Such events appear to be occurring more frequently and becoming more severe with global climate change, or their effects may be more destructive as poor land-use planning and population pressure leads to deforestation of watersheds, reduced infiltration of water and increasing potential for soil erosion. 'Once-in-a-lifetime' flooding on the western (and normally drier) side of Fiji in January 2009 was followed by three more severe floods during the period January to April 2012. The last event completely halted Fiji's exports of red papaya, the country's third-most-important agricultural export (after sugar and taro), and replacement plantings were just coming into production when Fiji was struck by Cyclone Evan, in December 2012.

Traditionally, Pacific islanders have coped with these periods of unfavourable weather by having a diverse range of 'reserve' crops, which, although less preferred in terms of taste or yield, may be more resilient in the face of adverse conditions. A good example is giant swamp taro, which tolerates waterlogging and salinity. On some atolls, such as the Gilbert Islands of Kiribati, where these conditions are limiting to horticulture even in normal times, giant swamp taro is the preferred starchy staple, along with breadfruit, and is routinely grown in brackish ponds. Elsewhere it survives in naturally waterlogged areas and is harvested only when other crops have failed. Other 'famine reserve' crops, such as bitter yam (*Dioscorea bulbifera*) and spiny yam (*D. nummularia*), may be wild-harvested from forested areas. However, a limitation on the use of such crops is that many contain significant levels of toxins, especially in the case of stink lily (*Amorphophallus paeoniifolius*) and Polynesian arrowroot (*Tacca leontopetaloides*); moreover, the traditional knowledge of how to prepare them safely for human consumption is being lost, perhaps along with the inclination to make the effort to do so.

THE HUMAN FACTOR IN HORTICULTURAL DEVELOPMENT

Part of the paradox of Pacific horticulture is that horticultural research and development in the region is severely constrained by the shortage of skills and information support systems. Despite the strong horticultural tradition in the region, there is a desperate lack of entrepreneurs ready to take up the opportunities offered by commercial horticulture and a shortage of people with appropriate formal skills and education to offer technical support. National fruit and vegetable strategies developed in Samoa, Fiji and Vanuatu, with the assistance of the Food and Agriculture Organization of the United Nations (FAO) and the International Trade Commission, have identified the low prestige of horticulture and the resultant unwillingness of young people to enter agribusiness and related professions as major limitations on the development of the sector.

Intensive production of traditional root crops under coconut in Tonga.

A plot in Fiji cleared from bush fallow according to traditional 'slash-and-burn' practices and planted with taro.

Commercial growers, in this case of taro and ginger, with short-term leases have little incentive to conserve or improve the soil.

This may be a relatively modern trend, but other aspects of the horticultural crisis appear to be deeply rooted in the traditional social system of land tenure and community obligations. For instance, the prevalent form of land-use in Melanesia involves various forms of 'shifting cultivation' in which plots for horticulture are cleared from forest by 'slash and burn', cultivated for a few seasons and then, as productivity declines, allowed to revert to a period of 'bush-fallow', sometimes lasting over twenty years, to recover their fertility. Traditional horticulturists are thus not accustomed to actively managing either the soil-borne pests and diseases that tend to accumulate in permanent horticulture or the various dimensions – physical, chemical and biological – of soil health and fertility. When growers observe the inevitable decline in productivity that occurs in repeated cultivation, their inclination is to abandon the land and let nature do the restoration work.

Although the exact system of land tenure varies between islands and cultures, the cycle of cultivation and bush-fallow in most of the Pacific islands is typically managed by elders of the community who control large tracts of land, allocating it to individuals and families according to need and status. Community members are expected to feed their own family and generate a surplus to support various community events, typically involving a feast of local produce and often organized in the name of the village elders or the local church. Some churches even demand a formal 'tithing' system, in which a fixed proportion of all produce is contributed to the church. Such systems have been successful over many generations in assuring the food security of communities, including providing a social 'safety net' for the old, infirm and those otherwise unable to farm or fish for themselves. However, these same systems now tend to discourage individual farmers from producing a visible surplus, fearing that it is likely to be immediately sequestered for community welfare.

The system of re-allocation of land by the elders discourages both long-term 'land care' (such as practices to conserve soil organic matter and fertility) and investment in basic land improvement (such as fencing to keep out the feral pigs that can be abundant and destructive on some islands). Even where a formal system of commercial leases is available, these can be difficult and expensive to initiate and short in duration, leading the tenant to 'mine' the soil resources, rather than maintain them. Leases can also be subject to abuse, for instance through attempts to raise the rent, when an enterprise appears to have become more profitable than initially anticipated.

A notable exception to these trends is found in Tonga, where every male citizen is allocated 8.25 acres (3.34 ha) of land on which to support his family. These allocations are 'permanent' (or at least long-term), providing an incentive to take good care of the land. Some farmers have responded by developing intensive horticultural systems, sometimes combining both fruit and vegetable crops, that are highly productive. However, the system does include its own inherent limitations. One of the most important is the need for larger commercial producers to enter into a series of agreements if they wish to consolidate sufficient acreages to permit larger-scale, more efficient production.

BUILDING ON THE PAST IN MOVING TO THE FUTURE

Some traditional systems include elements that can be used as a foundation for commercial horticulture. For instance, in Solomon Islands, some farmers clearing 'bush' for horticulture gather the plant residues into heaps, effectively compost heaps, and plant their crops onto and around the heap. Typically a mix of crops will be planted, with contrasting growth forms making the most of the space and providing a mix of foods. For example, cuttings of shrubby 'island cabbage' (*Abelmoschus manihot*) or cassava will be planted on top of the heap (providing leafy 'greens' and starchy tubers, respectively), while the vines of sweet potato (providing both edible leaves and tubers) or melons (*Cucumis melo*) cover the soil. Taro, yams and various other vegetables may be added into the same system. An innovative and passionate agricultural educator in Solomon Islands, the late Joini Tutua, former Minister of Education and Minister of Agriculture in that country, used this system as the starting point for a campaign, in collaboration with the Kastom Gaden farmer's association, to promote compost-making and other elements of sustainable horticulture.

On atoll islands, organic matter is also actively collected for horticulture. Soils on these islands are typically very poor, consisting predominantly of sand or coral rubble. Leaves of breadfruit, fronds of coconut palms and various other organic debris have traditionally been gathered into pits, cut into the rubble, and used for production of taro, giant swamp taro, bananas and other crops. A project recently funded by the Australian Centre for International Agricultural Research (ACIAR) in Kiribati is encouraging market gardeners to gather leaves in the same way but to add pig manure to promote more rapid formation of compost. Since organic matter in South Tarawa is in particularly short supply, a proportion of cardboard is even added to the mix. In a key modification of the traditional system, producers are encouraged to build the compost into raised beds, to improve drainage and reduce salt build-up, rather than placing it into pits.

Community groups in Kiribati learn how to make compost from leaves, manure and other organic matter.

The late Joini Tutua, a forceful advocate of sustainable, ecologically based farming practices in Solomon Islands, pictured here with local cultivars of 'island cabbage'.

THE SEARCH FOR SOLUTIONS: CONVENTIONAL TECHNOLOGIES IN A NEW SETTING

In general, the technologies needed to tackle the horticultural problems in the Pacific islands are familiar enough in other regions and, from a technical point of view, require only relatively minor adaptation to make them suitable for local conditions. On the other hand, the challenge of encouraging adoption should not be under-estimated. This may involve changing 'hearts and minds', both among smallholder producers and consumers, and may involve an intensive and innovative extension effort, a special effort to understand local social and economic constraints, and plenty of time to introduce new knowledge and to change attitudes.

The first imperative is to provide more reliably productive crop cultivars that are resistant to locally prevalent pests and diseases and adapted to Pacific climates. In the case of traditional, vegetatively propagated crops, the Centre for Pacific Crops and Trees (CePaCT), the genebank of the Secretariat of the Pacific Community (SPC), has been particularly effective in gathering germplasm of taro from the Pacific islands and beyond, assuring its conservation and promoting its exchange. The Centre now has the world's largest collection of taro in tissue culture. The 'Tarogen' (taro genetic resources) project provided a platform for a successful breeding program in Samoa, which is now

Farmers discuss the merits of various vegetable production technologies with researchers, extension workers and input suppliers in Solomon Islands.

delivering cultivars that are both tolerant of taro leaf blight and acceptable to farmers and local consumers. An extra effort is now needed to identify a subset of these cultivars that can withstand the rigours of export handling or processing and are thus suitable for commercial markets. Further effort is needed to multiply and sell to farmers a sufficient quantity of uniform, high quality planting material to support a commercial export industry. This alone may require a change of mindset among farmers who are accustomed to obtaining planting material for free from neighbours or from the previous year's crop.

In the case of 'western' vegetable crops, such as tomato and capsicum, one problem has been that local input markets are too small to interest commercial seed companies, while government research and extension services lack the systems to test, register and disseminate new cultivars, let alone breed new ones of their own. The result has been that retailers and agro-input suppliers have tended to bring in vegetable seed haphazardly, often importing cultivars that are better adapted to temperate or sub-tropical conditions in New Zealand and Australia. Following a successful pilot project in Solomon Islands, the World Vegetable Centre is now working with research services in Fiji, Samoa and Tonga as well, again with support from ACIAR, to import and evaluate a range of vegetable cultivars, starting with tomatoes, that should be better adapted to local conditions. In Solomon Islands the World Vegetable Centre complemented their work on farms with a broader public awareness effort, using a range of media including local radio and street theatre, to explain the health benefits of consuming more vegetables.

To tackle the problems of emergent pests and diseases, other projects supported by ACIAR are promoting the use of integrated pest management (IPM) approaches, and finding alternatives to the incautious use of chemical pesticides. An initial project on developing IPM approaches in brassicas, in Fiji and Samoa, has paved the way for an FAO Technical Cooperation Project to reduce the use of undesirable chemicals in these crops. Bearing in mind the need to develop new understanding and attitudes, season-long farmer field schools have been used as a means to introduce farmers to the concepts of monitoring pests and natural enemy abundance, and using an understanding of 'agro-ecosystems' as a basis for rational decision-making on pesticide applications. Subsequently, the research effort has been broadened to include solanaceous crops and additional Pacific island countries. A major focus of the current project is to develop research capacity and research-extension linkages, both in individual countries and by developing the capacity of SPC to provide support on a regional basis.

As a first step towards countering climate-related problems, simple drip irrigation systems were tested by the World Vegetable Centre project with smallholders in the Guadalcanal Plains of Solomon Islands, with the rather modest objective of extending the production season for vegetables into the dry season. Similar systems will now be tried on the dry northern and western sides of Fiji's main island, Viti Levu, and in Samoa. However, even with simple, robust, gravity-fed systems there are trade-offs to be made and recommendations to be tested. Drippers and accessories from industrialized countries like Australia and New Zealand are often regarded as too expensive by smallholders, yet cheaper alternatives sourced for the project from India have proven to be insufficiently durable.

Similar trade-offs face a project funded under

Taro breeder Tolo Iosefa in Samoa likes to offer his candidate, blight-tolerant cultivars to farmers at an early stage for on-farm evaluation.

ACIAR's agribusiness initiative, PARDI, to test systems of protected cultivation on the wetter side of Fiji and other islands. In the past, horticulturists in Fiji, Samoa and Tonga have tended to import polythene tunnels or screen-house structures from New Zealand, but a combination of new trading patterns and economic forces is encouraging a new generation of growers to try much cheaper structures from China. As well as the question of overall durability, such structures, whatever their origin, raise

Farmers prepare an 'agro-ecosystem analysis' as a basis for deciding whether or not to apply pesticides in the course of a Farmer Field School conducted near Sigatoka, Fiji.

Farmers test a low-cost drip irrigation kit for dry-season production of vegetables near Honiara, Solomon Islands.

A drama group in Solomon Islands prepares a short piece of street theatre to explain the health benefits offered by vegetables.

the question of how best to cope with extreme weather events, such as cyclones and tropical storms. Evidently, an important objective of a polythene tunnel or screen-house is to protect the crop from heavy rain. But at what stage should a grower decide to sacrifice his crop and save at least the frame of the structure? Only a combination of formal local research and commercial experience, over some years of variable weather, can inform such decisions.

In the meantime, perhaps the most fundamental problem to tackle is that of sustaining soil health. In a formal sense, this is a novel concept in the South Pacific region and one that demands that farmers be introduced to basic ecological processes that are cryptic in the field and, perhaps even in industrialized countries, only fully understood by a small community of enthusiasts. The foundations for current work in this area were laid by two European Union-funded projects: the Pacific Regional Agriculture Programme (PRAP) and then the project for Development of Sustainable Agriculture in the Pacific (DSAP). These projects promoted the use of multi-purpose agroforestry trees (such as *Gliricidia sepium*), green manure cover crops (such as the velvet bean, *Mucuna pruriens*), and vetiver grass (*Chrysopogon zizanioides*) for erosion control. It is not clear how widely these practices have been adopted and established in the mindset of farmers; however, these key 'indicator species' are now widely disseminated in the Pacific islands and there is an informal network remaining of national researchers with soil research experience.

More recently, an ACIAR-funded project in Fiji, led by researchers from the Queensland Department of Agriculture, Fisheries and Forestry, made considerable advances in providing a better understanding of the soil-borne pathogens of ginger and in introducing basic practices such as rotations with non-susceptible hosts (such as cassava) and the use of pest-free planting material (assured by production in a pest-free area or by hot water dipping). These results and recommendations have been handed over to the various stakeholders, private- and public-sector, in the Fijian ginger industry and seem to be gaining some acceptance among farmers.

Now the same team, in partnership with SPC and the respective national ministries, is tackling similar problems in the taro export industries of Fiji and Samoa. In this initiative, the focus is on restoring the organic matter content in soils, which can become disastrously depleted by repeated cropping under humid tropical conditions. Depletion of organic matter results in reduced nutrient- and water-holding capacity and a shift in the biological composition of the soil flora towards pathogenic species, which underlies the pest and disease issues in both ginger and taro. Reversing this trend is simple enough in principle and pays immediate dividends in terms of crop yield and quality, but in practice, finding the best resources to restore soil health, in terms of costs of labour and purchased inputs that seem reasonable to farmers, can present a challenge.

The Australian NGO Organic Matters Foundation developed the concept of Soil School™ and has been running these courses for several years in conjunction with the TeiTei Taveuni farmer's association in Fiji, familiarising the farmers with the basic concepts and practices. Now an

Large-scale commercial growers of vegetables in Fiji's Sigatoka Valley are using relatively low-cost protective structures imported from China.

Velvet bean is increasingly used as a green manure cover crop to suppress weeds and restore soil fertility, in this case in Tonga.

Extension workers in Taveuni, Fiji, demonstrate to members of the TeiTei Taveuni farmer's association how a chipper-mulcher machine can be used to prepare soil amendments from various kinds of organic waste.

ACIAR-funded project is conducting formal trials to establish the most effective combinations of organic residues and purchased fertilisers. At present, introducing rotations with velvet bean appears to be the single most promising tactic. However, more radical measures, including the use of chipper-mulchers to incorporate material from woody weeds and agroforestry trees and the use of biochar as a more durable form of soil carbon, are also being evaluated. Once more, however, the greatest challenge may not be the testing of candidate technologies so much as persuading farmers to invest time and money in taking care of the soil, a resource that they may have previously taken for granted.

THE ROLE OF THE INTERNATIONAL SOCIETY FOR HORTICULTURAL SCIENCE (ISHS)

The upcoming International Horticultural Congress in Brisbane in 2014 is providing an opportunity and stimulus to bring Pacific island horticulturists into the global network of their counterparts. In the first instance, SPC took out a 'regional membership' (the first of its kind at a global level) on behalf of its twenty-two member countries and territories, providing them with access to the Society's wealth of publications and other information resources. Representatives of the Pacific islands then participated in the Council meeting in Portugal in 2010 and a small group from the islands organised a workshop on prospects for the development of horticulture in the Pacific islands during the subsequent Congress.

A program for capacity building for Pacific island horticulturists in the intervening period, leading up to the Brisbane 2014 Congress, was approved at the Heads of Agriculture and Forestry Services meeting in Nadi, Fiji, later in 2010. Horticulturists from various island nations have subsequently participated in ISHS symposia in India and Thailand, as well as the Joint Conference of the Australian and New Zealand Horticultural R&D Societies, which was held in Lorne, Victoria, in September 2011.

The organizers of the 2014 International Horticultural Congress have truly taken to heart the cause of supporting the development of horticulture in the Pacific islands. They have made the Oceanic islands full partners in the organization of the Congress, with a Co-President from Tonga, Luseane Taufa, representing their interests, as well as assuring full participation of Pacific island representatives in the various committees supporting the development of the Congress.

While these measures are perhaps modest in comparison with the scale of the challenges set out above, it is hoped that this concerted international effort will help to turn the tide. Despite the challenges of economic forces, demography and climate change (to mention just a few), perhaps Pacific horticulture is on the threshold of a new era, in which the traditional skills of Pacific island horticulturists can be re-directed into a sustainable, modern form of commercial horticulture, with resulting benefits to community, health, prosperity and the beautiful-but-fragile environment of the Pacific islands. In conclusion, perhaps one key to resolving the seeming paradox of Pacific horticulture is to start by understanding how very different traditional, community-based horticulture is from its modern, market-oriented counterpart and by acknowledging how profound are the changes that are needed, not just in technology, but in knowledge and attitudes, if this transition is to be achieved successfully.

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Pepper (*Capsicum* spp.) Germplasm Dissemination by AVRDC – The World Vegetable Center: an Overview and Introspection

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Peppers (*Capsicum* spp.) are an important cash crop for smallholder farmers in developing countries. Hot pepper (chili) dominates world spice trade, and sweet pepper has become a popular vegetable and cash crop in the tropics for smallholders. Among the five cultivated species of the genus *Capsicum*, *C. annuum* (both hot and sweet pepper) is the most widely cultivated. According to estimates for 2011, peppers (dry and green) were cultivated on about 3.8 million ha, out of which 3.3 m ha were in developing and less developed countries of Asia (2.5 m ha) and Africa (0.8 m ha) (FAOSTAT, 2013). AVRDC – The World Vegetable Center, plays a major role in the conservation and distribution of vegetable germplasm held in the public domain. Headquartered in Taiwan, the institution initially was set up in 1971 as the Asian Vegetable Research and Development Center (AVRDC). The Center executes long term breeding projects in many vegetables including peppers, which contribute to improving nutritional security and improved income in the developing world. The Center holds a total of 8,165 accessions of *Capsicum*. This is the world's largest collection held by a single institution, comprising about 11% of all accessions held globally (Ebert, 2013). Over the past 25 years, the pepper breeding program at the Center has focused on improving *C. annuum* species (both hot and sweet peppers) by incorporating pest resistance, developing male sterile lines and heat tolerance. A total of 29,980 germplasm materials have been distributed, comprising 6,008 genebank accessions (20%) and 23,972 improved advanced lines (80%). National public and private sector partners have used AVRDC seed materials in various ways. Since 2005, based on AVRDC's germplasm and improved lines, a total of 51 open pollinated and hybrid cultivars of hot and sweet peppers have been released and commercialized by both public and private sectors in countries of South Asia, West Africa, Central Asia and the Caucasus. We have learned from seed distribution experiences that a major multiplying impact of our improved lines can been achieved in developing countries when people working in both public and private sectors have enhanced skills, for example, in India. Hence, capacity building of human resources in less developed and developing countries will remain an integral part of the Center's pepper breeding research cum developmental strategies.

INTRODUCTION

Peppers (*Capsicum* spp.) are an important cash crop for smallholder farmers in developing countries such as Ethiopia, Nigeria, Ghana, China, India, Pakistan, Bhutan, Indonesia, Cambodia, and Thailand. Hot pepper (chili) dominates today's world spice trade, and sweet pepper has become a popular vegetable in the tropics. Among the five cultivated species of the genus *Capsicum* (*C. annuum, C. frutescens, C. chinense, C. baccatum, C. pubescens*), *C. annuum* (both hot and sweet pepper) is the most widely cultivated. According to estimates for 2011, peppers (dry and green) were cultivated on about 3.8 million ha, out of which 3.3 m ha were in developing and less developed countries of Asia (2.5 m ha) and Africa (0.8 m ha) (FAOSTAT, 2013). Based on fruit shape and size, more than 20 market types of hot and sweet peppers are known. These can be grouped into five broad market categories: (i) fresh market (green, red, multi-color whole fruits), (ii) fresh processing (sauce, paste, canning, pickling), (iii) dried spice (whole fruits and powder), (iv) industrial extracts (paprika/oleoresin, capsaicinoids and carotenoids) and (v) ornamental (plants and/or fruits) (Poulos, 1994). These market types reflect that, besides conventional nutritional food uses, there are a number of alternative food (e.g. paprika oleoresin, medicines) and non-food (e.g. defense, spiritual, ethno-botanical) uses for peppers.

AVRDC – The World Vegetable Center plays a major role in the conservation and distribution of vegetable germplasm held in the public domain. Headquartered in Taiwan, the institution initially was set up in 1971 as the Asian Vegetable Research and Development Center (AVRDC). With the geographical expansion of its activities in the 1990s and 2000s, the Center now operates regional offices in Africa (established in 1992 in Tanzania), East and Southeast Asia (established in 1992 in Thailand), South Asia (established in 2004 in India), Central-West Asia and North Africa (established in 2010 in the United Arab Emirates). In addition, the Center has project offices around the developing world (Bangladesh, Cameroon, Mali, Indonesia, Fiji, Solomon Islands and Uzbekistan). The Center executes long term breeding projects in many vegetables including peppers, which contribute to improving nutritional security and improved income in the developing world. The Center makes its germplasm accessions and improved inbred lines derived from its breeding programs available as international public goods for global use (Keatinge et al., 2012) to the world community including public and private sector researchers, most of whom work in developing countries.

This paper focuses on the results of a survey of the Center's *Capsicum* seed distribution during the past decade, as well as information on the uses of peppers in different parts of the world. Some examples of successful use of supplied seed samples and lessons learned are given and future needs concerning ongoing collection of *Capsicum* germplasm and its conservation and utilization are discussed.

CAPSICUM GERMPLASM HOLDINGS AND CHARACTERIZATION

The Center holds more than 67,800 accessions of vegetable germplasm comprising 170 genera and 436 species from 156 countries of origin. With a total of 8,165 accessions, AVRDC's *Capsicum* collection is the world's largest held by a single institution, comprising about 11% of all accessions held globally (Ebert, 2013). These accessions belong to 11 species and the largest number of accessions is available for *C. annuum* (66%), followed by *C. frutescens* (8%), *C. chinense* (6%), *C. baccatum* (5%) and others (Fig. 1). Accessions grown out for regeneration are usually fully characterized with morphological and horticultural descriptors to allow

Figure 1. *Capsicum* species (holdings) and percentage accession characterized.

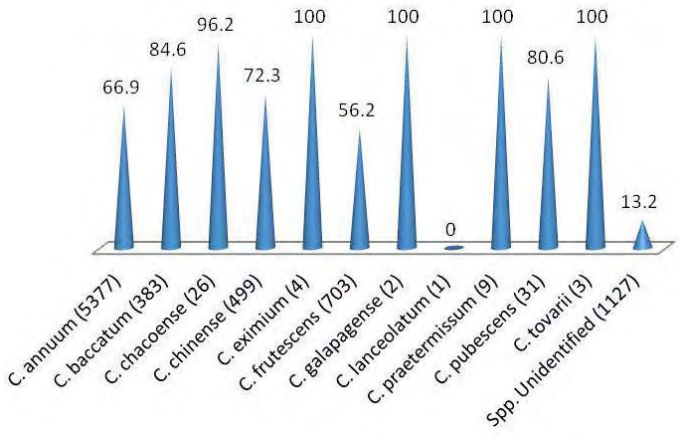


Figure 2. Seed distribution by recipient country during the period 2001 to 2012.

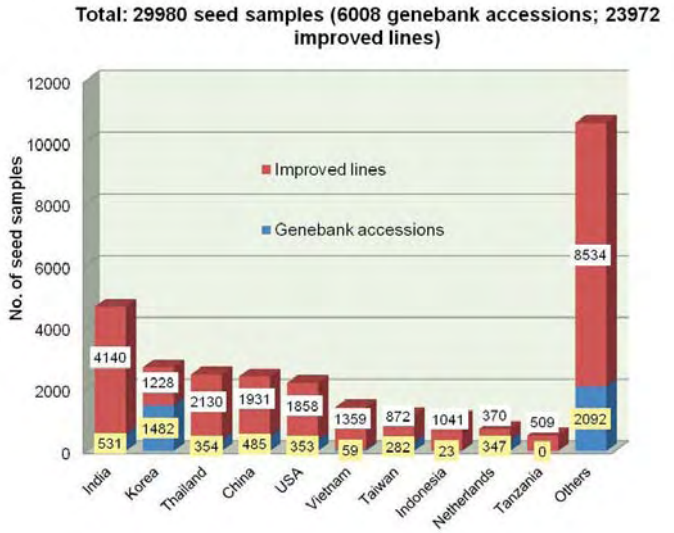
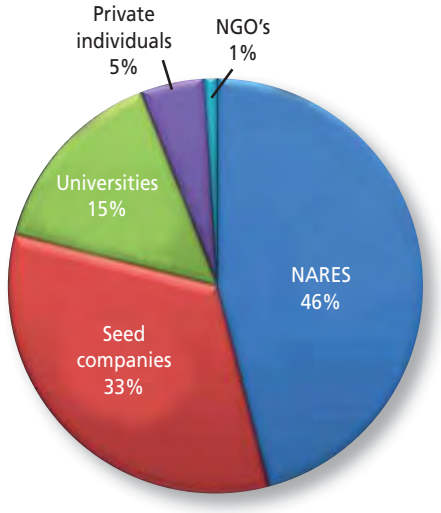


Figure 3. Seed distribution percentage by recipient category.



seed requesters to make an informed choice. The majority of accessions of the different *Capsicum* species have been fully characterized. However, a major effort is needed to regenerate, characterize and determine the taxa of the relatively large group of accessions (13%) without species identification (Fig. 1). Overall, the regeneration and characterization backlog is close to 40%.

SEED DISSEMINATION

Over the past 25 years, the pepper breeding program at the Center has focused on improving *C. annuum* species (both hot and sweet peppers) by incorporating pest resistance, developing male sterile lines and heat tolerance. A detailed search of *Capsicum* germplasm distribution from 2001 to 2012 in our database was conducted and data were analyzed. For this purpose, for each year the shipment lists were revisited and duplicate samples during the same year were ignored in the sample counting process. This analysis did not include seed samples supplied by our regional offices.

A total of 29,980 germplasm materials were distributed, comprising 6,008 genebank accessions (20%) and 23,972 improved advanced lines (80%). The top ten recipient countries of *Capsicum* germplasm were: India (4,671; 15.6%), Republic of Korea (2,710; 9.0%), Thailand (2,484, 8.3%), China (2,416, 8.1%), USA (2,211, 7.4%), Vietnam (1,418; 4.7%), Taiwan (1,154; 3.8%), Indonesia (1,064; 3.5%), The Netherlands (717; 2.4%) and Tanzania (509; 1.7%) (Fig. 2). A total of 10,626 acces-

Table 1. List of additional 113 countries/islands/territories that received pepper seeds from AVRDC – The World Vegetable Center during 2001-2012.

Geographical region	Name of the country (germplasm accessions/breeding lines/total)
East-South Africa	Angola (0/60/60), Botswana (0/129/129), Ethiopia (55/241/296), Kenya (0/190/190), Madagascar (0/9/9), Malawi (0/95/95), Mauritius (1/256/257), Mozambique (0/20/20), Namibia (0/50/50), Reunion (0/18/18), Rwanda (0/20/20), Lesotho (0/95/95), Somalia (0/4/4), Sudan (0/43/43), Uganda (4/288/292), Zambia (3/110/113), Seychelles (0/49/49), South Africa (82/307/389), Suriname (0/12/12), Swaziland (0/20/20), Zimbabwe (0/81/81)
West-Central Africa	Benin (0/31/31), Burkina Faso (0/55/55), Cameroon (0/55/55), Cote d'Ivoire (0/40/40), Democratic Republic of Congo (0/25/25), Gambia (0/15/15), Ghana (13/380/393), Liberia (0/10/10), Mauritania (0/23/23), Niger (0/156/156), Nigeria (11/43/54), Senegal (0/30/30), Sierra Leone (0/10/10), Togo (0/40/40)
Europe	Austria (46/0/46), Belgium (0/10/10), Czech Republic (1/0/1), Denmark (0/5/5), Finland (110/0/110), France (107/55/162), Germany 25/194/219), Greece (0/31/31), Hungary (3/0/3), Italy (163/82/245), Poland (5/0/5), Serbia (48/0/48), Slovenia (15/0/15), Spain (140/3/143), Sweden (60/0/60), Switzerland (0/1/1), Turkey (36/172/208), United Kingdom (20/35/55)
Central-West Asia & North Africa	Armenia (20/83/103), Azerbaijan (0/41/41), Bahrain (0/10/10), Egypt (0/82/82), Georgia (0/23/23), Iran (61/28/89), Israel (1/21/22), Jordan (4/5/9), Kazakhstan (223/18/241), Kyrgyzstan (0/15/15), Oman (0/95/95), Qatar (0/19/19), Saudi Arabia (0/57/57), Tajikistan (0/70/70), Turkmenistan (0/37/37), Tunisia (0/47/47), United Arab Emirates (0/3/3), Uzbekistan (0/56/56)
South-East-Southeast Asia	Afghanistan (0/83/83), Bangladesh (81/270/351), Bhutan (19/84/103), Cambodia (9/349/358), North Korea (0/81/81), Japan (75/281/356), Hong Kong (0/378/378), Indonesia (23/1041/1064), Lao PDR (32/192/224), Myanmar (0/154/154), Malaysia (13/186/199), Mongolia (0/24/24), Nepal (9/34/43), Pakistan (17/433/450), Philippines (129/353/482), Singapore (0/27/27), Sri Lanka (0/373/373)
Australia-Oceania	Australia (118/0/118), Fiji (0/164/164), Guam (0/20/20), Kiribati (0/10/10), Palau (0/8/8), Papua New Guinea (0/26/26), Samoa (0/2/2), Solomon Islands (0/25/25), Tonga (0/6/6), Vanuatu (0/15/15)
North-Central-South America	Belize (0/4/4), Bolivia (0/51/51), Barbados (0/31/31), Canada (19/0/19), El Salvador (0/33/33), Guatemala (219/50/269), Honduras (0/91/91), Mexico (0/52/52), Nicaragua (0/148/148), Panama (0/25/25), Bahamas (0/10/10), Saint Kitts and Nevis (0/25/25), Saint Vincent and the Grenadines (0/20/20), Trinidad and Tobago (4/28/32), Venezuela (0/79/79)

sions (35.4% of total) were shipped to 113 other countries (Table 1). The largest share of germplasm (13,672 samples) went to National Agricultural Research and Extension Systems (NARES), followed by seed companies (9,741), universities (4,558), private individuals (1,611), and non-governmental organizations (NGOs) (398) (Fig. 3).

Given the high consumption of hot pepper in Asian cuisine, high demand for pepper seed owing to the large area under cultivation, and well-developed pepper seed research and development industries, it is understandable why the majority of the top ten recipient countries (7 out of 10) were located in Asia and accounted for about 53% of all *Capsicum* germplasm distributed worldwide. The highest request and supply of seed samples to India (15.6% of the total) can simply be explained by the fact that after liberalization of national seed policy in India during the late 1980s there was a remarkable increase in the number of seed companies (Pray et al., 2001). These seed companies requested and received 64% of the seed samples sent out, which is almost double the average amount of seed samples sent to seed company recipients in other parts of the world (33%; Fig. 3). The presence of Tanzania, the sole country from Africa, among the top ten recipient countries is due to the Center's long presence of more than 20 years in the country.

Most countries preferred to receive AVRDC-developed improved lines. Only the Republic of Korea requested more genebank accessions than improved lines and was the top recipient of genebank accessions (Fig. 2). For The Netherlands, the ratio between the two types of germplasm was almost balanced. A relatively high demand of genebank accessions compared with improved lines in South Korea and The Netherlands may be because both are developed countries with very strong public and/or private pepper breeding programs that can exploit the full potential of germplasm accessions much more effectively than developing countries, which mostly rely on our improved materials. Apart from Korea and The Netherlands, Taiwan (32.3%) and China (25.1%) make relatively large acquisitions of genebank accessions.

USE OF GERMPLASM ACCESSIONS AND IMPROVED LINES

National public and private sector partners have used AVRDC seed materials in various ways. Mostly these lines have been: (i) directly released as open-pollinated varieties through national varietal release procedures, (ii) subjected to selection (in cases of segregating germplasm) according to local trait preferences and subsequently released as new varieties, (iii) used (possibly after further selection) as parental lines in hybrid development, or (iv) used as sources of traits in crosses to develop new breeding lines. Recent attempts to consolidate use of supplied seed samples have revealed that since 2005, 27 germplasm accessions (9) or improved lines (18) supplied by AVRDC have been released as open pollinated varieties for commercial cultivation after further evaluation by the NARES in seven countries. This included 15 hot pepper, 11 sweet pepper and one paprika cultivar (Table 2). In addition, 24 improved lines were used, mostly by private seed companies, as parents in the development of commercial hybrids. All in all, a total of over 51 lines (including several duplicate releases in different countries) were put into commercial use in 12 different countries of Asia and Africa (Fig. 4).

South Asia

In South Asia, the highest number of released and commercialized hybrids (based on AVRDC parents) were in India (13) followed by Sri Lanka and Bangladesh (Tables 2 and 3; Fig. 4). The vegetable breeders of the Indian Council of Agricultural Research (ICAR), New Delhi, have used AVRDC's cytoplasmic male sterility (CMS) hot pepper lines to study genetics and distribution of restoration-of-fertility (*Rf*) locus associated markers, hybrid development (Kumar et al., 2007) and the genetic relationship between two independently isolated commercialized male sterile cytoplasms (Kumar et al., 2009). Kashi Anmol, an open pollinated hot pepper variety, became popular in the Indo-Gangetic Plains for green fruit production because of its earliness, short duration and attractive fruit quality. This success has been attributed mainly to the availability of seed through continuous breeder seed production by the Indian Institute of Vegetable Research, Varanasi and truthfully labeled seeds produced by nascent seed companies and also by farmers themselves. Private seed companies in India use hot pepper CMS lines either for commercial hybrid development and cost-effective seed production, or for converting CMS lines into more desirable and preferred genetic backgrounds. For example, VNR Seeds Ltd., India, started using AVRDC's improved hot pepper lines in early 2000, and the company recently commercialized six hot pepper hybrids that possess parental inbred lines from AVRDC. One of these hybrids, 'Rani' (VNR332), was released in 2012 on the basis of its better performance in multi-location trials (2006-2008) conducted under ICAR's All Indian Coordinated Vegetable Improvement Project. Based on marketed seed of 'Rani' it is estimated that this hybrid variety alone has a cultivated area of about 3,000 hectares in India (Fig. 5). Seed companies use AVRDC's improved lines to develop inbred lines for use in commercial hybrids (Table 3). They have directly used our CMS and restorer lines to produce hybrid seed for commercial hybrids (Fig. 6). It is worthwhile noting that use of CMS lines brings down the cost of hybrid seed production by at least 40% compared with hybrid seed production through manual emasculation and pollination. This cost saving is mainly due to manual emasculation, which requires skilled agricultural laborers. However, skilled labor is more and more difficult to find in India due to migration of laborers to other sectors with higher remuneration like infrastructure development.

Figure 4. Number of open-pollinated released and commercialized hybrids in different countries since 2005.

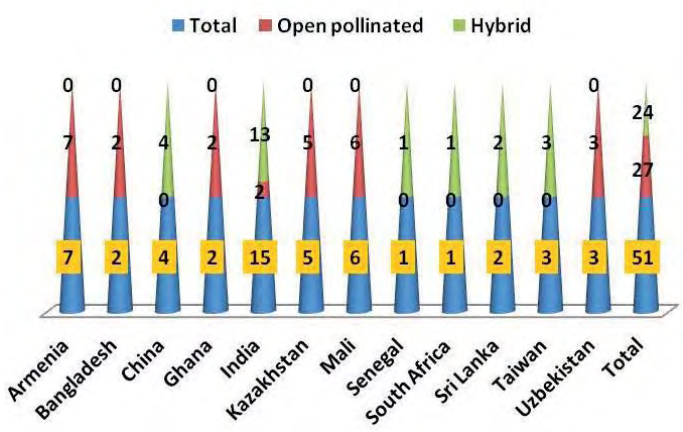


Figure 5. VNR-332 ('Rani'), a notified commercial hot pepper hybrid (3000 ha in 2012) in India developed from male parent from AVRDC.

Table 2. Open pollinated (OP) varieties released based on AVRDC germplasm and improved lines since 2005.

VRDC code for accession / improved lines	Locally released / commercialized name	Country	Year of release	Salient known features recorded in the country, where released
Hot (chili) peppers				
AVPP0305 (0337-7546)	Gita	Armenia	2010	Fruits are elongated (pointed end), green → red, 10.7 x 1.7 cm (size), 10 g average weight. Yield potential 28 t/ha. Appropriate for growing in an open field and greenhouses.
VI014204 (C02408 or PBC203)	Zspanak	Armenia	2010	Average fruit weight 27 g. Yield potential 25-28 t/ha. Good transportability and proceeding quality.
VI037591 (C05670 or PBC613)	Kon	Armenia	2011	Fruits are big elongated, green → red, 6.0 x 0.8 cm (size), 1.6 g average fruit weight, tolerant to anthracnose. Yield potential 24 t/ha.
VI013538 (PI124540 or C01803)	Punj	Armenia	2012	Fruits are elongated (pointed at the distal end), green → red, 12 x 0.8 cm (size), 3 g average fruit weight.
VI046912 (PBC462)	Bangla Lanka-1	Bangladesh	2005	Plants are bushy with profuse fruiting. Fruits are conical (blunt or sunken at distal end), green → red, 7.2 x 1.3 cm (size), 6.5 g average fruit weight.
VI046912 (PBC462)	CRI-Shito-Adope	Ghana	2005	Plants are bushy with profuse fruiting. Fruits are conical (blunt or sunken at distal end), green → red, 7.2 x 1.3 cm (size), 6.5 g average weight.
AVPP9813 (Terry's Joy)	CRI-Mako-Ntoos	Ghana	2005	Heat tolerant with compact plants. Fruits are elongate (pointed end), green → red, 9.0 x 1.7 cm (size), 10 g average weight. Yield potential 25 t/ha. Good transportability and proceeding quality.
VI037808 (PBC460)	Kashi Anmol	India	2005	Bushy plants with profuse fruiting. Fruits are compact, green → red, 6.0 x 1.0 cm (size), average fruit weight 6 g. Yield potential 20 t/ha.
AVPP0105 (PP0107-7058/ ICPN15#09)	Piquant	Kazakhstan	2010	Fruits are elongate (pointed end), green → red, 12 x 2 cm (size), 12 g average weight. Yield potential 14.5 t/ha. Good transportability and proceeding quality; resistant to CVMV and PVY.
AVPP0303 (PP0337-7069)	Erekshe	Kazakhstan	2012	Fruits are elongate (pointed end), green → dark red, 16.8 x 2.4 cm (size), 30 g average weight. Yield potential 21 t/ha.
AVPP0105 (PP9950-5177)	Nafama	Mali	2011	Fruits are elongate (pointed end), green → red, 12 x 2 cm (size), 12 g average weight. Yield potential 14.5 t/ha. Good transportability and proceeding quality; resistant to CVMV and PVY.
AVPP9905 (Susan's Joy)	Nisondia	Mali	2011	Fruits are elongated and mild pungent, yellowish → red, 15.5 x 2.6 cm (size), 29 g average weight. Yield potential 25 t/ha. Resistant to PVY.
AVPP0002 (PP0007-2244)	Bafarima	Mali	2011	Fruits are elongated, 8 x 0.8 cm (size), green dark red, very pungent. Yield potential 10 t/ha. Tolerant to high humidity.
AVPP0303 (PP0337-7069)	Uchkun	Uzbekistan	2009	Fruits are elongate (pointed end), green → dark red, 16.8 x 2.4 cm (size), 30 g average weight. Yield potential 21 t/ha.
AVPP9905 (Susan's Joy)	Tillarang	Uzbekistan	2010	Fruits are elongated and mild pungent, yellowish → red, 15.5 x 2.6 cm (size), 29 g average weight. Yield potential 27 t/ha. Resistant to PVY.
Sweet pepper				
AVPP0112 (0137-7025)	Natali	Armenia	2010	Fruits are conical (pointed end), green → yellow / orange, 7.9 x 5.3 cm (size), 100 g average weight. Yield potential 57 t/ha.
VI046956 (PBC271)	Mili	Armenia	2012	Late ripening (123 days). Fruits are red and rectangular, 9.0 x 7.0 cm (size), 100 g average weight. Yield potential 55 t/ha.
AVPP0114 (0137-7041 or ISPN5#8)	Emili	Armenia	2011	Fruits are blocky (sunken end), green → yellow, 6.7 x 6.5 (size), 160 g average weight. Yield potential 54.6 t/ha.
AVPP0408 (0437-7031 or ISPN9#2)	BARI Misti Mirich 1	Bangladesh	2005	Fruits are blocky (shaken end), yellowish → light yellow, 7 x 2 cm (size), 110 g average weight. Yield potential 25 t /ha.
VI046956 (PBC762 or PI659102)	Kaz-Tai	Kazakhstan	2010	Fruits are conical (blunt end), green → red, 14.0 x 5.5 cm (size), 125 g average weight. Yield potential 22.0 t/ha.
AVPP0119 (PP0037-7645)	Bayan Sulu	Kazakhstan	2010	Fruits are blocky (blunt end), green → yellow, 9 x 9 cm (size), 150 g average weight. Yield potential 30 t/ha.
AVPP0204 (0237-7011)	Kozy-Korpesh	Kazakhstan	2012	Fruits are conical (blunt end), green → red, 12.6 x 6.8 cm (size), 135 g average weight. Yield potential 22.0 t/ha.
AVPP0301 (ISPN6#5 or PP0337-7018)	Wassa	Mali	2011	Fruits are conical (blunt end), green → red, 10.3 x 7.0 cm (size), 140 g average weight. Yield potential 20 t/ha.
AVPP0416 (PP0437-7047)	Seguifa	Mali	2011	Fruits are blocky, green → red, 9.2 x 7.2 cm (size), 140 g average weight. Yield potential 35 t /ha.
AVPP0417 (PP0437-7005)	Poivron Jan	Mali	2011	Fruits are elongated, green → red, 10.3 x 5.6 cm (size), 100 g average weight, yield potential 40 t/ha.
AVPP0408 (0437-7031)	Sabo	Uzbekistan		Fruits are blocky (shaken end), yellowish → light yellow, 7 x 2 cm (size), 110 g average weight. Yield potential 25 t/ha.
Paprika				
VI037556 (PBC535)	Kashi Sinduri	India	2009	Fruits are green-dark red, 12 x 1.5 cm (size), very little pungent (0.002% capsaicin) with high oleoresin. Yield potential 25 t/ha. Resistant to bacterial wilt, CVMV and PVY.

Note: Immature fruit color → mature fruit color; yield potential (fresh ripe fruits); CVMV = *Chili venial mosaic virus*; PVY = *Potato virus Y*.

Central Asia and the Caucasus

Out of 243 samples of pepper genebank accessions and 83 samples of breeding lines distributed to eight countries in Central Asia and the Caucasus, 8 hot pepper and 7 sweet pepper cultivars have been locally released after extensive field trials conducted in Armenia, Kazakhstan and Uzbekistan (Table 2; Fig. 4). Among the released varieties, four hot pepper cultivars and two sweet pepper cultivars were derived from genebank accessions (Table 2). These new varieties possess unique, marketable, valuable traits (high yield, fruit quality and processing quality), and have provided opportunities for farmers to obtain higher farmgate prices. For example, 'Kaz-Tai' and 'Bayan Sulu' are now cultivated successfully in greenhouses in Kazakhstan during the cool autumn, winter and early spring seasons (Fig. 7). In Uzbekistan, farmers have adopted high yielding varieties such as 'Tillarang' (Fig. 8). Seeds of these released varieties are being produced by the Kazakh Research Institute of Potato and Vegetable Growing and the Uzbek Research Institute of Plant Industry and quality seeds are supplied to farmers. These varieties are widely cultivated by farmers and the private sector to meet fresh market demand and to supply the processing industry.

Table 3. Hot pepper hybrids developed and commercialized since 2005 by public institutes and private seed companies*.

Name of hybrid	Developed by	Country of release / commercialization
Kashi Surkh	Indian Institute of Vegetable Research, India	India
Arka Sweta, Arka Hybrid	India Institute of Horticulture Research, India	India
F_1 Hybrid Coral, F_1 Hybrid Dara	Clover Seeds, Hong Kong	China
VNR38, VNR108, VNR174, VNR200, VNR332	VNR Seeds, India	India
F_1 Forever	Tropicasem, Senegal	Many SSA countries
Remington, F_1	Alpha Seeds, South Africa	Many SSA countries
F_1 TSS AVRDC No.4	Suntech Seeds, Taiwan	Taiwan
F_1 TSS AVRDC No.2	Yung Shan Seeds, Taiwan	Taiwan
F_1 Hsing AVRDC No.3 (sweet pepper)	Suntech Seeds, Taiwan	Taiwan
Yun Pepper No.2	Horticulture Research Institute, YAAS, China	China
Yun High Pungency No.1	Horticulture Research Institute, YAAS, China	China
Ulka F_1, Masaya 315, Yuvraj IN	East-West Seeds, India	India
Super F_1, Muria F_1	East-West Seeds, Thailand	Sri Lanka
Hybrid	Indus Seeds, India	India

* Namdhari Seeds in India has used AVRDC lines in four commercial hybrids.
SSA = Sub Saharan Africa.

West Africa

A total of 8 pepper varieties have been catalogued in Mali and one hybrid has been commercialized by a private seed company based in Senegal (Tables 2 and 3; Fig. 4). AVRDC Mali has successfully promoted three hot pepper lines (AVPP9905, AVPP0002, AVPP0105) of *C. annuum* in West Africa, where low productive genotypes of *C. chinense* and *C. frutescens* are also cultivated. The promotion strategy was based on field visits, farmer participatory variety selection, on-farm discussion sessions with producers, sensory quality testing and organization of demand-creation fairs to enhance technology delivery (Fig. 9). The combined efforts successfully raised awareness about high yielding, more nutritious *C. annuum* hot pepper lines among smallholder farmers in Mali, who are requesting additional seed for planting. High quality seed must be available for farmers if these lines are to achieve their full potential for higher incomes and nutrition security (Afari-Sefa et al., 2012). Considering these facts and thanks to the support of the United States Agency for International Development (USAID), AVRDC staff have trained seed producers in the Sikasso region of Mali, who are now multiplying certified seed of released pepper varieties such as Nisonda, Bafarima, Nafama, Poivron and Wassa. In order to develop professional seed businesses, AVRDC has engaged Faso Kaba, a local seed company, to establish seed production contracts with these seed producers.

FEEDBACK & LESSONS LEARNED

The success of any breeding program is highly dependent on continuous operational breeding activities, as well as on receiving continuous performance feedback from different actors in the seed and crop production value chain,

Figure 6. Hot pepper hybrid seed production using AVRDC's CMS line (left) and CMS based hybrid crop (right) at the farmer's field: an example from India.

Figure 7. Commercial production of 'Bayan Sulu' (left) and 'Kaz-Tai' (right) sweet peppers in greenhouse, Kazakhstan.

including seed recipients and end-users. One of our strategies to disseminate improved pepper lines has been through the distribution of sets of the International Chili Pepper Nursery (ICPN) and the International Sweet Pepper Nursery (ISPN). 22 ICPN and 11 ISPN nurseries have been released, which included 142 newly developed improved chili (77) and sweet pepper (65) lines. From 2001 to 2011, a total of 1,039 sets of ICPNs (513) and ISPNs (526) were distributed to cooperators around the world. However, only 12% (127) of the recipients sent AVRDC feedback on field performance, which has been an area of concern. Likewise, lack of either positive or negative feedback on the use of other seed samples such as CMS and resistant breeding/germplasm lines are also of concern because (i) it is difficult to satisfy the need of donor communities on the use of the supplied seed samples and (ii) it might result in failure to appropriately adapt breeding activities to the needs of the collaborators and partners in different countries.

Poor feedback from collaborating partners in most cases is understandable, as often the recipients in developing and less developed countries do not have access to infrastructure and facilities to properly conduct trials. Another reason for limited use of the supplied materials could be attributed to limitations of human resources and the capacity to utilize the full potential of supplied seed. This is in contrast to the Indian seed industry, which was in a better position to exploit the potential of AVRDC's germplasm accessions and improved lines.

FUTURE BREEDING THRUST

We are currently revisiting our anthracnose and begomovirus resistance sources and some of the breeding populations derived from previously identified resistant sources. We have learned from seed distribution experiences that a major multiplying impact of our improved lines can been achieved in developing countries when people working in both public and private sectors have enhanced skills, for example, in India. Capacity building of human resources will remain a cornerstone of our strategy to harness a larger impact for the Center's bred pepper lines.

POTENTIAL *CAPSICUM* EXPLORATION

Out of the five cultivated *Capsicum* species, *C. chinense* and *C. pubescens* are poorly represented in international ex situ collections and require additional collection and conservation efforts. Many wild *Capsicum* species, such as *C. rhomboideum, C. flexuosum*, and *C. lanceolatum*, are hardly found in ex situ collections. This applies also to *C. annuum* var. *glabriusculum*, the putative wild ancestor of *C. annuum* (Kraft et al., 2013). The east Himalayan region (Bhutan, north Bangladesh, northeast India, east Nepal) has long been known as a hot spot of hot pepper biodiversity. This region has received renewed attention in the past decade due to the discovery of the world's hottest pep-

Figure 8. Mr. Vahhobov, an Uzbek farmer with a good crop from hot pepper 'Tillarang'.

Figure 9. Participatory pepper varietal selection by women growers in Mali.

pers and the occurrence of natural inter-specific derivative landraces believed to have originated in the region from sympatric domesticated species (Rai et al., 2013). In the post-Colombian era of *Capsicum* discovery, for the first time, a naturally occurring allotetraploid pepper has been discovered in the region (Jha et al., 2012). It would be worthwhile conducting a regional exploration for *Capsicum*-specific germplasm that recognizes the role of local communities in conserving these genetic resources before they become extinct due to agricultural intensification.

Acknowledgements

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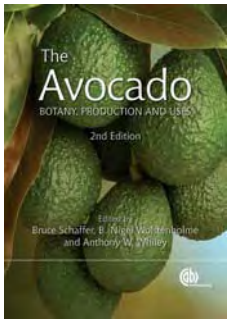
New Books, Websites

BOOK REVIEWS

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

The Avocado: Botany, Production and Uses. 2nd Edition. Bruce Schaffer, B. Nigel Wolstenholme and Anthony W. Whiley (eds.) 2013. CABI Publishing, Wallingford, Oxfordshire, UK. 560p. ISBN 978-1-84593-701-0 (hardback). £115.00 / $220.00 / €150.00. www.cabi.org



The avocado has been appreciated by humans for at least 9000 years, including the Mayan and Aztec civilizations. However, modern selection and vegetative propagation of superior cultivars have only occurred in the last 110 years. Avocado production technology, particularly in the subtropical commercial production areas of the world, although not exclusively so, continues to advance at a rapid rate. Concomitantly, the volume of published research, extension and marketing literature has increased dramatically. This second edition (first edition of this book was in 2002) details in a comprehensive manner the international scientific literature, and summarizes current knowledge of this fruit crop. The 15 chapters are written by 45 prominent avocado researchers from nine avocado producing countries on five continents. The editors themselves have made significant contributions to our knowledge on avocado.

The editors have nicely introduced the book to the readers in the first chapter 'Introduction', followed by chapters on history, distribution and uses; taxonomy and botany; genetics and breeding; ecology: climate and soil; reproductive biology; ecophysiology; cultivars and rootstocks; propagation; biotechnology; irrigation and mineral nutrition; crop management; foliar, fruit and soil borne diseases; insect and mite pests; and harvesting, packing, postharvest technology, transport and processing.

The genetics and breeding (Chapter 4) and biotechnology (Chapter 10) chapters provide a very useful introduction and overview of recent developments in these areas as applied to avocado. In-depth discussions of the effects of climate variables on basic avocado biology (Chapters 5, 6, and 7) and practical discussions of tree and orchard management in relation to environmental variables (Chapters 11 and 12) will enable avocado growers and researchers to make strategic decisions to mitigate the effect of environmental hazards. Chapters 13 and 14 discuss the major diseases and pests of avocado and their effective control measures including an integrated pest management programme. Current and best postharvest practices are discussed in Chapter 15. This new edition reaps the benefits of new development based on the latest findings produced by extremely active scientific research in this field. There have been significant changes in the new version, including in-depth modifications to present updated knowledge. The volume is extensively illustrated with black and white photographs in different chapters and with another 129 photographs in the annex. I believe this book will act as a valuable resource for everyone in the avocado industry. The editors and all the contributors are to be congratulated on the production of such a comprehensive account of the history, botany, production and uses of avocado.

Reviewed by Sisir Mitra, Chair of ISHS Section Tropical and Subtropical Fruits

Greenhouse Technology and Management. 2nd Edition. Nicolas Castilla. 2012. CABI Publishing, Wallingford, Oxfordshire, UK. 360p. ISBN 978-1-78064-103-4 (hardback), 978-1-78064-202-4 (e-book). £95.00 / $180.00 / €125.00. www.cabi.org

The second edition of this excellent textbook is the translation of the Spanish book entitled "Invernaderos de Plástico: Tecnología y Manejo". It has been translated by Esteban J. Baeza, agricultural engineer at IFAPA, Spain and reviewed by Dr. Papadopoulos, senior scientist at Agriculture and Agri-Food Canada.

This textbook examines the relationships between climate and greenhouse structure and technologies, focusing mainly on plastic greenhouses located in southern areas. All climatic aspects are presented and discussed in detail in chapters 2 and 3, such as radiation (intensity, photoperiod, light quality), air and soil temperatures, wind, CO_2 and water vapour contents in the atmosphere, etc. The book takes advantage of the early work of Prof. Nisen and co-workers at the University of Gembloux on light transmission.

Chapter 4 discusses the different types of plastic coverings, the construction of plastic greenhouses and the climate inside such structures, while chapter 5 deals mainly with heat transfer and temperature. These two aspects are of primary importance in southern hotter climates and are key elements in the recent rapid development of the greenhouse industry in Africa, South America and southern Europe.

Photosynthesis, transpiration, stomatal conductance as well as source-sink relationships are discussed in chapter 6 in relation to crop growth and yield and greenhouse climate.

Chapters 7 and 8 deal with temperature management; firstly low temperature vs. heating, and secondly high temperature vs. ventilation. Both aspects are critical as energy savings are always very important to reduce growing costs, while temperatures that are too high reduce fruit quality and yield and even prevent production during many months of the year in the warmest climates.

Chapters 9 and 10 discuss two very important growing factors; CO_2 enrichment and lighting. Optimizing these two factors facilitates substantial increases in crop yield and quality. In northern areas, CO_2 enrichment is much easier as greenhouses are not ventilated as much. Consequently, it is of utmost importance to take advantage of atmospheric CO_2 through adequate ventilation, both from outside and inside the crop canopy. On the other hand, supplemented lighting is not required as much in southern areas as natural radiation is usually sufficient to produce high yields. Supplemented lighting may be useful to create longer days or to supplement natural light during short days in winter.

Irrigation and fertilization of greenhouse crops (Chapter 11) are basic elements of high productivity and successful growing. Dr. Castilla's book discusses the basics of both irrigation and fertilization, mostly in relation to soil culture. These aspects are also of great relevance to organic growing of all crops in all areas.

Chapter 12 presents the basics of greenhouse control, including both the levels and various systems available. It briefly presents future uses and advantages of greenhouse crop models.

Plant protection, crop quality, greenhouse economy and marketing as well as growing strategies are discussed in the final chapters to ensure that the reader acquires a basic understanding of all aspects related to greenhouse management.

I certainly recommend this textbook to all professionals interested in greenhouse production and management, especially those who are looking to learn the practical aspects of plastic greenhouses in southern climates. Dr. Castilla's textbook will certainly become a world reference and landmark on greenhouse production.

Reviewed by André Gosselin, Université Laval, Québec, Canada

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

IFA/IFDC Phosphate Fertilizer Production Technology Workshop, 7-11 October 2013, Bangkok, Thailand. Info: Training and Workshop Coordination Unit, IFDC, P.O. Box 2040, Muscle Shoals, Alabama 35662, USA, Phone: +1 (256) 381-6600, Fax: +1 (256) 381-7408, Email: training@ifdc.org, Web: www.ifdc.org

International Pineapple Organization Global Pineapple Conference, 1 November 2013, San Jose, Costa Rica. Info: Will Cavan, International Pineapple Organization (IPO), Phone: 1+(760)6431153, www.i-pineapple-a.blogspot.com

Séminaire Internationale "Protection Phytosanitaire: Situation et Perspectives", 17-19 November 2013, Batna, Algeria. Info: Oussama Ali Bensaci, Laboratoire d'Amélioration des Techniques de Protection Phyosanitaire en Agrosystèmes Montagneux (LATPPAM), Département d'Agronomie, Institut des Sciences Vétérinaires et des Sciences Agronomiques, Université Hadj Lakhdar Batna, 05000 Batna, Algeria, Phone: 00213 33 86 17 17, Fax: 00213 33 86 17 47, Mobile: 00213 774 22 58 93, Email: latppam@univ-batna.dz, Web: http://inst-va.univ-batna.dz/latppam/index.html

Conference on Positive Plant Microbial Interactions: Their Role in Maintaining Sustainable Agricultural and Natural Ecosystems, 2-3 December 2013, North Lincs, UK. Info: Russell Millman, Association of Applied Biologists, Warwick Enterprise Park, Wellesbourne CV35 9EF, UK, Phone: +44 2476 575195, Fax: +44 1789 470234, Email: russell@aab.org.uk, Web: www.aab.org.uk

Conference on Advances in Nematology, 10 December 2013, London, UK. Info: Russell Millman, Association of Applied Biologists, Warwick Enterprise Park, Wellesbourne, Warwick, CV35 9EF, UK, Phone: +44 (0)2476 575195, Fax: +44 (0)1789 470234, Email: russell@aab.org.uk, Web: www.aab.org.uk

Advanced Course on Applications of Bioinformatics in Plant Breeding, 20-24 January 2014, Zaragoza, Spain. Info: Mediterranean Agronomic Institute of Zaragoza (IAMZ) – CIHEAM, Avenida Montanana 1005, 50059 Zaragoza, Spain, Phone: +34 976 716000, Fax: +34 976 716001, Email: iamz@iamz.ciheam.org, Web: www.iamz.ciheam.org

Symposia and Workshops

Section Nuts and Mediterranean Climate Fruits

Sixth Int'l Symposium on Almonds and Pistachios

The VI International Symposium on Almonds and Pistachios took place from 27 to 31 May 2013, at the headquarters of CajaMurcia in Murcia (Spain). The event was organized by the Department of Plant Breeding at CEBAS-CSIC (Spanish National Research Council) under the auspices of the International Society for Horticultural Science (ISHS). This international symposium, which is held every four years, brings together the world's leading experts on these two crops. The previous symposia were held in Agrigento, Italy (1993), California, USA (1997), Zaragoza, Spain (2001), Tehran, Iran (2005) and Sanliurfa, Turkey (2009).

The symposium was attended by more than 100 researchers from 14 countries (Algeria, Australia, Denmark, Egypt, Spain, United States, France, Iran, Israel, Italy, Morocco, Serbia, Tunisia and Turkey). It consisted of seven thematic sessions with oral presentations and posters. The sessions were moderated by internationally renowned researchers in each of the topics.

Participants of the symposium.

The inaugural lecture was given by Mr. Francisco Vargas (IRTA, Spain), who spoke of the great impact research has had in recent years on the modernization of almond and pistachio crops in the Mediterranean basin.

The session "Plant Breeding" was moderated

Cultural visit to Roman theatre of Cartagena.

Inauguration of the symposium. From left to right: Mr. Rafael Socías i Company, ISHS representative, Mrs. Isabel Martínez, Councillor of Economy, Town hall of Murcia, Mr. Antonio Cerdá, Counsellor of Agriculture, Region of Murcia, Mr. Juan José Alarcón, Director of CEBAS-CSIC, and Mr. Federico Dicenta, Symposium Convener, CEBAS-CSIC.

by Dr. Thomas Gradziel (University of California, Davis, USA). He highlighted the current influence of new improved cultivars on world production, and the utility of molecular markers in breeding programs.

The session entitled "Biology and Physiology" (moderated by Dr. Raquel Sánchez-Pérez, University of Copenhagen, Denmark) dealt with the impact of proper pollination on fruit set, the problems arising from flower incompatibility, and the impact of fulfilling chilling requirements for abundant flowering and production. In addition, work was also presented on "in vitro" multiplication and on the molecular basis of the sweetness or bitterness of the seed, a character of great importance for the almond.

Dr. Mehrnejad (IPRI, Iran) moderated the session on "Crop Protection". He reviewed the pests and diseases affecting almonds and pistachios, as well as the different strategies to control them.

The session entitled "Food Technology" (moderated by Dr. Agustí Romero from IRTA, Spain) analysed the chemical and nutritional characteristics of almonds and pistachios in relation to their industrial uses and highlighted the beneficial health properties of these commodities. Furthermore, new molecular techniques to determine the traceability of nuts in processed products such as nougat were presented.

Dr. Ak (University of Harran, Turkey) moderated the session on "Varietal Behaviour", in which the performance of cultivars and rootstocks of both species in different environmental conditions and cultures was discussed, highlighting the wealth of plant genetic resources existing in these species.

The session on "Orchard Management" was moderated by Mrs. Louise Ferguson (University of California, Davis, USA), and she highlighted the enormous importance of optimal crop management for farm profitability. New issues included high density almond orchards, the impact of different irrigation strategies on yield, the mechanization of pruning and the application of chemicals to improve fruit set.

Fried almonds and nougat of 'Antoñeta' almond cultivar from CEBAS-CSIC.

Finally, the session entitled "Economy and Markets," moderated by Mr. Christopher Joyce (Almond Board of Australia), highlighted the most recent world production trends and outlined the increasing demand for these products, which promises more profitable prices for farmers in the years to come.

During the symposium the GREMPA (Groupe de Recherches et d'Etudes pour l'Amandier Méditerranéennes et le Pistachier), a research group bringing together researchers working in these two species in the Mediterranean basin, held their 15th meeting. It was moderated by Dr. Mercè Rovira (IRTA, Spain) and Mr. Antonio López-Francos from CIHEAM. During the meeting the researchers responsible for the different institutions presented a summary of their current works.

The last day was devoted to a technical visit. The participants visited an almond orchard in the Region of Murcia, where recent almond cultivars released by CEBAS-CSIC were displayed. Dr. Federico Dicenta explained the main characteristics of the culture of almond in Spain, under rainfed and irrigated conditions. Participants visited an 80 ha solid orchard, where the high productivity of the self-compatible almond cultivar 'Antoñeta' of CEBAS-CSIC was observed. The owner of the property offered a delicious appetizer to participants with regional products, including fried almonds and nougat made by local craftsmen using his 'Antoñeta' almonds. Afterwards, participants visited the facilities of the Cooperativa Agraria de Totana (COATO). The president of the cooperative, Mr. José Luis Hernández, explained the functioning of the cooperative, highlighting its commitment to high quality organic products, especially almonds. Later, the participants visited the facilities of the cooperative and the Bioshop where a large variety of products from the cooperative partners were on display. The day ended with a lunch at the port city of Cartagena and a cultural visit to the downtown area, including the Roman baths and theatre.

At the end of symposium the ISHS Business Meeting was held, chaired by the ISHS representative Dr. Rafael Socías i Company. During the meeting, participants agreed to organize the next symposium in Australia, 2017, headed by Dr. Michelle Wirthensohn from the University of Adelaide.

Federico Dicenta

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Seventh Int'l Cherry Symposium

Opening ceremony of the symposium.

The 7th International Cherry Symposium was held on 23rd - 27th June 2013 in Plasencia (Spain) at the magnificent auditorium Santa Ana. The symposium was organized under the auspices of ISHS and the Government of Extremadura. The symposium was attended by 270 participants from US, Canada, Chile, Argentina, Australia, New Zealand, China, South Korea, Japan, Spain, France, The Netherlands, Italy, Portugal, UK, Belgium, Germany, Croatia, Latvia, Poland, Norway, Denmark, Serbia, Cyprus, Hungary, Bulgaria, Czech Republic, Greece, Slovenia, Uzbekistan, Lithuania, Israel, Turkey, and South Africa.

The symposium provided the opportunity for scientists, professionals and students to present their latest findings and discuss their current work in the area of basic and applied aspects of cherry production. The meeting promoted the exchange of ideas and international cooperation and collaboration among researchers and other people involved in the cherry industry around the world.

The Co-Conveners of the Symposium were Dr. Margarita López, Dr. Manuel Serradilla and Mª Josefa Bernalte. At the opening ceremony, Mr. Fernando Pizarro, Major of Plasencia, welcomed the delegates, and the opening address was presented by Mr. José Antonio Echavarri, Ministry of Agriculture of the Extremadura Regional Government.

After the inaugural ceremony, Professor Guglielmo Costa (Italy), Chair of the ISHS Section Pome and Stone Fruits, gave a presentation on the ISHS, and after that, a keynote lecture was presented by Professor Lang (US) entitled "Trends and characteristics of current, new, and future cherry cultivars around the world".

The symposium was organized into six sessions in which 31 oral and 149 poster papers were presented. The keynote lecture of Session 1: Breeding, Genetics and Biotechnology, entitled "Breeding sweet cherries at INRA-Bordeaux: from conventional techniques to marker-assisted selection", was presented by Dr. José Quero-García (France), under the chairmanship of Dr. Ryutaro Tao (Japan) and Dr. Ana Wünsch (Spain).

Session 2: Crop Production and Orchard Management was chaired by Dr. Lynn E. Long (US) and Dr. Matthew Whiting (US), and the keynote entitled "Integrating biology and technology to design the next generation sweet cherry orchard" was given by Dr. Whiting.

ISHS representative Prof. Costa presented the ISHS medal to Dr. Bernalte (left), Dr. Serradilla (right) and Dr. López-Corrales (not on the picture), Symposium Co-Conveners.

Prof. Tao and two colleagues with Dr. Serradilla. Prof. Tao will be the Convener of the 8th International Cherry Symposium at Yamagata (Japan) in 2017.

Visit to a cherry orchard.

At the end of the day, a guided visit to the historic center of Plasencia town took place.

On the second day, Prof. L.E. Long (US) presented a keynote speech on "Partnering with producers and consumers to enhance cultivar and rootstock selections", in Session 3: Rootstocks and Varieties Evaluation/Propagation, chaired by Dr. Cheryl Hampson (Canada) and Dr. José Quero-García (France).

Dr. Marlene Ayala (Chile) and Dr. María Herrero (Spain) conducted Session 4: Tree Fruit Physiology, Plant Growth, and Dr. Herrero made the keynote presentation on "Floral biology and flower biology and fruit set in sweet cherry (*Prunus avium* L.)".

Prof. Gregory Lang was the chairman of Session 5: Pests and Diseases Management. A tribute was rendered to Dr. Jörg Samietz, who was the invited speaker and passed away last April.

The social event on the second day was a trip to Cáceres and a guided tour to the old town.

On the third day, the participants went to visit a commercial cherry orchard and the experimental field belonging to Extremadura Government, where the Breeding Program of the Research Institute Finca 'La Orden-Valdesequera' is located. The objective of the program is obtaining new varieties adapted to the soil and climatic conditions of the Jerte Valley. Several packing houses were also visited. Lunch was served at the relaxing hotel Balneario del Jerte. A technical session took place after lunch, in which the symposium sponsors participated. After that, the ISHS business meeting was held to determine the next symposium venue. Yamagata (Japan) was the place chosen to host the 8th International Cherry Symposium in 2017. In the evening, the gala dinner was held at "San Francisco Church".

On the final day, Session 6: Postharvest Technology, Fruit Quality, Health Related Issues was chaired by Prof. Guglielmo Costa (Italy) and Dr. Jesús Alonso (Spain). Dr. Daniel Valero (Spain) gave a keynote speech on "Maintenance of sweet cherry quality attributes as affected by innovative postharvest treatments", and Dr. David González-Gómez (Spain) presented a discussion on "Bioactive compounds in sweet cherries: identification, quantification and distribution in different cherry cultivars".

After this session, the closing ceremony took place. The Symposium Co-Conveners thank all the members of the Organizing and Scientific Committees and the Organizing Secretariat (Fundecyt-Pctex) for their excellent work. Prof. Guglielmo Costa, on behalf of the ISHS, presented the Co-Conveners a medal award in recognition of their meritorious service to the Society. Finally, the Vice-President of the Government of Extremadura, Ms. Cristina Teniente, closed the 7th International Cherry Symposium.

Margarita López Corrales,
Manuel J. Serradilla Sánchez and
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Tenth Int'l Mango Symposium

Inauguration ceremony.

Delegates at the symposium.

The Xth ISHS International Mango Symposium was held on 2-7th June 2013 at the Convention Center of the Barceló Complex in Bavaro, Punta Cana, Dominican Republic under the theme of 'Mango, Opportunities and Challenges for the 21st Century'.

The objective of the symposium was to bring together local, regional and international actors dealing with mango production to share knowledge of all aspects of this crop, through oral and posters presentations and field trips. A total of 60 oral presentations, including 8 keynote lectures, and 30 posters covered different aspects of world market production, breeding and biotechnology, physiology and reproductive biology, cultural techniques, climatic change, pests and diseases, postharvest, fruit processing and marketing.

Keynote lectures discussed the effect of climate change and its probable impact on mango production and cultivation, the advantages and disadvantages of cultivating mangoes under subtropical conditions and the potential of greenhouse cultivation of mango.

Other guest speakers covered the areas of genetics, breeding and biotechnology, and strategies for breeding and production management of mango with a focus on the dynamics of market and postharvest aspects related to food safety and quality.

Among other interesting topics presented at the symposium, special mention should be given to genomics, mango breeding programs in different countries, studies of reproductive biology, horticultural practices dealing with propagation, rootstock evaluation, deficit irrigation, pruning, control of flowering, flower induction, greenhouse management, and pest and disease control, particularly in relation to fruit fly. A study of the characterization of the local cultivar 'Banilejo' mango for commercial exploitation in the Dominican Republic was also presented.

The meeting was attended by 254 participants from 32 countries, including 50 local extension people and leading mango producers. The symposium was inaugurated by Dr. Víctor Galán Saúco, Chair of the ISHS Mango Working Group, representing ISHS, Engineer Luís Ramón Rodríguez of the Ministry of Agriculture, Engineer Juan José Espinal of CEDAF (Centro para el Desarrollo Agropecuario y Forestal), Engineer Rafael Pérez Duvergé, Executive Director of IDIAF (Instituto Dominicano de Investigaciones Agropecuarias y Forestales), Engineer Rafael Leger, President of PROMANGO (Cluster of Dominican Mango) and Engineer Juan Chávez, Executive Director of CONIAF (Consejo Nacional de Investigaciones Agropecuarias y Forestales), among other representatives of local institutions. Engineer Luís Ramón Rodríguez gave the inaugural speech addressing the current situation and future perspectives of mango in the Dominican Republic.

During the field trip the participants visited mango farms and packing houses and also attended the Expo Mango 2013 Fair, an annual activity celebrated in the city of Baní. During this visit the ISHS was officially recognized as a "Distinguished visitor of the city".

The XIth International Mango Symposium will be convened by Mr. Bob Williams, Dr. Lucy Tran-Nguyen and Dr. Ian Bally from 28 September to 2 October 2015 in Darwin, Northern Territory, Australia. We hope to see you there!

Víctor Galán Saúco, José Richard Ortiz Núñez and Grace A. Zowe de Cabral

Farm visit.

Mango exhibition.

Contact

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First Int'l Symposium on Elderberry

Participants of the First International Symposium on Elderberry, Columbia, Missouri, USA, June 2013. Photo by Heather Bishop.

The First International Symposium on Elderberry (*Sambucus*) was held in Columbia, Missouri, USA, June 9-14, 2013. This unique, two-part symposium brought together not only dozens of elderberry researchers from around the world, but also elderberry producers and processors in a comfortable venue that promoted significant exchange and interaction among groups interested in all aspects of elderberry. The symposium was organized under the auspices of the International Society for Horticultural Science, and was hosted by the University of Missouri, Lincoln University, Missouri State University, Missouri Botanical Garden, and the Missouri Department of Agriculture. Numerous sponsors not only provided financial and moral support, but significantly contributed to the dynamic interaction and dialog that occurred among scientists, producers, and processors over several very stimulating days.

The first part of the symposium featured scientific presentations and discussions among 115 researchers from 12 countries, with additional attendance from numerous elderberry producers and processors. In addition to horticulture, a significant number of scientific presentations focused on elderberry's biochemistry and use as a medicinal plant. Colloquia included Elderberry Botany and Ethnobotany, Elderberry Biochemistry, Elderberry and Human Health, Elderberry Horticulture, Elderberry Business and Marketing, and the Albert Y. Sun Memorial Colloquium on Berries and Brain Health. Keynote addresses from Ákos Máthé (Hungary), Madeleine Mumcuoglu (Israel), Sigrun Chrubasik (Germany), and Vivian Barak (Israel) helped to place elderberry knowledge and background into a current context. Presentations on elderberry taxonomy, ethnobotany, genetic resources, pests, and cultivar evaluations were rounded out by outstanding papers on in vitro and in vivo effects of elderberry against cancer, stroke, inflammation, diabetes, and infectious diseases.

The second part of the symposium focused on elderberry producers and processors, and had an additional 90 attendees with continued participation by numerous international scientists. We were thrilled to have presentations from the two largest cooperative groups of elderberry growers in the world: the Styrian Berry Cooperative (Austria) and the Botesz Growers Cooperative (Hungary). These, along with keynote presentations by international scientists and industry representatives, were of tremendous interest, especially to North American producers.

A high point of the International Elderberry Symposium was the mid-symposium tours. The first tour, hosted by Patrick and Michele Byers, left Columbia early for a trip to St. Louis and the Missouri Botanical Garden, a world-class research facility and botanical garden. The group was met at the Monsanto Center, the garden's research facility, by Wendy Applequist and Doug Holland. Dr. Applequist led a tour of the herbarium, comprising over 6.3 million preserved plant specimens, and specifically showcased the *Sambucus* collection. Mr. Holland, Director of the extraordinary Peter H. Raven Library, displayed selections from the rare book collection, including herbals from the 15th and 16th centuries that describe several *Sambucus* species and their medicinal use. The tour then moved to the Botanical Garden, where an *al fresco* lunch was enjoyed at the Spink Pavilion. The group boarded a tram tour for an overview of the garden, and then enjoyed free time to further explore the garden. The tour moved on to the town of New Haven and Watershed Farm, an elderberry farm owned by John Bunge. After touring the elderberry plantings and the propagation greenhouse, the group enjoyed an informal tasting of Mr. Bunge's elderberry wines. The final stop on the tour was the evening gala at Nature's Organic Haven Farm near Hermann.

The second tour, hosted by James Quinn, started with visits to two of the premier research laboratories on the University of Missouri campus. The Center for Translational Neurosciences,

Tour hosts and elderberry farmer John Bunge (center) and family, Watershed Farm, share their beautiful farm and delicious elderberry wines with international guests. Photo by Patrick L. Byers.

Wood-cut illustrations of elderberry from Leonart Fuchs' 1542 masterpiece on medicinal plants, *De Historia Stirpium*, housed at the Missouri Botanical Garden's Peter H. Raven Library, and displayed to symposium guests during the tour. Photo by Heather Bishop.

directed by Grace Sun, conducts fascinating research on the effects of elderberry on stroke, using mouse models. The group toured the neurosurgical and histology units, the digital microscopy facilities, and the animal behavioral unit. Kevin Fritsche then led a tour of the Animal Sciences laboratories, where additional cutting-edge research on the effects of elderberry against cancer and infectious disease is conducted. Following the laboratory tours the group traveled to Eridu Farm at Hartsburg, owned by Terry Durham. Mr. Durham is a leading force in the development of the commercial elderberry industry in Missouri, with 15 hectares of elderberry under cultivation. The tour visited production fields, propagation facilities, and viewed specialized harvest and handling equipment. The next stop on the tour was Stone Hill Winery in Hermann, one of the oldest and most historically significant of Missouri's wineries. A cellar tour and tasting of Stone Hill wines were enjoyed by all. The group then drove to Nature's Organic Haven Farm for the evening gala.

Dr. Ákos Máthé, ISHS representative, presents the ISHS Medal to Symposium Convener Andrew Thomas. Photo by Heather Bishop.

Two separate evening banquets provided fun and informal atmospheres to bring together researchers with elderberry producers and processors. The first evening gala was hosted by Phyllis Hannan at Nature's Organic Haven, a certified organic elderberry farm with a spectacular view of the Missouri River Valley. The evening included horse-drawn wagon tours of the elderberry plantings, a tasting of elderberry and other wines, music by a local band, and a hog-roast banquet under a huge tent on the lawn. Symposium Convener Andrew Thomas was presented with a medal of appreciation by Ákos Máthé on behalf of the International Society for Horticultural Science that evening. The final formal banquet was themed "Scientists Meet the Farmers" and featured an elderberry-based feast created by Daniel Pliska, Executive Chef of the University Club of Missouri. This event provided yet another opportunity to bridge the various disciplines and people devoted to all aspects of elderberry.

A Trade Show featuring a plethora of elderberry plants, equipment, and internationally-made elderberry products, including juices, wines, jellies, and dietary supplements, complemented the symposium and provided a terrific forum for exchange of ideas. Plenty of elderberry wine and elderberry ice cream further stimulated camaraderie among international scientists, producers, and processors.

While elderberry has been grown, consumed, and studied for hundreds of years, the current rapidly-increasing interest in elderberry as a "superfruit", dietary supplement, and legitimate cultivated crop has concurrently increased the need for scientific research. Prior to this Symposium, few of the widely-scattered international elderberry researchers had had the opportunity to gather for the exchange of research results and ideas. We believe the First International Symposium on Elderberry served as a tremendous boost to the stature and awareness of elderberry as a viable agricultural crop and food product, and as a legitimate dietary supplement both nationally and internationally. New collaborations, partnerships, and initiatives were developed over these few days in Missouri, and will continue to develop over the coming years from friendships made. Publication of the all-elderberry volume of *Acta Horticulturae* will form the cornerstone of elderberry research and advancement for decades to come, and will serve as a springboard for additional international research, collaborations, and conferences.

Andrew L. Thomas and Patrick L. Byers

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Fifth Int'l Symposium on Human Health Effects of Fruits and Vegetables (FAVHEALTH2012)

Dr. M.B. Chetti, Symposium Convener, welcoming the participants.

The symposium was organized at the University of Agricultural Sciences, Dharwad, India from 7-8 January 2013 and from 9-11 January 2013 at the International Centre, Goa. The symposium was attended by over 150 delegates including students from 15 countries. The key sponsors for the symposium were the Indian Council of Agricultural Research, New Delhi, the National Horticulture Mission and Sathguru Foundation, Hyderabad.

The highlights of the presentations made in the different sessions are as follows:

INAUGURAL SESSION

The symposium was inaugurated by Shri. M.K. Shankaralingegowda, Principal Secretary, Horticulture Department, Government of Karnataka, Bangalore. In his inaugural address he stressed the need for conservation of the vast biodiversity of fruits and vegetables available in Karnataka and their role in food and nutritional security. Dr. N. Prabhudev, Chairman, Karnataka Health Systems Commission, Government of Karnataka, Bangalore, delivered the keynote address and emphasized the nutritive value of fruits and vegetables and their role in human health. Dr. Olaf van Kooten, Chair of the ISHS Commission Fruits and Vegetables and Health, Wageningen University, The Netherlands, Dr. Bhimu Patil, Vice-Chair of the ISHS Commission Fruits and Vegetables and Health & Director, VFIC, Texas A&M University, USA, and Dr. T.V. Muniyappa and Sri Muralidhar Bellur, Members of the Board of Management, UAS, Dharwad, were also present. Dr. R.R. Hanchinal, Vice-Chancellor, UAS, Dharwad, presided over the function. Dr. M.B. Chetti, Symposium Convener and Dean (Agri), welcomed the participants. The former Vice-Chancellors of UAS, Dharwad, Dr. J.V. Goud and Dr. J.H. Kulkarni, graced the occasion. Dr. S.M. Mantur, Symposium Co-Convener, proposed a vote of thanks.

CHALLENGES AND OPPORTUNITIES OF FAV FOR HEALTH

Dr. Bhimu Patil presented a paper on "Food and nutritional security at the intersection of horticulture, nutrition and health: Lessons learnt and future perspectives". He was of the opinion that this topic is very important in the development of India, and explained that even in USA 15-16% of people suffer from food insecurity. Dr. Patil elaborated on the causes and suggested a system-wide approach to obesity, which is a major problem in USA and leads to diabetes and cancer.

Dr. Tim O'Hare presented a paper on the challenges and opportunities for fruit and vegetable functional foods in Australia. He cited investigations done in several fruits and vegetables, viz., booster broccoli, capsicum, high lycopene tomato, and salad mixes, and their effects on vital health. He also explained how super corn and baby corn were developed in Australia and became popular in that country.

Dr. Olaf van Kooten from The Netherlands explained the positive health claims of fruits and vegetables. Deliberating on the definition of health, he observed that in India the definition is a positive one (the absence of disease), whereas in other parts of the world it is defined in negative terms.

BREEDING/GENETIC FACTORS AFFECTING BIOACTIVE COMPOUNDS

This session discussed various breeding factors associated with an increase in the bioactive components in some important crops like tomato, citrus and other tropical fruits. Information was provided on the significance of compounds that are beneficial to health to all participants from agricultural sciences and specifically to breeders.

ENVIRONMENTAL FACTORS AFFECTING BIOACTIVE COMPOUNDS

Research and findings on the influence of environment on the accumulation of health beneficial bioactive compounds were discussed in this session. Prof. Marie Olsson gave a brief account of how secondary metabolites such as carotenoids, ascorbic acid, anthocyanins, triterpenoids, etc., have been altered in carrot and other fruits and vegetables.

ANTIOXIDANTS IN FAV AND IMPROVING HUMAN HEALTH

This session consisted of presentations on the protection offered against various diseases by secondary metabolites of fruits and vegetables through their antioxidant properties. Discussions on how antioxidants can help in the prevention of stroke and other cardiovascular diseases took place. Another presentation highlighted the potential antioxidant properties of processed waste of pomegranate.

POSTHARVEST AND PROCESSING FACTORS AFFECTING BIOACTIVITIES OF FAV

Dr. Olaf van Kooten, Wageningen University, The Netherlands, presented a lead paper on "Modelling the level of the major glucosinolates

Organizers of the symposium with delegates from US and Europe.

Shri. M.K. Shankaralingegowda, Principal Secretary, Horticulture Department, Government of Karnataka, Bangalore, inaugurating FAVHEALTH2012.

(GLS) in broccoli as affected by controlled atmosphere and temperature during postharvest storage". Other papers discussed the enhancement of shelf life of fruits through postharvest treatment and the process to retain optimal levels of bioactive compounds in citrus fruits.

BIOAVAILABILITY AND BIOACCESSIBILITY OF BIOACTIVE COMPOUNDS

In this session, presentations focused mainly on factors contributing to, supporting and inhibiting bioavailability of vital compounds along with some of the screening tools available to determine bioavailability. Research was presented on the bioavailability of lycopene for prostate cancer prevention and compounds in blueberry for diabetes prevention.

AVENUES OF ENHANCING PRODUCTION / PRODUCTIVITY OF FRUITS AND VEGETABLES

Dr. Dandin (India) provided detailed information on current practices existing in India and how the same can be further improved to achieve optimum productivity of commodities for effective utilization. Other interesting topics discussed included how to enhance the health promoting compounds in citrus, sweet pepper, grapes and other widely used fruits and vegetables.

SANITARY AND PHYTOSANITARY ISSUES RELATED TO FRUITS AND VEGETABLES

Details on the Indian national regulatory mechanism based on the WTO agreement and implication of the SPS agreement on horticultural trade were discussed. Pest status, pest free areas for cultivation of fruit crops, and permitted limits of pesticides and disinfection treatments were also discussed.

ISOLATION AND CHARACTERIZATION OF BIOACTIVE COMPOUNDS

Presentations consisted of various high throughput screening techniques (flash chromatography) used for separation and purification of bioactive compounds. The session also provided details on available analytical techniques that can be used for quantification of bioactive compounds in pico molar concentration and below.

A view of the audience attending FAVHEALTH2012.

CANCER PREVENTION AND FAV

Discussions in this session focused on the theories of cancer prevention that have been accepted for decades without providing sufficient data for cancer prevention claims and Dr. Jeffery (Illinois, USA) suggested that alternative prevention proposals, using whole foods rather than drug-like purified bioactives, may bring some new vision to the area. From the presentation by Dr. K.N.C. Murthy on how to use cell culture, we were able to understand the benefit of various bioactive molecules from FAV.

OTHER THEMATIC SESSIONS

The symposium also focused on the following thematic areas:

- FAV and Sports Medicine
- Stem Cells, Inflammation and FAV
- FAV in Cardiovascular Disease and Diabetes Prevention
- FAV in Brain and Eye Health
- Skin Protection and Antimicrobial Protection from FAV
- Research in FAV: Graduate Students-Dialogue

Specific health benefits of FAV focused on eye, brain and bone health in these sessions.

M.B. Chetti

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Int'l Conference on Agricultural Engineering

Opening ceremony.

An International Conference on Agricultural Engineering, "New Technologies for Sustainable Agricultural Production and Food Security", was held at the Sultan Qaboos University (SQU) on 24-26 February, 2013, in Muscat, Oman. The conference was organized by the Department of Soils, Water and Agricultural Engineering of the College of Agricultural & Marine Sciences, SQU. This was the first engineering conference related to the field of agriculture and to the environment in general to be held in Oman.

The main objective of this conference was to provide a forum for engineers and associated professionals for discussion and sharing of information on current research developments, achievements and practical applications in all disciplines related to agricultural and biosystems engineering. The conference also aimed at highlighting the importance of the field of agricultural engineering and biosystems, especially with the increased emphasis nowadays on sustainable agriculture, environmental concerns and food security.

Most of the keynote speakers.

The conference received its main financial support from the Sultan Qaboos University and The Research Council of Oman. Other sponsors were Haya Water Company, Consolidated Contractors Company (CCC), and Al-Bareeq Company. Scientific collaborators were: Commission Horticultural Engineering of the International Society for Horticultural Science (ISHS), the American Society of Agricultural and Biological Engineers (ASABE) and the Asian Association for Agricultural Engineering (AAAE).

The conference had two main committees, namely the organizing and international scientific committees. The organizing committee consisted of members from the College of Agricultural and Marine Sciences, the College of Engineering, SQU Public Relations, the Ministry of Agriculture and Fisheries, the Royal Court, and the Oman Society of Engineers. The international scientific committee consisted of 20 members from 13 countries.

The total number of registered participants was 164, coming from 31 countries including Australia, Bangladesh, Canada, Egypt, Estonia, Ethiopia, France, Greece, India, Iran, Iraq, Japan, Jordan, Kuwait, Libya, Malaysia, Morocco, Netherlands, Nigeria, Oman, Pakistan, Palestine, Portugal, Qatar, Russia, Sri Lanka, Sudan, Turkey, United Arab Emirates, United Kingdom, and United States of America. Apart from the registered participants, many SQU students and faculty members attended the sessions. The conference organizers provided travel grants to 18 participants from developing countries.

The conference was opened on 24 February 2013 under the patronage of H.E. Mohammed bin Salim bin Said Al-Toubi, Minister of Environment and Climate Affairs, and in the presence of H.E. Dr. Fuad bin Jafar al Sajwani, Minister of Agriculture and Fisheries Wealth. In the opening ceremony Dr. Yaseen Al-Mulla, Convener, welcomed all participants and thanked everyone who made contributions in arranging the conference.

We had six distinguished keynote speakers. Professor Luis Pereira, former President of the International Commission of Agricultural Engineering (CIGR), Professor Emeritus at CEER - Biosystems Engineering, Institute of Agronomy, Technical University of Lisbon, Portugal, and co-author of the UN FAO publication (international practice standard) "Crop Evapotranspiration", presented the first keynote speech of the conference. The other keynote speakers were Professor Constantine Kittas from the Laboratory of Agricultural Constructions & Environmental Control of the University of Thessaly in Greece, Professor Digvir S. Jayas, Vice-President (Research and International) of the University of Manitoba in Canada, Dr. Steven Thomson from the United States Department of Agriculture (USDA), a Journal Editor for American Society of Agricultural and Biological Engineers (ASABE) manuscripts, Dr. Eiji Morimoto from the Department of Agricultural Engineering of the Ishikawa Agricultural Research Center in Japan, and Dr. Asadullah Al Ajmi, a former representative of the Academic Chair of His Majesty Sultan Qaboos in the field of desert farming.

During two days there were 20 oral sessions, 1 poster session, and 1 workshop on computational fluid dynamics (CFD), covering the six themes of the conference: soil and water engineering; power and machinery; precision farming; agriculture in controlled environment; food engineering and bioprocess technology; and contemporary topics in agricultural engineering.

Participants of the conference.

Technical trip.

A technical field trip was held on 26 February. A sea cruise on the Royal "Fulk Al Salama" ship was organized for 24 February in the afternoon and the conference dinner took place on 25 February. These informal occasions allowed the participants to get to know each other, exchange ideas and discuss future collaborative research projects. A closing ceremony was organized on the second day of the conference and certificates were distributed among the participants.

The conference was well covered by the media with live interviews on the national radio and television. In addition, all local (Arabic and English) newspapers and international related websites covered the event.

There are two publications arising from the conference. Firstly, a 265 page book of abstracts was published by the SQU press containing 136 of the accepted abstracts. Secondly, the accepted papers (oral and poster) will be published in the refereed Scopus indexed journal *Acta Horticulturae*.

Yaseen A. Al-Mulla and Mushtaque Ahmed

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Second Int'l Symposium on Discovery and Development of Innovative Strategies for Postharvest Disease Management

The symposium on postharvest disease management was held on April 28 – May 2, 2013 at the Fantasia Hotel in Kusadasi, Turkey on the shores of the Aegean Sea. Approximately 72 participants from 24 countries were in attendance representing researchers, industry, and graduate students. The symposium was partially supported by generous financial support from a number of private companies, including: BASF, AgroBest, Aegean Exporter's Society, SUMI AGRO, StePac, CITROSOL, TARMAK, Technidex, Syngenta, DILBAZ, ZOEpac. Most importantly, the logistics of the symposium were arranged by Prof. Pervin Kinay from Ege University in Izmir, Turkey and Dalya Tourism. All participants greatly appreciated the effort that resulted in a very informative symposium in a beautiful setting. The Dean of the College of Agriculture, Ege University, Dr. Hulya Ilbi, and the Chair of the Plant Protection Department, Dr. Zeynep Yoldas, presided over the opening of the symposium and provided the welcoming remarks.

The objectives of the symposium were to assess the current status of the development, biology, and utilization of new approaches for postharvest disease management that do not rely on the use of synthetic chemical fungicides. This includes the use of biocontrol agents such as yeast antagonists and the use of physical treatments (UV-C, heat) and natural compounds as additives or stand-alone treatments. The long-term goal of this series of symposia is to facilitate the development and use of alternative methods of postharvest disease control as effective and commercially viable approaches for postharvest disease management on a global basis. Consumers and government regulatory agencies are looking to reduce the use of chemical inputs to our harvested commodities. Feeding the world population will increasingly become a greater challenge as the amount of available arable land decreases and attempts to increase yields through breeding and technology become more difficult. It is now recognized that developing the ability to safely and effectively preserve the crops that are produced will be essential to providing an adequate food supply. That is the context that forms the basis of this ISHS Working Group on Biological Control of Postharvest Diseases and provides the long-term focus of our symposia.

Participants of the symposium.

SCIENTIFIC PROGRAM

The Convener, Prof. Pervin Kinay-Teksür, and Working Group Co-Chairs, Prof. Samir Droby and Dr. Michael Wisniewski, opened the symposium and Dr. Hulya Ilbi and Dr. Zeynep Yoldas provided welcoming remarks. This was followed by the plenary presentation given by Dr. Mark Davey, Catholic University, Leuven, Belgium, who set the tone for the rest of the symposium speaking on the topic of generating new ideas and innovative strategies to meet the short and long-term challenges of postharvest disease management.

Session I: Development and Commercial Application of Alternative Control Strategies

A global overview on the development and use of alternative strategies was provided by Dr. Neus Teixido, IRTA, Lleida, Spain. This presentation gave a realistic picture of successes and failures on the global use of alternative strategies. This was followed by a series of five specific examples on the testing and evaluation of alternative methods for postharvest disease management.

Session II: Epiphytic Microbiome and Detection Technologies

This session focused on the use of new detection technologies for determining the presence of pathogens on fruit and non-invasive determination of internal mold. Dr. Sebastian Liebe (Institute of Sugar Beet Research, Göttingen, Germany) gave a presentation on the microarray-based detection of microorganisms causing postharvest diseases of sugar beets. Dr. Piyamart Jannak (Rajamangala University of Technology, Isan, Thailand) presented a lecture on using near infrared spectroscopy to detect internal mold in tomato fruits. The session ended with an overview of postharvest decay of apples and pears in The Netherlands, given by Dr. Marcel Wenneker (Wageningen University and Research Center, Zetten, The Netherlands).

Session III: Epidemiology and Detection Technologies for Postharvest Pathogens and Their Toxic Metabolites

An interesting and enlightening presentation was given by Dr. Dani Steinberg (ARO, Bet Dagan, Israel) on the need to study the epidemiology of postharvest diseases. In the case presented, infection rates were associated with apple fruit load and so susceptibility to infection varied from year to year. The remainder of the session focused on the problem of mycotoxin production by postharvest pathogens and an excellent overview of the problem, as well as new detection technologies, was given by Dr. Simona Sanzani (University of Bari, Italy).

Session IV: Integrated Approaches for the Management of Postharvest Pathogens

Yeasts are the primary source of biocontrol agents used for the management of postharvest diseases. Prior to the start of this session a keynote presentation was given by Dr. Cletus Kurtzman (USDA-ARS, Peoria, Illinois) on the use of yeast genetic diversity for agricultural and biotechnological applications. Dr. Kurtzman is recognized as a world-wide authority on yeast taxonomy and it was a great privilege to have him as part of the symposium. This session focused on a wide range of integrated approaches to postharvest disease control. Presentations were given on the use of GRAS compounds (e.g. sodium bicarbonate, potassium sorbate), natural compounds (chitosan, essential oils), and physical treatments (hot water, UV-C) as stand-alone treatments or in combination with each other to control postharvest diseases. The use of these approaches in combination with postharvest biocontrol agents was also discussed.

Session V: Molecular and Genomic Technologies to Study Fruit-Pathogen Interactions and Host Resistance

A revolution has occurred in DNA sequencing that has made it possible to obtain the genome sequence of an increasing number of both plant and fungal species. New approaches, such as RNA-seq, are also allowing researchers to obtain a global view of gene expression during host-pathogen-biocontrol agent interactions. This session focused on how these new technologies are being utilized to develop a greater knowledge of how biocontrol systems work and to identify new sources of disease resistance. Dr. Luis Gonzalez-Candelas (IATA, Valencia, Spain) provided an "omics" insight into the pathogenicity of *Penicillium digitatum*.

Participants visiting Ephesus.

Symposium organizers. From left to right: Samir Droby, Pervin Kinay-Teksür and Michael Wisniewski.

Dr. John Norelli (USDA-ARS) provided information on how genomic information was being used to identify novel sources of postharvest disease resistance in *Malus sieversii,* a progenitor species of the modern, domesticated apple. Dr. Guozheng Quin (Chinese Academy of Sciences, Beijing, China) also provided an overview on the use of molecular and genomic technologies to study fruit-pathogen interactions. Prof. Samir Droby (ARO, Bet Dagan, Israel) provided gene expression data on yeast when they are applied to fruit tissues and Dr. Davide Spadoro (University of Torino, Italy) discussed the role of hydrolases in the biocontrol of postharvest fungal pathogens by yeast antagonists. Dr. Michael Harding (Alberta Agriculture and Rural Development, Canada) gave a fascinating presentation on microbial biofilms. Dr. Rosario Torres (IRTA, Lleida, Spain) discussed the effect of maturity stage on the wound-healing process in orange and resistance to *Penicillium digitatum*.

Session VI: New Approaches for Controlling Postharvest Diseases

This session provided an opportunity for industry representatives to provide their view of alternative disease management strategies and the challenges in developing new technologies and getting packing houses to adopt the new approaches. New products being marketed and that are in the pipeline were also discussed. This was followed by a lengthy, open discussion on topics presented during the entire symposium.

BUSINESS MEETING

A presentation was given on the mission and objectives of ISHS. The current symposium was discussed and ideas were presented on topics that could be addressed at the next symposium in three years. It was suggested to improve the communication and interaction between the members of the Working Group using various communication technologies. Dr. Michael Wisniewski and Prof. Samir Droby announced that they will be happy to step down as Co-Chairs of the Working Group as Prof. Antonio Ippolito and Prof. Pervin Kinay-Teksür were elected as the new Co-Chairs. Prof. Ippolito agreed to host the next meeting in Italy in 2016.

OTHER ACTIVITIES

A fantastic banquet was held in the evening of May 1 in which Prof. Pervin Kinay-Teksür and the Co-Chairs of the Working Group (Prof. Samir Droby and Dr. Michael Wisniewski) were recognized for their efforts in organizing the symposium. All invited speakers were also recognized for their contributions to the symposium. Dalya Tourism was recognized for providing excellent support in handling all the logistics of the symposium. After dinner, there was a great amount of socializing and dancing with excellent music being provided by a live band playing a mix of Turkish and modern popular music. The next day, there was an excursion to the amazing and extensive archeological site of Ephesus and the House of Mary (where the mother of Jesus was believed to have spent her last days). In all, the symposium received many compliments from the participants on its scientific quality, the hotel setting, and the overall quality of the audio/visual equipment in the meeting rooms.

Michael Wisniewski, Samir Droby and Pervin Kinay-Teksür

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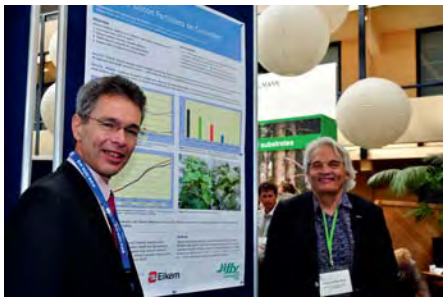
Int'l Symposium on Growing Media and Soilless Cultivation – GroSci2013



Symposium Co-Conveners Chris Blok (left picture, on the left), Erik van Os (center picture) and Wim Voogt (right picture, on the left). Photo by Wageningen UR Greenhouse Horticulture, photographer Paula van Ommen.

The rapidly increasing global demand for high quality horticultural products is identified as a chance to increase resource use efficiency. The key technique to increase resource efficiency is the collection and re-use of drainage water known as recirculation. Recirculation boosts water and nutrient use efficiency and decreases the emission of plant protection products. The use of growing media or soilless culture is a prerequisite for full recirculation.

Regarding this subject, over 225 science and industry delegates from 40 countries debated properties and possibilities of growing media and soilless culture at the GroSci2013 Symposium on 17-21 June 2013 in Leiden, The Netherlands. The symposium was organised under the auspices of the Commission Plant Substrates and Soilless Cultivation of ISHS and in cooperation with the International Peat Society. It was hosted by Wageningen UR Greenhouse Horticulture, the world's leading glasshouse horticultural research institute.

"World Wide Water Use Efficiency" was the theme for GroSci2013. In the opening session Dr. Cecelia Stanghellini emphasised that despite higher inputs of energy and nutrients, resource efficiencies reached in greenhouse horticulture (with recirculation of irrigation water) are the highest the planet has ever seen. Simple techniques such as irrigation timing, water storage and drip irrigation decrease the loss of water not used by plants. Increased climate control using screens and covers increases yields. Yield increase itself directly results in higher water use efficiencies. Compared to conventional soil growing, optimized water management techniques can improve water use efficiencies by a factor of 15! Decision makers in countries with expanding horticulture must be aware of these advantages.

The three keynote speakers for the technical sessions described state-of-the-art thinking on physical properties, chemical interactions and bio-control of rooting media.

Dr. Jean Caron showed how the focus shifts from static to dynamic quality parameters for stability and transport of water, nutrients and oxygen. For example, a static parameter for unhampered growth could be a minimum oxygen level of 3 mg/L (or more than 10% of air filled pores). A dynamic approach would say the maximum plant use in the rooting medium requires a flux of 2 mg/h through the medium, which is only possible with minimum conductivity related to a minimum air filled pore content. The advantage of the dynamic approach is that modelling can now easily evaluate any combination of rooting medium, container size, water content and plant growth.

Dr. Nikolaos Katsoulas showed how poor irriga-

Poster award winners Els Mechant, Michael Emmel and Amy Papineau (not on the picture) announced. Photo by Wageningen UR Greenhouse Horticulture, photographer Paula van Ommen.

Explanation at Sion Orchids. Photo by Wageningen UR Greenhouse Horticulture, photographer Paula van Ommen.

Lettuce on water. Photo by Wageningen UR Greenhouse Horticulture, photographer Paula van Ommen.

tion water can be used, avoiding quality problems related to the use of irrigation water with high sodium chloride content. This type of study will help growers and regional administrators to choose between options such as water pretreatment, water storage, alternative sources and drainage and discharge strategies.

Associate Professor Sammar Khalil described the progress in creating resilient systems. Rooting media offer scientists more possibilities than soils to create and control rich and diverse microbial communities. These communities may provide the desired protection against the development of plant diseases caused by bacteria and fungi. New tools to measure microbial species and environmental factors such as pH and the organic matter fractions boost the developments.

On Thursday, a day focused on substrates, the last keynote speaker, Mr. Johannes Welsch, gave the latest figures on peat use world-wide and in particular in Germany. He challenged the audience to accept peat as a sustainable growing medium and asked for fair comparisons of the alternatives on both technical and sustainability criteria. Subsequent discussions showed that increasing amounts of alternatives such as composts and coir products are mixed with peat. The resulting mixes of peat and e.g. compost and coir have properties superior to their single constituents.

Plenary debates addressed the following topics: 'Global or local production of substrates' and 'Substrate growing around cities or water based cultivation in the cities'. Small workshops offered chances to join new initiatives related to growing media.

On Tuesday and Friday successful excursions were made to the Wageningen UR Greenhouse Horticulture facility in Bleiswijk, the Klasmann-Deilmann potting soil factory in Schiedam, Sion Orchids, Deliflor chrysanthemum breeders and Dry hydroponics/Topkrop lettuce on water companies. The organisers sincerely thank these companies for their time and great interest during the visits. Organisers also wish to thank the principal sponsors associated with the symposium – Dutch Plantin; Hortimax; Grodan; Haifa; PB Techniek; Klasmann Deilmann; SQM and Prayon.

Chris Blok, Erik van Os and Wim Voogt

This symposium was the first in the Commission Plant Substrates and Soilless Culture to encompass all Working Groups of the Commission: Growing Media, Hydroponics, Aquaponics, Composting for Horticultural Applications and Substrate Analysis. The Conveners, ably assisted by Hans Verhagen from the RHP foundation, deserve very great credit for the superb organisation and hosting of this event. At the symposium dinner, it was a pleasure to welcome Dr. Cees Sonneveld, the Convener of the 1994 symposium of the Commission in Naaldwijk, along with Dr. Abraham Steiner, for long the driving force behind the International Society for Soilless Culture. Furthermore, delegates were delighted to see the Bram Steiner award for the best published paper on soilless culture given to Dr. Wim Voogt.

Bill Carlile, Chair, Commission Plant Substrates and Soilless Culture

Contact

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Commission Protected Cultivation

Int'l Workshop on Good Agricultural Practices (GAP) for Greenhouse Vegetable Production in the Mediterranean Region

The International Workshop on Good Agricultural Practices (GAP) for Greenhouse Vegetable Production in the Mediterranean Region was held from 9 to 12 December 2012 at the Dead Sea, Jordan, organized by the National Center for Agricultural Research and Extension (NCARE) in cooperation with the Food and Agriculture Organization (FAO) of the United Nations and the International Society for Horticultural Science (ISHS), represented by the Commission Protected Cultivation.

Over the last years, Near East and North African countries (NENA) adjacent to the Mediterranean Sea region have developed a sizeable greenhouse industry and have become increasingly competitive producers of greenhouse vegetables. During the last decade, there has been a revolution in greenhouse production technol-

Opening ceremony of the workshop under the patronage of His Excellency Mr. Ahmed Al-Khatab (Jordanian Minister of Agriculture), Dr. Fawzi Al-Sheyab (Director General of NCARE), Mr. Talal Al-Faiez (FAO officer representative in Jordan) and Prof. Nicolas Castilla (ISHS representative).

ogy in terms of type of greenhouse, quality of the plastic cover, fertigation, plastic mulch, new high-yield hybrids and cultivars, specific pesticides, soil solarization, etc. However, the greenhouse crop sector in this region is characterized by a predominance of small-scale farmers who produce a large range of horticultural crops for local consumption and export. The purpose of this workshop was to bring together researchers from various disciplines of protected horticulture, extension agents, policy makers and other relevant horticultural sector bodies to discuss appropriate solutions to address problems that the protected horticulture industry is facing in production and post-production areas in these countries.

More than 55 scientists and extension officers, engineers and farmers from different countries participated in the workshop. During the event, delegates got the chance to be informed of the latest results of research and technologies regarding good agricultural practices for greenhouse vegetable production. The FAO regional working group on greenhouse horticulture production in the Mediterranean region also participated in the workshop. This working group has existed since 1993, consisting of experts from countries in the Mediterranean region including Algeria, Cyprus, Egypt, Jordan, Lebanon, Libya, Malta, Morocco, Palestine, Syria, Turkey; and invited experts from Belgium, Spain, France, Italy, Germany, Greece and New Zealand.

We all believe that GAP must be conceived in the present production systems and appropriate research and experimentation programmes must be developed in order to produce good quality products respectful of the environment and consumer health. Because of that, the FAO working group on protected cultivation produced a technical manual on "Good Agricultural Practices for Greenhouse Vegetable Crops" and organized this workshop as a crowning achievement of joint efforts between the FAO regional working group in the NENA countries and the ISHS Commission Protected Cultivation in cooperation with NCARE in Jordan.

This technical manual, which was distributed to the workshop participants, illustrates the benefits that can be drawn from an "integrated production and protection" (IPP) approach linking production technologies and plant protection practices to minimize the use of pesticides and adopting "sustainable intensification" of greenhouse crop production as the guiding principle. It is in line with the new FAO "Save and Grow" paradigm that helps to limit agriculture's impact on climate change and strengthens resilience of open-field and greenhouse farming systems to socio-economic and climate risks. The authors of the manual have presented the individual chapters, a key step in the implementation of the new FAO concept for "sustainable intensification of agriculture system" known as "Save and Grow".

During the workshop, a well-organized and very interesting field trip brought the group to visit greenhouse vegetable production in Jordan Rift Valley (Jordan Valley) with its unique location at the lowest point on earth, the Dead Sea. Jordan Valley, which is characterized by a subtropical climate with hot, dry summers and mild, humid winters with low rainfall, is in fact a natural greenhouse with temperatures that in winter usually do not fall below 10-12°C and with enough light to achieve excellent quality in uncontrolled greenhouse productions. The season in this region begins in September and the first harvest takes place in January.

The success of this workshop demonstrated a demand to organize more regional conferences and workshops in the future, with special topics under the ISHS guidance and experience involving local and international experts from science, commerce and government institutions.

Fawzi Al-Sheyab and Muien Qaryouti

Contact

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Dr. Muien Qaryouti, National Center for Agricultural Research & Technology Transfer (NCARTT), PO Box 639, 19381 Baqa', Jordan, email: qaryouti@ncare.gov.jo

Eleventh Int'l Controlled and Modified Atmosphere Research Conference - |CA|MA|2013|

Participants of the conference.

|CA|MA|2013|, the XI International Controlled & Modified Atmosphere Research Conference was held in Trani (Italy) from 3 to 7 June 2013, organized by the Unit in Postharvest Technology at the University of Foggia, in cooperation with DARe Puglia and the International Society for Horticultural Science.

Italy has always been a leading country for horticultural production, with major reference to pome fruit, table grapes, kiwifruit and several vegetable crops. About 60% of the country's storage capacity, an estimated 14 million m3, is equipped with controlled atmosphere technology applied in particular for long-term storage of apples (84% of the total), pears (44%), and kiwifruit (35%). On the other hand, the vegetable industry is also very well developed (leafy greens, artichokes, potatoes and tomatoes), and Italy represents one of the largest European markets for fresh-cut salads, where modified atmosphere packaging is commonly applied. Specifically, Puglia Region contributes one fifth of national horticultural production: 70% of table grapes and sweet cherries and more than 30% of tomatoes, cauliflowers and artichokes are produced here.

There was no better location to hold the conference, which represents one of the most important international scientific meetings dedicated to postharvest aspects of fresh fruits and vegetables.

More than 230 participants, including scientific personalities, as well as key members of the industry, business representatives and students from 43 countries, participated at the event.

Dr. Sirichai Kanlayanarat, Chair of the ISHS Commission Quality and Postharvest Horticulture (left), handing out the ISHS medal award to Conference Convener Dr. Giancarlo Colelli (right).

About 200 research reports were submitted. Six keynote lectures were presented, along with 52 oral presentations in 9 regular sessions, 8 oral presentations in one special session, and 131 posters. All discussed the most recent results of R&D on applications of controlled and modified atmospheres on whole and fresh-cut products.

During |CA|MA|2013| the first edition of the "Dr. Adel A. Kader Award for Young Scientists" was introduced, with a small, symbolic sum of money awarded to two young scientists participating in |CA|MA|2013|. The award is in memory of Dr. Adel Kader, Professor Emeritus at the University of California, Davis, for his prominent scientific position in the field of postharvest biology and technology.

Further satisfaction for the organizers was due to the high number of delegates from countries where traditionally CA/MA applications are not common, including countries both developing (Egypt, Ghana, Pakistan, Palestine) and in the middle of economic growth (Brazil, India, Saudi Arabia, China, Singapore and Thailand). Not by chance Dr. Yahia Elhadi, FAO - Regional Office (Egypt), was invited to give the opening lecture on the status of CA/MA applications in developing countries, and on the increasing role of

these technologies as a tool for food security in every part of the world.

In general, the main conference topics were related to the effects of CA/MA applications on product physiology and quality, and their optimization during transport and distribution. In depth analysis was dedicated to the influence on the biosynthesis of secondary metabolites with nutraceutical properties, on sensory quality, and on physiological disorders of different commodities, also taking into account biochemical and molecular responses. A whole session was dedicated to ethylene inhibitors, including 1-MCP. In addition, a good number of presentations addressed recent developments in CA and MA atmospheres. In particular, the successful adoption of Dynamic Controlled Atmosphere (DCA) as a replacement for chemical application during storage was discussed, as well as the optimization of DCA from chlorophyll fluorescence to fruit respiration control. Other works were related to the application of CA/MA for microbial and pest control, exploring novel packaging technologies and applying hypoxic atmosphere coupled with temperature control. Finally, several speakers discussed predictive methods to improve the implementation of CA/MA. Predictive models were presented for the effect of atmosphere, temperature and time of storage on the quality of fresh products, and computational modeling was presented for the optimization of modified atmosphere packaging.

A special session was dedicated to reporting the first results of Project QUAFETY, an EU-funded collaborative project on quality and safety of fresh-cut produce, involving 14 partners from 6 countries and coordinated by the University of Foggia.

A CA/MA industry workshop was held within the sessions, where representatives from companies involved in CA/MA and in general postharvest technologies, introduced their missions and their R&D-related activities. The audience was involved in a debate, and interesting aspects emerged such as the weak linkage between R&D institutions and industry.

All covered topics represented an important opportunity for interaction among participants, sharing knowledge, ideas and inputs for international cooperation.

During the ISHS Business Meeting, the location for the next International Controlled & Modified Atmosphere Research Conference was selected, which will be Skierniewice, in Poland.

Fedele Colantuono and Giancarlo Colelli

Contact

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email: giancarlo.colelli@unifg.it

From the Secretariat

New ISHS Members

ISHS is pleased to welcome the following new members:

NEW INDIVIDUAL MEMBERS:

Argentina: Leandro Pisano, Mr. Juan Rautenstrauch; **Australia:** Mr. Salem Aljamaan, Mr. Anthony Allen, Dr. Mubarak Alrashedi, Mr. Duncan Farquhar, Mr. Tony Filippi, Mr. Philip Galloway, Mr. Nick Irani, Mr. Mark Kempster, Dr. Tahir Khurshid, Mr. Marc Lanham, Dr. Sharmane Mattinson, Michael Mifsud, Ms. Jasna Mitic, Mr. Craig Trestrail, Mr. Robert Trost; **Belgium:** Mr. Gaston Opdekamp; **Brazil:** Carlos Diniz, Prof. Dr. Sergio Schwarz; **Bulgaria:** Mr. Tihomir Dochev; **Chile:** Dr. Edgar Devaud, Marcel Foessel, Gabriel Marfan, Ms. Diana Quezada, Mr. Claudio Vial; **China:** Mr. Shouquan Ma, Mr. Shuzhen Zhang; **Colombia:** Nancy Camargo; **Costa Rica:** Dr. Ramón Molina-Bravo; **Croatia:** Assist. Prof. Aleksandar Mesic; **Egypt:** Dr. Ali R. El-Shereif; **France:** Mr. Jean-Michel Bourrousse, Vincent Omer-Decugis; **Georgia:** Mr. George Rapava; **Greece:** Mr. evangelos papadopoulos; **Hungary:** Dr. Nora Mendlerné Drienyovszki; **India:** Mr. Prasad N K, Dr. Keshav Pujari; **Indonesia:** Ass. Prof. Sandra Arifin Aziz, Dr. Muhammad Jusuf, Dr. Sarifah Nurjanah; **Iran:** Ms. Seyedeh Mahsa Mousavi Derazmahalleh, Mr. Ehsan Ranjbaran; **Israel:** Amos Cohen; **Italy:** Raffaello Castoria, Franco Nigro, Dr. Massimiliano Scalirò; **Japan:** Prof. Dr. Yuji Hara, Prof. Dr. Takahisa Hayashi, Dr. Hiroyuki Kohmura, Prof. Dr. Tamae Sugihara; **Kenya:** Ms. Everlyn Okoth, Alejandra Tapia; **Korea (Republic of):** Assist. Prof. So-Young Park; **Lebanon:** Dr. Marc El Beyrouthy; **Macedonia:** Mr. Tome Shapkarov; **Malaysia:** Shahzalan Adam, Mr. Khairul Azree Rosli, Dr. Nor Azma Yusuf; **Mexico:** Alejandro D. Coba Tun, Mr. Gerardo de los Santos, José Luis Lorenzo Manzanarez, Prof. Dulce M. Rivera Pastrana; **Netherlands:** Paulus de Bruin, Lia Pijpers; **New Zealand:** Mr. Nathan Balasingham, Dr. Elly Nederhoff; **Philippines:** Andrew Brooke Smith, Mr. Glenndie Gigante; **Portugal:** Dr. Violante Medeiros; **Romania:** Lucia Horga, Dr. Costel Pohrib; **South Africa:** Dr. Hendrik Swart; **Spain:** Daniel Molina; **Switzerland:** Mr. Andreas Graber; **Tanzania:** Dr. Srinivasulu Rajendran; **Thailand:** Mr. Taweesak Klinkong; **Turkey:** Prof. Dr. Yasar Akca, Okan Aydin, Prof. Dr. Ali Ergul, Dr. Erol Kucuk, Mr. Yasin Mercan, Prof. Dr. Mücahit Taha Özkaya; **United Arab Emirates:** Mr. ryan singlehurst; **United Kingdom:** Mr. William Deasy, Mr. Richard Friend, Ms. Angela Huckle, Ms. Rebecca Ward; **United States of America:** Roberto Ante, Dr. Gurreet Brar, Edward Burke, Duncan Cameron, Ralph Crevoshay, Dr. Pradeep Damle, Michael Dearing, Dr. Kathleen Delate, Prof. Dr. Jeffrey Ebdon, Ms. Victoria Ernst, Mr. Jonathan Fresnedo Ramírez, Dr. Osman Gutierrez, Brett Gyrti, Wanda Heuser Gale, Dr. Shahidul Islam, Dong-Man Khu, Daniel Leep, Mr. George Murray, Zion Needham, Dr. Valerie Pence, Dr. Abbas Shirazi, Mr. David Story, Stephanie Travers, Dr. Arthur Villordon, Mr. Chien Wang, Weiming Wang, Harold Wilkins, Billy Wiswall, Dr. Harrison Yoon; **Venezuela:** Prof. Dr. R.H Gutierrez.

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 menu for a comprehensive list of meetings for each Section, Commission or Working Group.
To claim reduced registration for ISHS membership your personal membership number is required when registering. Ensure your ISHS membership is current before registering, and if in doubt, sign in to your membership account and check/renew your membership status first: www.actahort.org or www.ishs.org

YEAR 2013

- September 9-13, 2013, Naivasha (Kenya): **I International Symposium on Ornamentals in Africa.** Info: Dr. Arnold Opiyo, Horticultural Association of Kenya (HAK), PO Box 562, 20100 Nakuru, Kenya. Phone: (254)723119044, Fax: (254)512111113, E-mail: aopiyo@hotmail.com Web: http://hakenya.net/index.php/ishs-symposium
- September 12-14, 2013, Kolkata (India): **IV International Conference on Landscape and Urban Horticulture: Impact of Landscape Horticulture on Development of Urban Economy with Green Environment.** Info: Nilimesh Royhowdhury, Faculty of Horticulture, BCKV, PO Mohanpur, Nadia, West Bengal 741252, India. E-mail: nilimesh59@rediffmail.com or P.K. Chattopadhyay, Faculty of Horticulture, BCKV, PO Drishiviswavidyalaya, Mohanpur, West Bengal, 741252, India. E-mail: profpkc@rediffmail.com or Prof. Dr. Sisir Kumar Mitra, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741252, West Bengal, India. Phone: (91)3325823017, Fax: (91)3325828460, E-mail: sisirm@vsnl.net Web: http://www.icluh.in/
- September 20-24, 2013, Taian (Shandong Province) (China): **III International Symposium on Pomegranate and Minor Mediterranean Fruits.** Info: Prof. Dr. Zhaohe Yuan, Shandong Institute of Pomology, 64 Longtan Rd., Tai'an, Shandong Province 271 000, China. Phone: (86)538-8334070, Fax: (86)538-8225563, E-mail: zhyuan88@hotmail.com Web: http://www.pomegranate2013.com
- September 25-27, 2013, Riva del Garda (Italy): **III International Symposium on Molecular Markers in Horticulture.** Info: Dr. Riccardo Velasco, Genomics & Biology of Fruit Crop Dept., Fondazione Edmund Mach, Via E. Mach, 1, 38010 S. Michele all'Adige, Italy. Phone: (39)0461 615 257, E-mail: riccardo.velasco@fmach.it E-mail symposium: events@fmach.it Web: http://eventi.fmach.it/Molecular-markers-2013
- October 6-11, 2013, Jeju (Korea (Republic of)): **Greensys 2013 - New Technologies for Environment Control, Energy-saving and Crop Production in Greenhouse and Plant Factory.** Info: Prof. Jung-Eek Son, Department of Plant Science, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul 151-921, Korea (Republic of). Phone: (82)28804564, Fax: (82)28732056, E-mail: sjeenv@snu.ac.kr or Prof. Dr. Yong-Beom Lee, Dept.Environmental Hortic., The University of Seoul, Jeonnong Dong Dongdaemun Ku, 130-743 Seoul, Korea (Republic of). Phone: (82)2-2210-2385, Fax: (82)2-2217-0158, E-mail: hydropo@uos.ac.kr E-mail symposium: info@greensys2013.org Web: http://www.greensys2013.org
- October 9-12, 2013, Debrecen (Hungary): **II European Congress on Chestnut.** Info: Dr. László Radócz, 138 Böszörmenyi Street, 4032 Debrecen, Hungary. Phone: (36)52508459, Fax: (36)52508459, E-mail: radocz@agr.unideb.hu or Dr. Milan Bolvansky, Institute of Forest Ecology SAS Zvolen, Branch of Woody Plants Biology, Akademická 2, 949 01 Nitra, Slovak Republic. Phone: (420)376943368, E-mail: milan.bolvansky@sav.savzv.sk or Prof. Dr. Mihai Botu, University of Craiova, SCDP Valcea, Str. Calea Traian nr. 464, 240273 Rm. Valcea, Romania. Phone: (40)250740885, Fax: (40)250740885, E-mail: stpomvl@onix.ro Web: http://www.chestnutdebrecen.eu
- October 14-16, 2013, Lima (Peru): **International Symposium on Medicinal Plants and Natural Products.** Info: Dr. Jalal Ghaemghami, PO Box 320172, West Roxbury, MA 02132, United States of America. Phone: (1)3393686838, Fax: (1)3393686838, E-mail: jalal@shmen.org or Prof. Dr. Roberto Ponugal, Universidad Global Peru, Av. Camina Real L126, Urb. Quispicanchis, Cuzco, Peru. E-mail: antigua-ishs@shmen.org Web: http://www.ISMPNP2013.org

NEW

- October 17-19, 2013, Nanchang (China): **XIII International Asparagus Symposium.** Info: Prof. Chen Guangyu, Jiangxi Academy of Agricultural Sciences, 330200 Nanchang, Jiangxi Province, China. Phone: (86)7917090308, Fax: (86)7917090001, E-mail: genebksh@hotmail.com E-mail symposium: asparaguschina@vip.sina.com Web: http://www.ias2013China.com

NEW

- October 20-25, 2013, Santiago (Chile): **II International Symposium on Organic Matter Management and Compost Use in Horticulture.** Info: Dr. Rodrigo Ortega, Avenida Santa Maria 6400, Vitacura, Santiago, Chile. Phone: (56)2-3531330, Fax: (56)2-3531228, E-mail: rodrigo.ortega@usm.cl E-mail symposium: ishs2013chile@usm.cl Web: http://www.compost-for-horticulture.com
- October 28-31, 2013, Avignon (France): **II International Symposium on Organic Greenhouse Horticulture.** Info: Nicolas Sinoir, ITAB, 149 rue de Bercy, 75595 Paris Cedex 12, France. Phone: (33)467062370, E-mail: nicolas.sinoir@itab.asso.fr or Jérôme Lambion, GRAB, BP 11283, 84911 Avignon Cedex 9, France. Phone: (33)490840170, Fax: (33)490840037, E-mail: jerome.lambion@grab.fr Web: http://www.amiando.com/OGH_Symposium2013.html
- October 28-31, 2013, Palermo (Italy): **VIII International Congress on Cactus Pear and Cochineal.** Info: Prof. Dr. Paolo Inglese, Department DEMETRA, Università degli Studi di Palermo, Viale delle Scienze, ED. 4, 90142 Palermo, Italy. Phone: (39)09123861234, Fax: (39)09123860820, E-mail: paolo.inglese@unipa.it or Prof. Dr. Innocenza Chessa, Dept. Of Economic & Woody Plants, University of Sassari, Via E. de Nicola 9, 07100 Sassari, Italy. E-mail: chessa_i@uniss.it E-mail symposium: cactus2013@unipa.it Web: http://www.soishs.org/cactuspear/
- November 4-8, 2013, Tbilisi (Georgia) and Yerevan (Armenia): **International Symposium on Fruit Culture and its Traditional Knowledge along Silk Road Countries.** Info: Dr. Gagik Santrosyan, National Agrarian University, 74 Teryan Street, Yerevan, Armenia. Phone: (374)10528677, E-mail: g.santrosyan@asau.am or Dr. Aleksandr Kalantaryan, Head of Development Division, Raed Piu, 37 Mamikonyants street. ap.49, 00010 Yerevan, Armenia. Phone: (374)94 237805, E-mail: alikjan@gmail.com or Dr. David Bedoshvili, Agricultural University of Georgia, 13.Km Alley David Aghmashenebeli, Tbilisi 0131, Georgia. Phone: (995)577210905, E-mail: d.bedoshvili@agruni.edu.ge Web: http://www.silksym.com
- November 19-22, 2013, Mt Maunganui (New Zealand): **I International Symposium on Bacterial Canker of Kiwifruit (Psa).** Info: Dr. David J. Tanner, General Manager - Science & Innovation, ZESPRI International, PO Box 4043, Mt Maunganui South, New Zealand. Phone: (64)75727665, Fax: (64)75748031, E-mail: david.tanner@zespri.com Web: http://www.psa2013.co.nz/
- December 4-7, 2013, Vientiane (Laos): **II Southeast Asia Symposium on Quality Management in Postharvest Systems.** Info: Dr. Antonio Acedo Jr, Postharvest Technology Division, Department of Horticulture, Visayas State University, 6521 Leyte Baybay, Philippines. Phone: (63)53-5637135), Fax: (63)53-3352752, E-mail: junacedo@yahoo.com or Dr. Sirichai Kanlayanarat, King Mongkut's University of Technology, Thonburi, Division of Postharvest Technology, Thungkhru, Bangkok 10140, Thailand. Phone: (66)2 470 7720, Fax: (66)2 452 3750, E-mail: sirichai.kan@kmutt.ac.th E-mail symposium: sea2013.ishs@gmail.com Web: http://www.kmutt.ac.th/SEAsia2013

YEAR 2014

- NEW February 19-21, 2014, Bangkok (Thailand): **II International Orchid Symposium.** Info: Assist. Prof. Apiradee Uthairatanakij, 83 M.8 Tientalay Rd., Bangkhuntien, Bangkok 10150, Thailand. Phone: (66)02 470 724, E-mail: apiradee.uth@kmutt.ac.th or Chin-An Chang, Chaoyang Technology University, 168 Jifong E. Rd.,, Wufong Township Taichung County, 413 Taichung, Chinese Taipei. Phone: (886)423331089, E-mail: cachang@cyut.edu.tw or Prof. Dr. Fure-Chyi Chen, 1 Hsue-fu Rd, National Pingtung University of Sci & Tech, Department of Plant Industry, 91201 Pingtung, Nei-pu Town, Chinese Taipei. Phone: (886)8-7740371, E-mail: fchen@mail.npust.edu.tw Web: http://www.kmutt.ac.th/IOS2014/
- NEW March 17-21, 2014, Wuhan, Hubei Province (China): **I International Symposium on Vegetable Grafting - ISVG2014.** Info: Prof. Dr. Zhilong Bie, Huazhong Agricultural University, College of Horticulture & Forestry, Wuhan 430070, Hubei Province, China. Phone: (86)27-87286908, Fax: (86)27-87282010, E-mail: biezhilong@hotmail.com Web: http://www.grafting2014.com
- April 1-3, 2014, Zhangzhou, Fujian (China): **III International Symposium on the Genus Lilium.** Info: Dr. J.M. Van Tuyl, Plant Breeding, Wageningen University & Research Center, Droevendaalse steeg 1, 6708 PB Wageningen, Netherlands. Phone: (31)317481085, Fax: (31)317483457, E-mail: jaap.vantuyl@wur.nl or Dr. Wangzhao Zhu, No. 1 Wageningen Road, Zhangzhou, Fujian, 363105, China. Phone: (86)5966859258, E-mail: zhu@seadc.com Web: http://www.lilium2014.org
- April 7-12, 2014, Baku (Azerbaijan): **II International Symposium on Wild Relatives of Subtropical and Temperate Fruit and Nut Crops.** Info: Dr. Zeynal Akparov, Genetic Recources Institute ANAS, 155 Azadlig Ave, 1106 Baku, Azerbaijan. Phone: (994)125639171, Fax: (994)124499221, E-mail: akparov@yahoo.com
- May 12-15, 2014, Palermo (Italy): **IV International Symposium on Loquat.** Info: Dr. Francesca Barone, Università degli Studi di Palermo, Dept.of Agricultural & Forestry Sciences, Viale delle Scienze, 90128 Palermo, Italy. E-mail: baronefr@unipa.it or Dr. Riccardo Lo Bianco, Università degli Studi di Palermo, Dept.of Agricultural & Forestry Sciences, Viale delle Scienze 11, 90128 Palermo, Italy. Phone: (39) 09123896092, Fax: (39) 09123860813, E-mail: riccardo.lobianco@unipa.it Web: http://www.loquatsymposium2014.org/
- NEW June 8-11, 2014, Sirmione (Italy): **XIII International Symposium on the Processing Tomato - XI World Processing Tomato Congress.** Info: Dr. Adriano Battilani, c/o Consorzio di Bonifica di, 2°Grado Canale Emiliano Rom., Via E. Masi 8, 40137 Bologna, Italy. Phone: (39)0514298811, Fax: (39)051390422, E-mail: battilani@consorziocer.it or Prof. Dr. Montaña Cámara, Dpto. Nutrición y Bromatología II, Facultad Farmacia. UCM, Plaza Ramón y Cajal sn, 28040 Madrid, Spain. Phone: (34) 913941808, Fax: (34) 913941799, E-mail: mca-mara@farm.ucm.es E-mail symposium: wptc2014@tomate.org Web: http://www.worldtomatocongress.com
- June 10-13, 2014, Lemesos (Cyprus): **V International Conference Postharvest Unlimited.** Info: Assist. 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 or Dr. Panagiotis Kalaitzis, Mediterranean Agronomic Inst. Of Chania, 85, Macedonia Str. P.O. Box 85, 73100 Chania, Greece. E-mail: panagiot@maich.gr E-mail symposium: a.orphanides@cut.ac.cy Web: http://web.cut.ac.cy/postharvest/
- July 13-18, 2014, Torino (Italy): **VIII International Symposium on Chemical and Non-Chemical Soil and Substrate Disinfestation.** Info: Prof. Maria Lodovica Gullino, Univ.delgi Studi di Torino, Patologia Vegetale, Via Leonardo da Vinci 44, 10095 Grugliasco (TO), Italy. Phone: (39)0116708539, Fax: (39)0116708541, E-mail: marialodovica.gullino@unito.it or Prof. Angelo Garibaldi, Univ.degli Studi di Torino, Patologia Vegetale, Via Leonardo da Vinci 44, 10095 Grugliasco (TO), Italy. Phone: (39)0116708539, Fax: (39)0116708541, E-mail: angelo.garibaldi@unito.it E-mail symposium: SD2014@unito.it Web: http://www.sd2014.org
- NEW July 14-18, 2014, Leuven (Belgium): **XII International Pear Symposium.** Info: Dr. Tom Deckers, Proefcentrum Fruitteelt vzw, Fruittuinweg 1, 3800 Sint Truiden, Belgium. Phone: (32)11586960, Fax: (32)11674318, E-mail: tom.deckers@pcfruit.be Web: http://www.pcfruit.be/12th_International_Pear_Symposium_ISHS/27076/pcfruit
- July 28 - August 8, 2014, Beijing (China): **XI International Conference on Grapevine Breeding and Genetics.** Info: Dr. Li Shao-Hua, Institute of Botany, Chinese Academy of Sciences, Beijing, 210095, China. Phone: (86)0162836026, Fax: (86)0162836026, E-mail: shhli@ibcas.ac.cn or Dr. Chen Zong-Ming, Institute of Botany, Chinese Academy of Sciences, Beijing, 210095, China. Phone: (86)0162836026, Fax: (86)0162836026, E-mail: zmc@njau.edu.cn Web: http://www.grapebreeding2014.com/publish/portal4/tab164
- August 17-22, 2014, Brisbane (Australia): **XXIX International Horticultural Congress: IHC2014.** Info: Prof. Dr. Roderick A. Drew, Griffith University, Nathan Campus, Nathan Q4111, Australia. Phone: (61)737357292, Fax: (61)737357618, E-mail: r.drew@griffith.edu.au or Prof. Dr. Ian J. Warrington, Emeritus Professor, Massey University, Private Bag 11 222, Palmerston North, New Zealand. Phone: (64)63505243, Fax: (64)63575619, E-mail: ianjw@xtra.co.nz or 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: info@ihc2014.org Web: http://www.ihc2014.org/

SYMPOSIA AT IHC BRISBANE 2014

- August 17-22, 2014, Brisbane (Australia): **III International Jujube Symposium.** Info: Prof. Dr. Mengjun Liu, Research Center of Chinese Jujube, Agricultural Univesity of Hebei, Baoding, Hebei, 71001, China. Phone: (86)312754342, Fax: (86)3127521251, E-mail: lmj1234567@yahoo.com.cn or Dr. Guijun Yan, School of Plant Biology MO84, The University of Western Australia, 35 Stirling Hwy, Crawley WA 6009, Australia. Phone: (61) 8 6488 1240, Fax: (61) 8 6488 1108, E-mail: guijun.yan@uwa.edu.au Web: http://www.ihc2014.org/symposium_43.html
- August 17-22, 2014, Brisbane (Australia): **VIII International Pineapple Symposium.** Info: Dr. Garth Sanewski, Maroochy Research Station, PO Box 5083, SCMC, 47 Mayers Rd, Nambour Queensland 4560, Australia. Phone: (61)7 54535949, Fax: (61)7 54535901, E-mail: garth.sanewski@daff.qld.gov.au Web: http://www.ihc2014.org/symposium_35.html
- August 17-22, 2014, Brisbane (Australia): **VII International Symposium on Education, Research Training and Consultancy.** Info: Dr. Alan Hunter, School of Agr., Food Sci and Vet Medicine, Agriculture and Food Science Centre, University College Dublin, Belfield, Dublin 4, Ireland. Phone: (353)1 716 7754, Fax: (353)1 716 1104, E-mail: alan.hunter@ucd.ie or Associate Professor Dr. David Aldous, 37 McCartney Street, Ormiston, QLD 4160, Australia. Phone: (61)07 3821 2082, E-mail: dealdous@gmail.com Web: http://www.ihc2014.org/symposium_20.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Eco-efficiency in the Lifecycle of Horticultural Production.** Info: Brent Clothier, Plant & Food Research, Climate Lab, Batchelar Road, PO Box 11-600, 4442 Palmerston North, New Zealand. Phone: +64 (6) 953-7687, E-mail: brent.clothier@plantandfood.co.nz or Dr. Ian Goodwin, Senior Research Scientist, Department of Primary Industries, Private Mailbag 1, Tatura, VIC 3616, Australia. Phone: (61)358335222, Fax: (61)358335299, E-mail: ian.goodwin@dpi.vic.gov.au Web: http://www.ihc2014.org/symposium_31.html

- August 17-22, 2014, Brisbane (Australia): **V International Conference on Landscape and Urban Horticulture.** 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 Associate Professor Dr. David Aldous, 37 McCartney Street, Ormiston, QLD 4160, Australia. Phone: (61)07 3821 2082, E-mail: dealdous@gmail.com Web: http://www.ihc2014.org/symposium_28.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Plant Breeding in Horticulture.** 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 or Dr. Alastair Currie, Plant and Food Research, 55 Old Mill Rd, RD3, Motueka 7198, New Zealand. E-mail: alastair.currie@plantandfood.co.nz Web: http://www.ihc2014.org/symposium_23.html
- August 17-22, 2014, Brisbane (Australia): **II International Berry Fruit Symposium: Interactions! Local and Global Berry.** Info: Dr. Chad E. Finn, USDA ARS, Hort. Crops Lab., 3420 NW Orchard Ave., Corvallis, OR 97330, United States of America. Phone: (1)541738-4037, Fax: (1)541738-4025, E-mail: chad.finn@ars.usda.gov or Prof. Dr. Bruno Mezzetti, Dip.di Scienze Amb. e delle Prod.Veg., Università Politecnica delle Marche, Via Brecce Bianche, Ancona 60100, Italy. Phone: (39)0712204933, Fax: (39)0712204856, E-mail: b.mezzetti@univpm.it Web: http://www.ihc2014.org/symposium_12.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Tropical Fruit.** Info: Mr. Robert Nissen, 3 Maheno Court, Tin Can Bay, QLD 4580, Australia. Phone: (84) 838254457, Fax: (84) 838254457, E-mail: robertnissenahi1@gmail.com or Prof. Dr. Sisir Kumar Mitra, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741252, West Bengal, India. Phone: (91)3325823017, Fax: (91)3325828460, E-mail: sisirm@vsnl.net or Dr. Songpol Somsri, Senior Export Office, Horticulture Research Institute, Department of Agriculture, Chatuchak, Bangkok 10900, Thailand. Phone: (66)25790583, Fax: (66)25614667, E-mail: songpolsom@yahoo.com Web: http://www.ihc2014.org/symposium_37.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Micropropagation and In Vitro Techniques.** Info: Dr. Maurizio Lambardi, IVALSA/Trees and Timber Institute, National Research Council (CNR), Polo Scientifico, via Madonna del Piano 10, I-50019 Sesto Fiorentino, Firenze, Italy. Phone: (39) 055 5225685, Fax: (39) 055 5225656, E-mail: lambardi@ivalsa.cnr.it or Sharon Ms. Hamill, Maroochy Research Facility, PO Box 5083 SCMC, Nambour Q4560, Australia. Phone: (61)754535942, Fax: (61)754535901, E-mail: sharon.hamill@daff.qld.gov.au or Prof. Dr. Roderick A. Drew, Griffith University, Nathan Campus, Nathan Q4111, Australia. Phone: (61)737357292, Fax: (61)737357618, E-mail: r.drew@griffith.edu.au Web: http://www.ihc2014.org/symposium_26.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Global Development and World Food Production.** Info: Dr. Alistair Gracie, Univ. of Tasmania TIAR, Private Bag 98, Hobart, Tasmania 7001, Australia. Phone: (61) 3 6226 7468, E-mail: alistair.gracie@utas.edu.au or Dr. Makiko Taguchi, FAO, Plant Production and Protection Division, Viale delle Terme di Caracalla, 00153 Rome, Italy. E-mail: makiko.taguchi@fao.org or Mr. Francis Appiah, Kwame Nkrumah University, Faculty of Agriculture, Department of Postharvest Technology, Knust, Kumasi, Ghana. Phone: (233)242070556, Fax: (233)5163769, E-mail: fappiah_sp@yahoo.com Web: http://www.ihc2014.org/symposium_3.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Organic Waste to Horticultural Resource.** Info: Dr. W.R. Carlile, Bord na Móna (Horticulture), Main Street, Newbridge, Co.Kildare, Ireland. E-mail: bill.carlile@bnm.ie Web: http://www.ihc2014.org/symposium_30.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Plants, as Factories of Natural Substances, Edible & Essential Oils.** Info: Prof. Dr. Ákos Máthé, Borbély Street 5, 1132 Budapest, Hungary. Phone: (36)13204007, Fax: (36)13204007, E-mail: akos.mathe@upcmail.hu or Dr. Vera Sergeeva, 15/2 Hilts road, Strathfield NSW,2135, Australia. E-mail: sergeeva@tpg.com.au Web: http://www.ihc2014.org/symposium_42.html
- August 17-22, 2014, Brisbane (Australia): **IV International Symposium on Plant Genetic Resources: Genetic Resources for Climate Change.** Info: Dr. Hannah Jaenicke, Burghof 26, Schloss Gelsdorf, 53501 Grafschaft-Gelsdorf, Germany. Phone: (49)2225-8389895, E-mail: hannah.jaenicke@t-online.de or Dr. Sarah Ashmore, Griffith University, School of BBS, Kessels Rd. nathan, Brisbane, QLD 4111, Australia. Phone: (61)37357346, Fax: (61)37357656, E-mail: s.ashmore@griffith.edu.au or Dr. Luigi Guarino, The Global Crop Diversity Trust, c/o FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy. E-mail: luigi.guarino@croptrust.org Web: http://www.ihc2014.org/symposium_27.html
- August 17-22, 2014, Brisbane (Australia): **XVII International Symposium on Horticultural Economics and Management & V International Symposium on Improving the Performance of Supply Chains in the Transitional Economies.** Info: Dr. Peter J. Batt, Horticulture, Curtin University of Technology, GPO box U1987, Perth, WA 6845, Australia. Phone: (61)8 9266 7596, Fax: (61)8 9266 3063, E-mail: p.batt@curtin.edu.au or Prof. Dr. Peter P. Oppenheim, 3 Brooke Drive, Doncaster East, Victoria 3109, Australia. Phone: (61)3 9842 0145, E-mail: peter.oppenheim@ymail.com Web: http://www.ihc2014.org/symposium_21.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on the Impact of Asia-Pacific Horticulture - Resources, Technology and Social Welfare.** Info: Prof. Dr. Ki Sun Kim, Department of Plant Science, CALS, Seoul National University, Seoul 151-921, Korea (Republic of). Phone: (82)2-880-4561, Fax: (82)2-873-2056, E-mail: kisun@snu.ac.kr or Prof. Dr. Rifei Sun, Inst. of Vegetables and Flowers, Chinese Academy of Agric. Sci., 12 Zhongguancun Nandajie, Beijing 100081, China. Phone: (86)1082109511, E-mail: rifei.sun@caas.net.cn 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 Web: http://www.ihc2014.org/symposium_4.html
- August 17-22, 2014, Brisbane (Australia): **XII International People Plant Symposium: Horticulture and Human Communities: People, Plants and Places.** Info: Dr. Candice Shoemaker, 2021 Throckmorton, Department of Hort, Forestry, Rec Res, Kansas State University, Manhattan, KS 66506, United States of America. Phone: (1)7855321431, Fax: (1)7855326849, E-mail: cshoemak@ksu.edu or Prof. Dr. Francesco Di Iacovo, Dept. of Veterinary Science, University of Pisa, Vle Piagge 2, Pisa, Italy. E-mail: francovo@vet.unipi.it or Dr. Erja Rappe, Agricultural and Food Science, Editorial office, Department of Agricultural Sciences, PO Box 27, FI-00014 University of Helsinki, Finland. E-mail: erja.rappe@helsinki.fi Web: http://www.ihc2014.org/symposium_2.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Molecular Biology in Horticulture.** Info: Prof. Dr. Rosario Muleo, Dept.. Crop Production, Università della Tuscia, Via S.C. De Lellis snc, Viterbo 01100, Italy. Phone: (39)0761357532, Fax: (39)761357531, E-mail: muleo@unitus.it or David Chagne, The NZ Institute for Plant & Research Ltd., Private bag 92169, Auckland Mail Ctr,, 1142 Auckland, New Zealand. E-mail: david.chagne@plantandfood.co.nz Web: http://www.ihc2014.org/symposium_24.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on the Non-destructive Assessment of Fruit Attributes.** Info: Prof. Guglielmo Costa, Full Professor of

Arboriculture, Dept. of Fruit Trees and Woody Plant Sci., Via G. Fanin 46, 40127 Bologna, Italy. Phone: (39)051 20 9 6443, Fax: (39)051 20 9 6401, E-mail: guglielmo.costa@unibo.it or Assist. Prof. Kerry Walsh, Plant Sciences Group, Central Queensland University, Bruce Highway, North Rockhampton QLD 4702, Australia. Phone: (61)749309707, Fax: (61)749306536, E-mail: k.walsh@cqu.edu.au Web: http://www.ihc2014.org/symposium_17.html

- August 17-22, 2014, Brisbane (Australia): **International Symposium on Postharvest Knowledge for the Future.** Info: Prof. Julian Heyes, Inst of Food, Nutrition & Human Health, Massey University, Private Bag 11222, Palmerston North, New Zealand. Phone: (64)63505963, Fax: (64)63517050, E-mail: j.a.heyes@massey.ac.nz or Dr. John Golding, NSW DPI, Gosford Horticultural Institute, Locked Bag 26, Gosford NSW 2250, Australia. Phone: (61) 02-43481926, Fax: (61) 02-43481910, E-mail: john.golding@dpi.nsw.gov.au or Dr. Peter A. Toivonen, Ag. & Agri-Food Canada, Summerland, British Columbia, V0H 1Z0, Canada. Phone: (1)2504946386, Fax: (1)2504940755, E-mail: peter.toivonen@agr.gc.ca Web: http://www.ihc2014.org/symposium_19.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Innovative Plant Protection in Horticulture.** Info: Dr. Chris Hale, 83 Edmonton Road, Henderson, Auckland, New Zealand. Phone: (64)98387956, E-mail: hale@actrix.co.nz Web: http://www.ihc2014.org/symposium_18.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Mango.** Info: Dr. Chitose Honsho, Faculty of Agriculture, University of Miyazaki, 1-1, Gakuenkibanadai Nishi, Miyazaki 889-2192, Japan. Phone: (81)985-58-7988, Fax: (81)985-58-7988, E-mail: chitose@cc.miyazaki-u.ac.jp or Dr. Wasan Pongsomboon, Phichit Agric. Res. & Develop. Center, Rongchang, Muang, Phichit 66000, Thailand. E-mail: wasan_psb@hotmail.com Web: http://www.ihc2014.org/symposium_39.html
- August 17-22, 2014, Brisbane (Australia): **IV International Symposium on Papaya.** Info: Dr. Maureen Fitch, Hawaii Agriculture Research Center, P.O. Box 100, Kunia, HI 96759, United States of America. E-mail: mfitch@harc-hspa.com or Dr. Yun Judy Zhu, Hawaii Agriculture Research Centre, P.O. Box 100, Kunia, HI 96759, United States of America. E-mail: jzhu@harc-hspa.com or Prof. Dr. Roderick A. Drew, Griffith University, Nathan Campus, Nathan Q4111, Australia. Phone: (61)737357292, Fax: (61)737357618, E-mail: r.drew@griffith.edu.au Web: http://www.ihc2014.org/symposium_34.html
- August 17-22, 2014, Brisbane (Australia): **IV International Symposium on Tropical Wines and International Symposium on Grape and Wine Production in Diverse Regions.** Info: Prof. Paul E. Read, Univ. Nebraska, Inst. of Agr., & Nat. Resources, Dept. Hort., 377 Plant Sci., East Campus, Lincoln, NE 68583-0724, United States of America. Phone: (1)402-472-2854, Fax: (1)402-472-8650, E-mail: pread@unl.edu Web: http://www.ihc2014.org/symposium_10.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Tropical Ornamentals.** Info: Ms. Doris Marcsik, GPO Box 3000, Darwin Northern Territory 0801, Australia. Phone: (61) 8 89992017, E-mail: doris.marcsik@nt.gov.au or Dr. Vivian Loges, Univ.Federal Rural de Pernambuco, Rua José Bezerra de Albuquerque 38a, Recife, 54315-580, Brazil. Phone: (51)8134624552, Fax: (51)8133206250, E-mail: vloges@yahoo.com Web: http://www.ihc2014.org/symposium_38.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Sustainable Management in the Urban Forest.** Info: Dr. Greg Moore, University of Melbourne, Burnley Campus, Swan Street, Richmond Victoria 3121, Australia. E-mail: gmmoore@unimelb.edu.au or Mr. Neville Fay, The Old Rectory, Pilgrims Way, Chew Stoke, BS408TT Somerset Bristol, United Kingdom. Phone: (44)7968489588, E-mail: nevfay@treeworks.co.uk or David Lawry, Chair, TREENET, Director, Lawrys Landscapes & Nurseries, 580 Cherry Gardens Road, Cherry Gardens SA 5157, Australia. E-mail: david@treenet.org Web: http://www.ihc2014.org/symposium_33.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Water Scarcity, Salinization and Plant Water Relations for Optimal Production and Quality.** Info: Dr. Richard L. Snyder, University of California, 1 Shields Avenue, 243 Hoagland Hall, Davis, CA 95616-8627, United States of America. Phone: (1)5307524628, Fax: (1)5307521552, E-mail: rlsnyder@ucdavis.edu or Dr. Samuel Ortega-Farias, Casilla 747, Talca, Chile. Phone: (56)71200214, Fax: (56)71200214, E-mail: sortega@utalca.cl Web: http://www.ihc2014.org/symposium_5.html
- August 17-22, 2014, Brisbane (Australia): **III International Genetically Modified Organisms in Horticulture Symposium - Past, Present and Future.** Info: Dr. Bart Panis, Lab. Tropical Crop Improvement, Willem de Croylaan 42, bus 2455, 3001 Leuven, Belgium. Phone: (32)16-321690, Fax: (32)16-321993, E-mail: bart.panis@biw.kuleuven.be or Dr. Trine Hvoslef-Eide, Norwegian University of Life Sciences, UMB, Boks 5003, 1432 Aas, Norway. Phone: (47) 64 96 50 04, Fax: (47) 64 96 60 24, E-mail: trine.hvoslef-eide@umb.no or Dr. Violy Villegas, Syngenta Philippines, 12th F, Two World Square, 22 Upper McKinley Rd., Fort Bonifacio, 1630 Taguig City, Philippines. E-mail: violeta.villegas@syngenta.com Web: http://www.ihc2014.org/symposium_25.html
- August 17-22, 2014, Brisbane (Australia): **III International Conference on Turfgrass Management and Science for Sports Fields.** Info: Prof. Dr. Panayiotis Nektarios, Dept. of Floriculture and Landscape Archite, Agricultural University of Athens, 75, Iera Odos, 118 55 Athens, Greece. Phone: (30)210 5294554, Fax: (30)210 5294553, E-mail: pan@aua.gr Web: http://www.ihc2014.org/symposium_29.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on New Technologies in Protected Cultivation.** Info: Prof. Stefania De Pascale, University of Naples, Department of Agricultural Eng. & Agronomy, Via Universita 100, 80055 Portici (Naples), Italy. Phone: (39)0812539127, Fax: (39)0817755129, E-mail: depascal@unina.it or Mr. Geoff Connellan, 372 Main Road, Lower Plenty Lower PLenty 3093, Australia. Phone: (61) (3) 9439 9830, Fax: (61) (3) 9431 2829, E-mail: geoffc@unimelb.edu.au or Prof. Weijie Jiang, Institute of Vegetables and Flowers, Chinese Academy of Agric. Sciences, 12 Zhongguancun S. Street, Beijing 100081, China. Phone: (86)1068918797, Fax: (86)1062174123, E-mail: jiangwj@mail.caas.net.cn Web: http://www.ihc2014.org/symposium_22.html
- August 17-22, 2014, Brisbane (Australia): **VI International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2014.** Info: Dr. Tim O'hare, Gatton Research Station, Locked Bag 7, MS 437, Gatton Q4343, Australia. E-mail: t.ohare@uq.edu.au or Prof. Dr. Olaf Van Kooten, Wageningen University, Horticultural Production Chains Group, PO Box 630, 6700 AP Wageningen, Netherlands. Phone: (31)317-484091, E-mail: olaf.vankooten@wur.nl or Dr. Bhimanagouda Patil, VFIC, Texas A&M University, Department of Horticulture, 1500 Research Parkway Ste A120, College Station, TX 77845, United States of America. Phone: (1)9794588090, Fax: (1)9798624522, E-mail: bpatil@ag.tamu.edu Web: http://www.ihc2014.org/symposium_1.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Mechanisation, Precision Horticulture, and Robotics in Fruit and Vegetable Production.** Info: Dr. Matthew Whiting, Washington State University, IAREC, 24106 N. Bunn Road, Prosser, WA 99350, United States of America.

E-mail: mdwhiting@wsu.edu or John McPhee, Vegetable Centre, Tasmanian Institute of Agriculture, Private Bag 3523, Burnie Tasmania 7320, Australia. E-mail: john.mcphee@utas.edu.au Web: http://www.ihc2014.org/symposium_16.html

- August 17-22, 2014, Brisbane (Australia): **International Symposium on Ornamental Horticulture in the Global Greenhouse.** Info: Dr. Ed Morgan, Plant & Food Research, Private Bag 11600, Palmerston North 4442, New Zealand. Phone: (64) 6 3568300, Fax: (64) 6 3517050, E-mail: ed.morgan@plantandfood.co.nz or Prof. Dr. Richard A. Criley, Dept. of Tropical Plant & Soil Sci., University of Hawaii, 3190 Maile Way, No. 102, Honolulu, HI 96822, United States of America. Phone: (1)808-956-8492, Fax: (1)808-956-3894, E-mail: criley@hawaii.edu or Prof. Dr. Margrethe Serek, Leibniz University of Hannover, Faculty of Natural Sciences, Herrenhäuser Str. 2, 30419 Hanover, Germany. Phone: (49)511 762 2657, Fax: (49)511 762 2654, E-mail: serek@zier.uni-hannover.de Web: http://www.ihc2014.org/symposium_15.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Horticulture to Improve the Livelihoods of Communities in Developing Countries.** 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. Steven Underhill, 32 Stanley Terrace, Taringa Queensland 4068, Australia. Phone: (61)7 3371 6429, E-mail: s.underhill@uq.edu.au Web: http://www.ihc2014.org/symposium_6.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Physiology of Perennial Fruit Crops and Production Systems in a Changing Global Environment.** Info: Dr. Stuart Tustin, HortResearch, Havelock N-Res.C, Private Bag 1401, Havelock North, New Zealand. Phone: (64)68778196, Fax: (64)68774761, E-mail: stuart.tustin@plantandfood.co.nz or Dr. Ben van Hooijdonk, Plant and Food Research, Hawkes Bay, Private Bag 1401, Havelock North, 4130, New Zealand. E-mail: ben.vanhooijdonk@plantandfood.co.nz Web: http://www.ihc2014.org/symposium_8.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Biosecurity, Quarantine Pests and Market Access.** Info: Dr. Bob Ikin, 25 Mayfair Place, Boondall, Queensland 4034, Australia. E-mail: bobikin@bigpond.net.au or Dr. Peter Whittle, 81 Diamond Street, Holland Park, Queensland 4121, Australia. Phone: (61)732393953, Fax: (61)732113253, E-mail: peter.whittle@qut.edu.au Web: http://www.ihc2014.org/symposium_32.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Abscission Processes in Horticulture and their Manipulation to Improve Crop Growth, Development and Quality.** Info: Dr. Shimon Meir, Dept.Postharvest Sci.Fresh Pr., The Volcani Center, ARO, PO Box 6, Bet Dagan 50250, Israel. Phone: (972)39683667, Fax: (972)39683622, E-mail: shimonm@volcani.agri.gov.il or Jeremy Roberts, University of Nottingham, School of Biosci. Sutton Bonington Campus, LE12 5RD Loughborough, United Kingdom. E-mail: jeremy.roberts@nottingham.ac.uk or Prof. Dr. Jens N. Wuensche, University of Hohenheim, Department of Crop Science, Section: Crop Physiology of Specialty Crops, 70599 Hohenheim, Emil-Wolff-Str. 25, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de Web: http://www.ihc2014.org/symposium_9.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Consumer and Sensory Driven Improvements to the Quality of Fruits and Nuts.** Info: Dr. Yair Erner, Department of Fruit Tree Sciences, ARO, The Volcani Center, PO Box 6, Bet-Dagan 50-250, Israel. Phone: (972)3-9683414, Fax: (972)3-9669583, E-mail: yerner@volcani.agri.gov.il or Dr. Damiano Avanzato, International Horticulturist Consultant, Via Casaserena, 42, 00040 Pomezia (Roma), Italy. Phone: (39)3381109542, E-mail: damiano.avanzato@gmail.com or Dr. Roger Harker, Hort. Research, Mt. Albert Research Ctr Private Bag 92169, Auckland, New Zealand. E-mail: roger.harker@plantandfood.co.nz Web: http://www.ihc2014.org/symposium_11.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Indigenous Vegetables.** Info: Dr. Dyno Keatinge, AVRDC-The World Vegetable Ctr., P.O. Box 42, 741 Tainan Shanhua, Chinese Taipei. Phone: (886-6) 583 7401, Fax: (886-6) 583-0009, E-mail: dyno.keatinge@worldveg.org or Dr. Jaw-Fen Wang, 60 Yi Ming Liao, Shanhua, Tainan, Chinese Taipei. Phone: (886)6-5837801, E-mail: jaw-fen.wang@worldveg.org Web: http://www.ihc2014.org/symposium_13.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on Unravelling the Banana's Genomic Potential.** Info: Dr. Inge Van den Bergh, Bioversity International, 1990 Boulevard de la Lironde, Parc Scientifique Agropolis II, 34397 Montpellier, France. Phone: (33)4-67611302, Fax: (33)4-67610334, E-mail: i.vandenbergh@cgiar.org or Dr. Mike Smith, QDPI, Maroochy Research Station, PO Box 5083, SCMC, Nambour, QLD 4560, Australia. Phone: (61)754412211, Fax: (61)754412235, E-mail: mike.smith@deedi.qld.gov.au Web: http://www.ihc2014.org/symposium_36.html
- August 17-22, 2014, Brisbane (Australia): **International Symposium on High Value Vegetables, Root and Tuber Crops and Edible Fungi - Production, Supply and Demand.** Info: Assist. Prof. Colin Birch, PO Box 3523, Burnie Tasmania 7320, Australia. Phone: (61) 3-64304938, Fax: (61) 3-64304959, E-mail: colin.birch@utas.edu.au or Dr. Bruce Searle, Plant & Food Research, Private Bag 11600, 4442 Palmerston North, New Zealand. E-mail: bruce.searle@plantandfood.co.nz Web: http://www.ihc2014.org/symposium_14.html
- September 18-22, 2014, Dujiangyan city, Chengdu (China): **VIII International Symposium on Kiwifruit.** Info: Prof. Dr. Hongwen Huang, Director South China Inst. of Botany, Chinese Academy of Sciences, Xingke Road #723, Tianhe District, Guangzhou 510650, China. Phone: (86)20-37252778, Fax: (86)20-37252711, E-mail: huanghw@scbg.ac.cn E-mail symposium: secretariat@kiwifruit2014.com Web: http://www.kiwifruit2014.com
- NEW September 29 - October 2, 2014, Zagreb (Croatia): **VI Balkan Symposium on Vegetables and Potatoes.** Info: Dr. Bozidar Benko, Faculty of Agriculture, Department of Vegetable Crops, Svetosimunska 25, Zagreb 10000, Croatia. Phone: (385)12394058, Fax: (385)12393616, E-mail: bbenko@agr.hr or Dr. Sanja Fabek, Svetosimunska 25, 10000 Zagreb, Croatia. Phone: (385)1 2394059, E-mail: sfabek@agr.hr

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- NEW March 16-18, 2015, Bogotá (Colombia): **International Symposium on Medicinal Plants and Natural Products.** Info: Dr. Jalal Ghaemghami, PO Box 320172, West Roxbury, MA 02132, United States of America. Phone: (1)3393686838, Fax: (1)3393686838, E-mail: jalal@shmen.org or Yann-Olivier Hay, Calle 235 #79-30 Casa 6, Conjunto Santillana Bogotá, Colombia. Phone: (57)1-8619400, E-mail: yann.olivier.hay@gmail.com E-mail symposium: antigua-ishs@shmen.org
- April 21-24, 2015, Izmir (Turkey): **II International Workshop on Bacterial Diseases of Stone Fruits and Nuts.** Info: Prof. Dr. Hatice Özaktan, University of Ege, Faculty of Agric., Dept. Plant Protection, 35100 Bornova-Izmir, Turkey. Phone: (90)232 3884000, Fax: (90)232 3744848, E-mail: hatice.ozaktan@ege.edu.tr

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