Chronica Horticulturae

Volume 47 - Number 2 - 2007

A publication of the International Society for Horticultural Science

Fruit Issue

Horticultural Highlights

The Future of Horticultural Science and Education: A European Perspective • Ornamental Bananas: Focus on *Rhodochlamys* • Loquat: An Ancient Fruit Crop • The Photographs of Antonio Cezar d'Abrunhoza • Strawberry Production in Turkey • Fruit Production in India

Symposia and Workshops

Royal Flora Ratchaphruek 2006 • Seed, Transplant and Stand Establishment of Horticultural Crops • Indigenous Vegetables and Legumes • HORTIMODEL2006

ISHS

CHRONICA HORTICULTURAE

Chronica Horticulturae© ISBN: 978 90 6605 247 5 (Volume 47 - Number 2; June 2007); ISSN: 0578-039X.

Published quarterly by the International Society for Horticultural Science, Leuven, Belgium. Lay-out and printing by Drukkerij Geers, Gent, Belgium. ISHS© 2007. All rights reserved. No part of this magazine may be reproduced and/or published in any form, photocopy, microfilm or any other means without written permission from the publisher. All previous issues are also available online at **www.ishs.org/chronica**. Contact the ISHS Secretariat for details on full colour advertisements (1/1, 1/2, 1/4 page) and/or mailing lists options.

Editorial Office and Contact Address:

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

Membership and Orders of Chronica Horticulturae

Chronica Horticulturae is provided to the Membership for free: Individual Membership 50 EUR annually (special rate for Individual Members from selected developing countries: 50 EUR for 2 years), Student Membership 20 EUR per year. For all details on ISHS membership categories and membership advantages, including a membership application form, refer to the ISHS membership pages at **www.ishs.org/members**.

Payments

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

Acta Horticulturae

Acta Horticulturae is the series of proceedings of ISHS Scientific Meetings, Symposia or Congresses (ISSN: 0567-7572). ISHS Members are entitled to a substantial discount on the price of Acta Horticulturae. For an updated list of available titles, go to **www.ishs.org/acta**. A complete and accurate record of the entire Acta Horticulturae collection, including all abstracts and full text articles is available online at **www.actahort.org**. ISHS Individual membership includes credits to download 10 full text Acta Horticulturae articles. All Acta Horticulturae titles - including those no longer available in print format - are available in the **ActaHort CD-ROM** format.

Scripta Horticulturae

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

Cover photograph: Women hoeing vineyards, a photograph of Antonio Cezar d'Abrunhoza, see article p.16.

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

ISHS

CONTENTS

News from the Board

3 The Future of Horticultural Science and Education in Academia *R.J. Bogers*

Issues

4 The Future of Horticultural Science and Education: A European Perspective, *R.P. Bogers*

Horticultural Science Focus

7 Ornamental Bananas: Focus on *Rhodochlamys*, *M. Häkkinen*

Horticultural Science News

12 Loquat: An Ancient Fruit Crop with a Promising Future, *S. Lin, X. Huang, J. Cuevas and J. Janick*

History

16 Remembrance of Things Past: The Photographs of Antonio Cezar d'Abrunhoza, *M.I. d'Abrunhosa Mansinho*

The World of Horticulture

18 Strawberry Production in Turkey, *E. Turhan and S. Paydas Kargi*

21 Fruit Production in India, *C. Ravindran, A. Kohli and B.N. Srinivasa Murthy*

26 AIPH and ISHS Sign Memorandum of Understanding

27 New Books, Websites

28 Courses and Meetings

29 Opportunities

Symposia and Workshops

29 Royal Flora Ratchaphruek 2006

31 Int'l Workshops held at Royal Flora Ratchaphruek

37 IVth Int'l Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops

39 Ist Int'l Conference on Indigenous Vegetables and Legumes: Prospects for Fighting Poverty, Hunger and Malnutrition

42 IIIrd Int'l Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation (HORTIMODEL2006)

News from the ISHS Secretariat

43 New ISHS Members

44 Calendar of ISHS Events

47 Available Issues of Acta Horticulturae

Robert J. Bogers

The Future of Horticultural Science and Education in Academia

Robert J. Bogers, ISHS Treasurer

In this issue of *Chronica Horticulturae* (p. 4 to 6) you will find an article by Rik Bogers (my son by the way) that summarizes a conference organized in November last year by the BeNeLux Society for Horticultural Science. Here, I want to go into more detail concerning one of the issues raised at this meeting: the reason why young people choose plant sciences, and horticulture in particular, as their field of study at university.

Martin Mulder, Professor in Educational Competence Studies at Wageningen University, has done some research on this topic and found six main reasons why students choose plant sciences at Wageningen:

1. The University. Students choose Wageningen University because of its small size and informal atmosphere, its international character, the freedom of choice and the presence of high-level expertise.

2. The Contents of Study. Plant sciences are a large field of study with varied job opportunities; there are many specializations possible within the plant sciences; the knowledge can be applied in practice; the study is orientated to both research and industry; the students like what they hear about it on information days.

3. Their Personal Interest. Students choose plant sciences because they like biology and/or working with plants; they are interested in cell biology but don't want to work with animals; they are fascinated by the beauty and variation of plants and want to know how they function.

4. Their Personal Background. Having grown up at a farm (such as arable crops, greenhouse crops or flowerbulbs) or having worked with plants (during school holidays or in an allotment garden) can be a stimulus to choosing plant sciences at university.

5. The Kind of Jobs Available. Many students prefer a job in practice, without being confined to an office. Also the possibility of working in foreign (developing) countries or in organic farming appeals to many students.

6. Making a Useful Contribution to Society. Plant science is considered useful to society since people cannot live without plants and plants are at the basis of life on earth. Plants can help solve important problems such as food insecurity.

The conference of the BeNeLux Society for Horticultural Science made it clear that many young people are reluctant to study "horticulture" because they think horticulture contributes to environmental pollution and is, generally speaking, connected with low-qualified agricultural work and, consequently, not attractive. Based upon my experience with students I have the impression that the decision why a student wants to study plant sciences or horticulture is different based on the student's background: agricultural/rural versus non-agricultural/urban.

For some pupils at secondary schools in urban areas, studying at an agricultural university has the connotation of learning to become a farmer, which to most of them, if not impossible, is far less attractive than becoming a lawyer, economist or medical doctor. Therefore, I think it will be necessary to emphasize the modern, positive aspects of plant sciences: the great importance of plants for human health (nutrition, medicines) and welfare (recreation, domestic and environmental embellishment, industrial applications). At Wageningen University "horticulture" is no longer an option for new undergraduate students to initiate their studies. Instead, they have to start studying "plant sciences", which include aspects of such fields as breeding, crop growing and human nutrition, and specialize later. Thus, every plant science student at Wageningen comes into contact with important aspects of horticulture, which is not the case with biology students at the general universities. It is my feeling that by doing this Wageningen University has found new opportunities for recruiting students from non-agricultural backgrounds and making them enthusiastic about the opportunities horticulture can offer. In summary, this University has chosen the strategy of making horticulture an advanced option in plant sciences. This was done because it was considered a positive way to proceed that will in the end capture students for horticultural careers rather than drive them away.

It should be emphasized that horticulture involves a lot more than just plant sciences. It consists of many activities that form a global chain, such as plant breeding and production, greenhouse construction, irrigation, climate control, information processing, product processing, packaging, transport and retail. All these activities are based on knowledge and expertise of various disciplines in science and technology. Horticulture is a truly multidisciplinary sector, and people working at academic level in horticulture have very different backgrounds (plant sciences, physics, engineering, information technology, logistics, economics). As horticultural products are moved from and to all parts of the world, developing and developed, the decisions that are made in the international trade in horticultural products also require a global view and a feeling for sociology, politics etc. This, too, must be made clear to future students. Thus, plant science students who specialize in horticulture will find themselves in a very stimulating environment. This can be a reason for students from all backgrounds to choose horticulture as their specialization: the "urban" students because they have seen the many opportunities a modern, knowledge-based horticultural sector can offer, and the "agricultural" ones also because they realize an academic degree in horticulture is a perfect basis for a leading position in the sector they know and like.

It will not be enough, though, to make it clear to future students why plant sciences, and horticulture in particular, can be such a rewarding choice. The conference of the BeNeLux Society for Horticultural Science has shown that universities, industry and politics can and must work together to convince students and the general public of the importance of horticulture and to secure long-term financing of horticultural research and education. However, how this must be done to be really successful is still not clear, and innovative ideas are more than welcome. The discussion in the Internet Forum has shown that the opinions of ISHS members on this topic vary considerably. Wageningen University has chosen an approach that I hope will make horticulture a prestige option for students, and that is what our profession needs.

The Future of Horticultural Science and Education: A European Perspective

Roderik P. Bogers

Horticulture is a blooming business. Not only is it of great economic importance, but it also fulfils an important social function. The horticultural industry is facing several challenges and opportunities that result from globalisation of the market and technological advancements in the production chain. To meet tomorrow's expectations, the maintenance of an adequate knowledge base and close contacts between educators, researchers, governments, producers, processors, distributors and retailers are essential. A conference on 22 November 2006 in Brussels, organised by the BeNeLux Society for Horticultural Science with the support of the European Economic and Social Committee, the Flemish government and EURAGRI, was the first that brought together all these parties to discuss the future of horticultural science. This article summarises the presentations and conclusions of this meeting.

THE ECONOMIC AND SOCIAL FUNCTION OF HORTICULTURE

Horticulture is of great economic importance in Europe, as evidenced by the large value of the production industry and the many employment opportunities that horticulture offers. However, the market in Northern and Northwestern Europe, and also in the new EU member states, is now ruled by large retail chains.

Horticulture plays an important role in the public's wellness; it contributes to a large extent to the maintenance of food security. Furthermore, ornamental plants and the rural areas needed for horticultural production embellish our landscape and fulfil a social function because they serve as recreation areas. Consumption of fruit and vegetables can prevent or slow down the onset of chronic diseases. Despite these benefits, consumers are generally unaware of the origin of their food and the role of horticulture.

DEVELOPMENTS IN THE MARKET AND THE PRODUCTION CHAIN

In order to maintain its strong position in the world, horticulture has to adapt to several changes in the market and the production of horticultural products. These developments include globalisation of the market, an increasing production in developing countries, and a growing influence of the retail sector. Regarding developing countries, especially China will become a major producer of horticultural products.

Developments in the production of horticultural products will be characterised by a decreasing number of growers, while the area used for production remains the same. Growers will also form more alliances and intensify the co-operation with retailers. The increasing production in developing countries may lead to the disappearance of some producers from Europe.

REFORM OF MARKET REGULATION

In Europe, a reform of the market regulation for fruit and vegetables is underway. The sector is facing several difficulties, including a negative trade balance due to high imports, trade negotiations, strong pressure from retail and discount chains, a low to average fruit and vegetable consumption, and market crises due to sudden increases in low-priced imported products and production within the EU. The objective of the reform of the Common Market Organisation (CMO) is to create the best conditions for the EU's fruit and vegetable producers to compete and produce in a sustainable way. The European Commission has not yet adopted the formal reform proposal. There are indications that it would be appropriate to maintain producer organisations in the new CMO, as they are the key tool of the fruit and vegetables CMO. Further, the current schemes for fruit and vegetables intended for processing should be aligned with the new Common Agricultural Policy, and processed products should be introduced in the Single Payment Scheme to make producers more market-orientated and competitive.

EXPECTATIONS AND CONCERNS

The ambitions of producers are to expand their market share, strengthen the position of European horticulture in the world, beat the competition with market-driven enterprise, and improve the position in knowledge areas such as green genetics. The EU can support this by supporting entrepreneurship, creating the right conditions for the playing field and providing funds. These ambitions and developments underscore the necessity of sustaining an adequate knowledge base and a high level of education. This education should not only emphasise traditional horticultural science, but should also focus on knowledge about the market and logistics.

Processors and distributors are concerned with strategy to meet expectations. Their vision is to build long-lasting relationships with leading retailers in managing the daily fresh-produce supply by negotiating long-term sourcing plans, logistic excellence and providing solutions in convenience food. Long-lasting relationships with growers and retailers, as opposed to operating as a spot-market player, could advance mutual profit for growers and the retailers.

The expectations of the produce industry lie in the use of new areas and regions, new cultivars, harvesting and post-harvest practices, logistics (packaging, transport, cold storage, increasing shelf life, and traceability of products) and marketing (consumer research, promotion and communication). Innovation is needed from horticulturists, but the pool of educated people is decreasing.

The consumers' interests and the way consumers decide to purchase food now involve the concept of authenticity: consumers want their food to be trustworthy and produced with consideration for ethical values like fairness in the supply chain and care for the environment. Consumers' trust is very much influenced by the response of the producers to their concerns, and thus not only by food safety and associated risks. Consumers look for value for money. At the top of the consumers' expectations are taste, which must be consistently pleasant, and convenience. Health considerations only play a minor role, because health effects are hard to determine for the consumer, due to inconsistent expert information about food and health.

Consumers' purchasing decisions for food are based on noticing, buying, consuming and liking food. The liking or not liking can be remembered or forgotten. Repeated purchases occur when food is recognised and remem-

bered as liked. The second purchase is important in the long term: if it is liked, the consumer remembers this purchase, and gets "hooked". Therefore, it might be a better strategy to let consumers buy good products only, rather than attempting to provide the product the year round, with varying quality.

The horticulture industry can support the consumers' interests in various ways: it should provide tasty products with no unnecessary risks, provide local produce (as far as climate and season allow), provide variety throughout the year, allow consumers more control, and demonstrate responsiveness to consumer feedback.

DYNAMIC MODELLING FOR INCREASING PROFITS

Mathematical models can be employed to enhance profit in the whole chain. Dynamic modelling is a technique that combines information on consumer behaviour with production, logistics and marketing strategies. For example, sweet peppers are harvested in batches of different quality, and the ripeness of the fruit at harvest determines how much of the product is lost due to over-ripeness and how much the product is liked by the consumer. Because of this variation in batch quality of fruit and vegetables, profit can be gained from vertical co-operation. Although it may sound counterintuitive, more profit can be made in the chain as a whole if the retailer and the trader share the costs. Profit can also be enhanced if the trader pays for the waste due to over-ripeness.

Horticultural science combines the various sciences needed to develop and implement this technology. Since the success of dynamic modelling depends on good data on product quality and consumer behaviour, the scientist who creates this information will be important. However, before dynamic modelling can be implemented, chains need to get organised in a better way.

THE FUTURE OF HORTICULTURE IN ACADEMIA

Horticultural science within academia is facing problems due to a diminishing number of students and the merging of horticulture departments into more general plant-science departments. To receive input from a wider audience on what contributes to the diminishing number of students and how to reverse this, an internet forum was launched by the International Society for Horticultural Science (ISHS) and the American Society for Horticultural Science.

Generally, the dropping numbers of students who choose a career in horticulture may be explained by three factors. The first is the inability to define horticulture: is it a distinct science or the integration of a broad range of sciences; is it a science or a technology? The second factor is the stigma associated with applied horticultural research and the emphasis on competitive grants. Horticulture is not viewed as an attractive career option by students. Furthermore, success in science is based on publications and grantsmanship in disciplinary research rather than applied research and/or the development of horticultural technologies and practices. Thirdly, there is a negative public perception of horticulture. Terms that come to people's minds are pollution, dirty hands, long hours, low wages, unscientific, a hobby, not glamorous, and a non-lucrative career path.

The question is whether the decline in the number of students can be reversed. Several ideas were mentioned in the forum. Basically these ideas could be categorised as changing the emphasis of horticulture departments, marketing horticulture in the media as an attractive career, and using opportunities during early education to make pupils and students familiar with horticulture.

Finally, there is a debate going on about whether horticulture departments should retain their own identity. Two contradicting viewpoints exist, stating that merging would either result in irreparable harm or aid horticulturists in academic success.

CO-OPERATION IN EDUCATION

Since no single university can cover all areas of horticulture with excellence, co-operation between educational institutions creates opportunities to improve education in horticulture. The EuroHort thematic network is an informal horticultural network with the aim to co-operate in education on the MSc and PhD levels. EuroHort initially consisted of the CHAINS-iT group (Challenges in Horticulture: An intensive program for European Students), the NOVA/BOVA Nordic/Baltic University Network, the Euro League for Life Sciences (ELLS), and the BOKU-TUM-Bologna MSc Network in Horticulture. EuroHort today involves 43 partners, including universities, research stations and horticultural organisations. The co-operation consists of various things, including mapping of scientific competencies and modules in horticulture among the partner institutions, promoting employability and modifying educational profiles. Ultimately, the goal is to create a European MSc degree in horticulture and make EuroHort a formal Erasmus Thematic Network.

TRENDS AND DEVELOPMENTS IN SCIENCE

Can exogenous and endogenous trends in horticulture be combined? Exogenous trends include temporal and geographical variations in the diet (including fruit and vegetable consumption), an increasing emphasis on food safety and quality, mechanisation of production systems, and changes in climate. As a result of the latter, changes occur in plant phenology (e.g., time of pollination and harvest) and the life cycle and epidemiology of pests. This has many implications. For example, plant cultivars that are resistant to diseases and drought have to be designed.

Endogenous trends in science are a shift from high-throughput analytical biology towards integrative biology. Integration can occur at various levels and aspects of horticulture, e.g., integration of data on genes and functions of plants, integration along plant development and horticultural cycles, up- and down-scaling across organisation levels, and comparative approaches across species.

At INRA (France) the exogenous and endogenous trends are combined; there is no separate horticulture department but there are a few multidisciplinary research centres focusing on horticulture. In addition there are multidisciplinary expert groups that deal with the whole chain of fruits and vegetables and ornamental plants. These expert groups map the research system and identify research programmes and projects. Trends and needs that are identified generally are an increasing emphasis on product quality and safety, and more attention to environmental aspects. The question for the future is whether horticulture as an autonomous scientific and academic topic is fading away.

CHALLENGES AND OPPORTUNITIES OF FP7

There are opportunities for horticulture in the European Union's seventh framework programme (FP7). Although the horticulture chain as such is not mentioned as a priority area, many of its constituting processes and industrial and commercial activities can be found in many places in FP7, especially under the headings of "life sciences". In addition, FP7 offers a multitude of meta-scientific modalities (such as co-ordination actions, knowledge transfer and agenda setting) that are orientated to a better underpinning of the performance of the general knowledge base and are certainly accessible for initiatives from the horticultural sector.

CLOSING PANEL DEBATE

The main points made by the various presenters were summarised as follows: horticulture is important from an economic and social point of view, and there is a broad range of expectations from producers, suppliers, distributors and consumers, which is necessary to make horticulture fulfil its role in European economy. The knowledge supporting horticulture is based on traditional horticultural science, but there is much interesting threshold-surpassing research to be done. However, there is a lack of visibility of horticulture as a coherent science, and global competition will be difficult without an ade-

quate knowledge base. The key question is: how to proceed? The themes brought up by the audience concerned the visibility of horticulture for the public and students, the sharing of knowledge between commercial companies and universities, and the issue of how to achieve greater co-operation between all parties involved in horticulture.

Visibility of Horticulture

Although it was observed that horticulture lacks visibility to the public, there were also encouraging sounds from the audience. Examples of the public's interest in horticulture include people's enthusiasm when they visit small farms and greenhouses in the Netherlands at the annual *"Kom in de kas"* ("Come into the greenhouse") event. Each year this event attracts 350,000 to 400,000 people.

Sharing of Knowledge

Successful co-operation requires that knowledge be shared among colleagues; exchanging knowledge is difficult, however. For example, as a result of confidentiality of commercial research it is hard to have students visit commercial companies. A possible solution is to make good consortium agreements that are useful for protecting and sharing knowledge. A "horticultural cluster academy" was mentioned, where leading persons in the field share ideas with their peers and also with colleagues from outside horticulture. In France, strong relationships exist between universities and industry, while student internships strengthen this link.

Co-operation

The conference made it clear that co-operation between all parties involved in horticulture is essential. Generic issues should be identified so that the whole industry can benefit. With respect to the knowledge base, horticultural science should do more work on logistics and retail. Co-operation can clearly be improved. It was noted that each part of the horticultural sector (research, industry, retail) organises its own conferences. Despite the strong need to bring all parties together, it had also been difficult to achieve this for the present conference.

There was agreement that one partner should take the lead and drag the other partners along. But who will take responsibility, and are all partners coherent in their wishes? There may be reluctance to let another lead. Various panel members were of the opinion that governments should listen to the horticultural sector and take the lead, but the current situation is far from that. For example, in the Netherlands, there is not even one person at the ministry of agriculture who is particularly concerned with horticulture. At the end of the debate the observation was made that serious advocacy of the horticultural sector is needed and that the sector should make its educational needs clear to the government. This was done in Norway for civil engineering, where the industry initiated a reform in education by making its needs clear.

To conclude, the conference has given a new impulse to intensify the co-operation between the various parts of the horticultural sector. The suggestion was made that the next conference theme should be "From Seed to Consumer"; the BeNeLux Society for Horticultural Science is certainly willing to contribute to organising such a conference.

SPEAKERS AND DISCUSSION LEADERS AT THE 2006 ANNUAL CONFERENCE OF THE BENELUX SHS

Mr. Frank Allen
Member of the Section for Agriculture, Rural Development and the Environment of the European Economic and Social Committee (EESC)

Dr. Robert J. Bogers
President of the BeNeLux Society for Horticultural Science

Dr. Kirsten Brandt
Dept. of Food Quality and Health, University of Newcastle, UK

Professor Dr. Rebecca Darnell
Dept. of Horticultural Sciences, University of Florida, USA

Dr. Doeke Faber
President of the International Association of Horticultural Producers (AIPH)

Mr. Peter Hostens
Managing Director Belgium and Eastern Europe, UNIVEG Group of Companies

Dr. Francois Houllier
General Director of Plant Sciences, INRA, France

Professor Dr. Rolf Larsen
Department of Crop Science, Swedish University of Agriculture, Sweden

Dr. Ciaran Mangan
Scientific Officer, Directorate of Life Sciences, DG Research, European Commission

Mrs. Linda Mauperon
Deputy Head, Unit Olives and Vegetables, DG Agriculture, European Commission

Dr. Daniel Retureau
Member of the Section for Agriculture, Rural Development and the Environment of the EESC

Mrs. Maria Candela Sánchez Miguel
President of the Section for Agriculture, Rural Development and the Environment of the EESC

Professor Dr. Olaf van Kooten
Dept. of Horticultural Production Chains, Wageningen University, The Netherlands

Mr. Frank van Oorschot
Member of the Section for Agriculture, Rural Development and the Environment of the EESC

Professor Dr. Fons Werrij
Secretary General of the European Agricultural Research Initiative (EURAGRI)

Roderik P. Bogers

About the author

Rik Bogers is an epidemiologist who works at the Dutch National Institute for Public Health and the Environment. He has written a PhD thesis about measurement and determinants of fruit and vegetable consumption. His main interests currently concern the health consequences of overweight and its prevention and treatment through lifestyle interventions. Email: rikbogers@hotmail.com

Ornamental Bananas: Focus on *Rhodochlamys*

Markku Häkkinen

Musa along with *Musella* and *Ensete* are the three genera of the Musaceae. Sagot (1887) and Baker (1893) distinguished three subgenera for the genus *Musa: Physocaulis, Eumusa,* and *Rhodochlamys*. Cheesman (1947) then divided *Musa* into four sections: *Australimusa, Callimusa, Eumusa,* and *Rhodochlamys* based on chromosome numbers and morphological characters. This classification remains widely accepted by botanists.

Most of the species in sections *Callimusa* and *Rhodochlamys* are characterized by having inflorescences that are erect, at least at the base, with fruit pointing towards the bunch apex. These species also typically have relatively few fruits and are best known for their brightly coloured bracts, a feature that makes them popular as ornamental plants. This paper focuses on nine *Musa* species of the section *Rhodochlamys*. Seven of these species (*Musa ornata, M. laterita, M. velutina, M. rosea, M. mannii, M. rubra, M. aurantiaca*) are well recognized and described; and the remaining two, *M. siamensis* and *M. sanguinea*, are less well known and are of somewhat less definite status.

Rhodochlamys consist of the only *Musa* species adapted to withstanding seasonal droughts, which are common in the monsoon areas to which they are native. The natural habitat of *Rhodochlamys* species is Northeast India, Bangladesh, Myanmar and Northern Thailand, except *Musa rosea*, which is native to Cambodia and southern Vietnam. *Musa sanguinea* is also known to occur in Yunnan, China. Much of the diversity in the section is therefore located in areas that have been difficult to access and the present-day distribution, extent, and status of many of the undescribed species are not clear despite some 200 years of study.

HYBRIDIZATION

The section *Rhodochlamys* has long been recognized as being "close" to the section *Eumusa*, which contains the cultivated bananas, and hybridizations between members of the two sections have been carried out by a number of researchers. Analyses of *Musa* diversity using various molecular techniques support the theory that the sections *Rhodochlamys* and *Eumusa* are closely related and provide potential source of exploitable new genes, thus expanding the genepool available to banana breeders (Carreel, 1994; Jarret and Gawel, 1995; Wong et al., 2001, 2002, 2003). One particular feature of the group that could be of interest to breeders is the special mechanism that some species have for surviving drought. In unfavourable, dry conditions, they die back to the corms, but rapidly produce new growth as soon as the first rains appear.

The products of hybridization and introgression involving the *Rhodochlamys* are likely to be attractive, and will therefore have ornamental potential. With the growing interest in exotic ornamental plants amongst gardeners in Europe, USA and recently in South East Asia, hybrids and partial hybrids of *Rhodochlamys* species have found their way into commerce. With the exception of their use as ornamental plants in the horticultural and florist industries, there is a little recorded human use of species in this section. In some areas of Northeast India, the male buds are collected and eaten as a vegetable, but the fruit are seedy and unpalatable, and therefore are not used for food.

SPECIES WITH ORNAMENTAL POTENTIAL

Musa ornata

This species (Fig. 1) has been recently recorded in wild populations along the slopes in certain moist regions of Araku Valley in Andhra Pradesh, and it also grows wild in NE states of India, and in the Howaikong Forest, Hari Khola, of Bangladesh in Dipterocarp forest growing on slopes by streams. Roxburgh recorded *Musa ornata* as "a native of Chittagong" (Roxburgh, 1814). *Musa ornata* is described by Roxburgh in *Flora Indica* (Roxburgh, in Carey ed., 1824) but some taxonomic confusion still exists, particularly in horticultural texts, between *Musa ornata* and *Musa rosacea*, however, *M. ornata* is the taxon valid name.

Figure 1. *Musa ornata* unripe fruit. Photograph by courtesy of Markku Häkkinen.

Pseudostem	1.0-1.8 m high, green, slender and waxy. Suckers profuse and emerge slightly at an angle from the mother plant.
Leaves	Up to 2 m long, 35 cm wide, medium green in colour, truncate at the apex, midrib often flushed with red beneath. Petiole up to 60 cm long and clasping the pseudostem at the base.
Inflorescence	Erect, 30-35 cm, glabrous, sterile bracts usually 2, the first a shortened foliage leaf with broadened and coloured petiole, the second a fully coloured true bract. Basal flowers pistillate.
Male bud	Top-shaped, acute, the bracts convolute or slightly imbricate at the tip. Pink in colour, yellow at the extreme tip.
Male flowers	Orange yellow in colour, 4-6 flowers per hand in one row. Compound tepal about 4 cm long, orange-yellow in colour, free tepal is more or less as long as compound tepal, bowl shaped, tip is more or less smooth.
Fruit	6-8 cm long, 2-2.5 cm in diameter, green at maturity and bright yellow at ripeness.
Seeds	Dull black, irregular, smooth surfaced, 5 mm in diameter and 3 mm in height.

Musa laterita

Musa laterita (Fig. 2) is native to Northeast India, Myanmar and Northern Thailand. It is, however, common in cultivation as an ornamental plant worldwide. It is frequently sold as an ornamental under the name of *Musa ornata* 'Bronze' or *Musa ornata* 'Red Salmon' and lately under the name *Musa laterita* (Häkkinen, 2001). The name "laterita" derives from the colour of its bracts, which resemble the brick-red tropical soil, known as "laterite". Cheesman described the species in the *Kew Bulletin* as a plant that spreads freely, sending up suckers at long distances from the mother plant, and forming only lax, open clumps (Cheesman, 1949). The plant is slender, reaching a height of 1-2 m. The inflorescence is erect, and the peduncle velvety with dense, minute hairs. The bracts are brick red, the same colour inside as outside. The fruit bunch is very compact, with the fruit almost pressing against the rachis. The fruits reach about 8-10 cm in length and the peel becomes yellow on ripening. The staminate flowers are orange-yellow in colour. Cheesman also noted that the plant has a strong general resemblance to *Musa ornata* but, while it hybridizes with it, it does not show a strong genetic affinity with that species and in other respects it approaches the section *Eumusa* species more closely than any other *Rhodochlamys*. The ability of the plant to hybridize with *Musa ornata* suggests one possible origin of some of the plants commonly but sometimes erroneously known in tropical horticulture as cultivars of *Musa ornata*.

Figure 2. *Musa laterita* male flower. Photograph by courtesy of Markku Häkkinen.

Pseudostem	Slender, 1-2 m in height, green, devoid of wax, profuse suckering, this can emerge up to 1 m away from the mother plant.
Leaves	Blades 1.50 m long and 40 cm wide, medium dark green in colour, truncate at the apex, narrowing down rather with a gradual acute base. Petiole 40-50 cm long, its base closely clasping the pseudostem, midrib is flushed red on the lower surface.
Inflorescence	Erect, peduncle is slightly hairy in nature; first sterile bract is usually a foliage leaf with a broadened petiole, developing red colour, and this followed by one sterile true bract. Basal flowers are pistillate.
Bunch	Very compact, erect in position, 4-5 hands, 4-6 fingers in each hand.
Male bud	Ovate, slightly imbricate and yellow at the tip, bracts are brick red, slightly grooved, 6-10 flowers per bract, biseriate.
Male flowers	Compound tepals 4 cm long, orange yellow in colour, lobes slightly darker, the lateral lobes 5 mm long with minute dorsal appendages. Free tepal more than 1 cm long, opaque white, boat-shaped.
Fruit	Bunch very compact, the fruits almost appressed to the rachis. Individual fruit about 8-10 cm long, very short pedicel, yellow upon ripening.
Seeds	Dull black, irregularly depressed, 4 mm in diameter and 3 mm high.

Musa velutina

This species (Fig. 3) is found growing wild in the sub-tropical evergreen forests of Arunachal Pradesh and Assam in India. It was collected in Upper Assam by Gustav Mann and described by Wendland and Drude from a plant that flowered in the garden at Herrenhousen Botanical Gardens, Hanover, Germany (Wendland and Drude, 1875). A probable synonym of this species is *Musa dasycarpa* described by Kurz (1865/66). The name "velutina" was derived from the hairy, velvety nature of the fruit. On maturity the fruit peel splits and separates into irregular strips from apex to base, revealing a central mass of white flesh, filled with black seeds. *Musa velutina* is one of only four known *Musa* species in which the fruit splits (or dehisces or is schizocarpic) on maturity.

Figure 3. *Musa velutina*, painting from *Kew Herbarium.* Photograph by courtesy of Markku Häkkinen.

Habitat	Grows wild in sub-tropical evergreen forests of Arunachal Pradesh and Assam in India.
Pseudostem	Up to 1.5 m high, yellowish-green, devoid of wax. Profuse suckering and spreading to a distance of 0.5 to 1.0 m.
Leaves	Blades up to 1 m long, 35 cm wide, truncate at apex, lamina shining dark green above, paler beneath but scarcely glaucous. Petiole 50 cm long, with spreading pink coloured surface along the midrib.
Peduncle	Short 15-20 cm, erect, velvety with or without empty nodes. Peduncle is uniquely crimson red in colour.
Inflorescence	Erect, the peduncle red, heavily clothed with white pubescence, basal flowers hermaphrodite, the fertile "hands" 2-4, upper flowers male.
Bunch	Erect, 3-6 hands, hands are closely spaced and fingers are compact.
Male bud	Lanceolate, convolute and pink in colour, moderately wax coated, more or less smooth. Bracts open 2-3 at a time, both reflex and revolute.
Male flowers	Pink flowers with pinkish red streaks. Compound tepal cream in colour pink tinged. Lobes are yellow.
Fruit	Crimson red at all stages of maturity. Fruits exhibit unique character of dehiscence. Mature fruits short 10-12 cm, 4 cm diameter, 3-4 fruits per hand
Seeds	Dull black, irregular, smooth surfaced, 5 mm in diameter and 3 mm in height.

Musa rosea

Musa rosea (Fig. 4) has long been considered a "lost species" whose identity has been obscure since Baker's time in the 1890s. It has been regarded as a distinct taxon, and incorrectly regarded as a synonym of *Musa ornata* (Cheesman, 1931, 1949). Much speculation had taken place since then as to whether *Musa rosea* is a true species or not. The first published information regarding *Musa rosea* emerged in the late 19th century, when Kew botanist J.G. Baker described the species from two sketches drawn from dried specimens in the herbarium of the Botanic Garden Calcutta, in June 1882. This species originates in Cambodia and was described as having the habit of *Musa coccinea*, but with leaves much shorter and broader in proportion to length. The inflorescence is short and erect with red bracts. The conclusion is that the plant shown in the sketches is *Musa rosea* and not *Musa ornata*. This species has been recently reclassified *Musa rosea* and synonymized with *Musa ancgorensis* (Häkkinen, 2006).

Pseudostem	1.5 m in height, green, slender and devoid of wax. Profuse suckering, this can emerge up to 0.5 m away from the mother plant.
Leaves	Up to 1 m long, 30 cm wide, green in colour and shiny, leaf bases symmetric and pointed. Petiole up to 30 cm.
Inflorescence	Erect, 30-35 cm, glabrous, medium green, sterile bracts usually one, red in colour soon shriveling. Basal flowers pistillate.
Male bud	Narrowly ovoid acute, bracts red, slightly imbricate at the tip. Red in colour, yellow at the extreme tip.
Male flowers	Orange in colour, 2-4 flowers per hand in one row. Compound tepal about 3 cm long, orange in colour, free tepal 8 mm long, oblanceolate, translucent white.
Fruit	Bunch rather lax, individual fruit 7 cm long, 1.5 cm in diameter, green at maturity and bright yellow at ripeness.
Seeds	Dull black, irregularly depressed, 5 mm in diameter and 3 mm high.

Figure 4. *Musa rosea.* Photograph by courtesy of Markku Häkkinen.

Musa mannii

This species (Fig. 5) is a native of the Assam valleys in India and was described by Baker in J.D. Hooker's *Flora of British India*, 1892 and in *Curtis' Botanical Magazine*, 1893. This species differs from *Musa sanguinea* in the shorter pseudostem and longer leaves and from *Musa ornata* in the shorter-petiole leaves, large pale purplish bracts and shorter yellow male flowers. It is described by Cheesman (1949) as follows: *"This is a peculiarly dwarf-habited and elegant species, and has been imported from Upper Assam. The slender pseudostems are about a foot and half high, green, bearing a crowded tuft of several elliptic lanceolate leaves, which are stalked, about a foot in length, remarkably unequal-sided at the base, acute at the apex, and running out into a slender tendril-like point. The leaves are green, with a narrow purple border."*

Figure 5. *Musa mannii*, painting from *Curtis' Botanical Magazine.*

Pseudostem	Slender, cylindrical, 60-80 cm in height, tinged with black, devoid of wax. Profuse sucker and emerge slightly at an angle from the mother plant.
Leaves	Blades 60 cm long and 20 cm wide, oblong lanceolate, green in colour, rounded and asymmetric at the base. Petiole 20 cm long and its base heavily corrugated.
Inflorescence	The lax, smooth inflorescence, about 15 cm long in the flowering portion, is somewhat inclined but neither horizontal or recurved. Basal flowers are hermaphrodite.
Male bud	Oblong, slightly imbricate at the tip, bracts are rose coloured.
Male flowers	Compound tepal 3 cm long, orange yellow in colour. Free tepal 2.5 cm long, opaque white, boat-shaped.
Fruit	Bunch very lax, horizontal, 3-5 hands, and 3 fingers on each hand. Individual fruit about 5 cm long, triangular, yellow at ripening.
Seeds	Dull black, irregularly depressed, 5 mm in diameter and 3 mm high.

Musa rubra

Musa rubra (Fig. 6), a native of Myanmar, also found in the Mizoram area of India, was first described in the work by S. Kurz (1865/66) from specimens collected by himself in Pegu but appears to have been discovered many years earlier. There are several specimens of *Musa rubra* at Indian Institute of Horticultural Research station Bangalore in cultivation, which were collected in India close to the border with Myanmar, and at Kew Garden London. These plants correspond very closely with the illustration of *Musa rubra* in *Curtis' Botanical Magazine* (Hooker, 1895). The plant is described by Baker as having the habit of *Musa coccinea* (*Callimusa*), with the stem being slender and reaching about 1.5-2.5 m in height. The peduncle and inflorescence are erect; the bracts are bright rose-red with golden tips, and the male flowers golden yellow (Baker, 1893). The author has revised the species (Häkkinen, 2003).

Figure 6. *Musa rubra*, painting from *Curtis' Botanical Magazine.*

Pseudostem	Slender, 1.5-2 m in height, lower sheaths pale brown, upper green, devoid of wax. Profuse sucker and emerge slightly at an angle from the mother plant.
Leaves	Blades 1.2-1.8 m long and 30-40 cm wide, oblong lanceolate, green in colour, truncate at the apex, narrowing down rather with cuneate asymmetric base. Petiole 40-60 cm long, its base closely clasping the pseudostem.
Inflorescence	Erect, peduncle is slightly hairy in nature, first sterile bract is usually a foliage leaf with a broadened petiole, developing pale red colour, and this followed by one sterile true bract. Basal flowers are pistillate.
Bunch	Very compact, erect, 4-5 hands, on average 4 fingers on hand.
Male bud	Ovate, slightly imbricate at the tip, bracts are pale red, slightly grooved, 6-10 flowers per bract, biseriate.
Male flowers	Compound tepal 4 cm long, orange yellow in colour, lobes slightly darker, the lateral lobes 5 mm long with minute dorsal appendages. Free tepal more than 1 cm long, opaque white, boat-shaped.
Fruit	Bunch very compact, the fruits almost appressed to the rachis. Individual fruit about 8-10 cm long, very short pedicel, yellow upon ripening.
Seeds	Dull black, irregularly depressed, 5 mm in diameter and 3 mm high.

Musa aurantiaca

This species (Fig. 7) is one of the most elegant members of *Rhodochlamys* with bright orange buds. They have a wide distribution from West Arunachal Pradesh to East Arunachal Pradesh in India, and are found mostly in higher altitudes. It occurs also commonly in the valleys of southern Tibet in China. Unlike the other members of *Rhodochlamys*, *Musa aurantiaca* is highly prolific suckering and each clump is of 10-12 plants. Under undisturbed conditions the clump is in flowering at any given time of the year; 4-5 buds at one place give a false appearance of forest flame. *Musa aurantiaca* is found in damp areas in the Changlang District between Deban and Haldi Barie, Assam, India. Baker in the *Annals of Botany*, 1893, describes the species and there is also a more recent description by the author (2005). The author has also studied the species in China 2006 in its natural habitats.

Figure 7. *Musa aurantiaca.* Photograph by courtesy of Markku Häkkinen.

Habitat	Grows wild in the wet temperate forest of upper Assam, Arunachal Pradesh and in southern Tibet.
Pseudostem	Slender, stoloniferous, 0.8-1 m height, yellow green in colour with black blotches. Clumping habits, many suckers emerge very close to the mother plant.
Leaves	Erect to intermediate, 90-95 cm long, light green, glabrous on upper and dull on lower surface, laminar bases are pointed. Petiole 20-25 cm long, wide open petiole canal, winged margins.
Bunch	4-6 hands, 2-4 fingers per hand, uniseriate in arrangements. Peduncle erect, very short with only 10-15 cm length, glabrous in nature. Rachis short, barren, scars are less predominant.
Male bud	Lanceolate, orange in colour, convolute.
Male bract	Orange on both inner and outer faces, open two at a time, takes two to three days for shedding, neither reflex nor revolute, lacks wax coating.
Male flowers	Orange in colour, 6-8 flowers per hand, arranged in uniseriate manner. Compound tepal about 4 cm long, orange in colour, free tepal is more or less as long as compound tepal, opaque white in colour and rectangular in shape.
Fruit	Does not reflex, sub sessile, not edible, skin watery green in colour and glabrous in nature.
Seeds	Warty, dull black in colour, very small, 1.5 mm in diameter.

Musa siamensis

I have tentatively named this undescribed species as *Musa siamensis* (Fig. 8). It was discovered from eastern Thailand in 2002 and soon after that introduced to western horticulture markets under the commercial name 'Thai Gold' by Thai nursery people. This species is called Chek Meas in Cambodia and has been cultivated for a long time over there as ornamental. It is closely related to *Musa rosea* and having similar growing habits with traveling rhizomes.

Figure 8. *Musa siamensis.* Photograph by courtesy of Markku Häkkinen.

Pseudostem	1.5 m in height, green, slender and devoid of wax. Profuse suckering, this can emerge up to 0.5 m away from the mother plant.
Leaves	Up to 1 m long, 30 cm wide, green in colour and shiny, leaf bases symmetric and pointed. Petiole up to 30 cm.
Inflorescence	Erect, 30-35 cm, glabrous, medium green, sterile bracts usually, yellow in colour soon shriveling. Basal flowers pistillate.
Male bud	Narrowly ovoid acute, bracts yellow, slightly imbricate at the tip. Yellow in colour, green at the extreme tip.
Male flowers	Orange in colour, 2-4 flowers per hand in one row. Compound tepal about 3 cm long, orange in colour, free tepal 8 mm long, oblanceolate, translucent white.
Fruit	Bunch rather lax, individual fruit 7 cm long, 1.5 cm in diameter, green at maturity and bright yellow at ripeness.
Seeds	Dull black, irregularly depressed, 4 mm in diameter and 3 mm high.

Musa sanguinea

Musa sanguinea (Fig. 9) is a native of the Mahuni forests on the banks of the Booree Deling River in Upper Assam, India. It is also reported to occur in western Yunnan, China but I have not observed any pure forms of it over there. The species was described by J.D. Hooker in *Curtis' Botanical Magazine*, 1872, and again by Baker in *Annals of Botany*, 1893 and by Cheesman in the *Kew Bulletin*, 1949. It is a slender plant, with the pseudostem about as thick as a stout cane, reddish, and growing to about 1-1.5 m high. The leaf midribs are red on both sides on young leaves, later becoming green above, but remaining red on the lower surface. The fruit stalk is red and velvety and the inflorescence grows out horizontally. The bracts are dark pink or pale crimson and the whole bud usually aborts before the fruit are ripe. The staminate flowers are orange-yellow and the fruit become greenish yellow when ripe.

Figure 9. *Musa sanguinea*, painting from *Curtis' Botanical Magazine.*

Habitat	Grows wild in the Mahuni forest of Assam and Arunachal Pradesh.
Suckers	Many, emerging vertically upward and very close to the mother plant.
Pseudostem	Very slender, 1.25-1.6 m high, reddish in colour. Leaves erect, 75-85 cm long, 30-35 cm wide, green, leaf bases are symmetrically rounded.
Petiole	20-25 cm long, wide-open canal, free margins.
Peduncle	Erect, very short with 10-12 cm long, reddish and velvety in nature.
Bunch	3-5 hands of fingers, parallel to the axis, uniseriately arranged, horizontal or slightly erect in position.
Rachis	Short and barren with medium bract scars.
Male bud	Lanceolate, bright red in colour, convolute.
Male bract	Lanceolate, bright red on outer face and orange red on inner face.
Male flowers	Yellow in colour, 5-6 flowers per hand, compound tepal is yellow in colour, 3-3.5 cm long and free tepal is oblong in shape.
Fruit	Does not reflex, sub sessile, not edible, pale yellowish green in colour and variegated with pink pigmentation.
Seeds	Small, black, irregularly depressed.

CONCLUSIONS

The author has tested various *Rhodochlamys* species over 15 years in Finland and found that they were suitable for indoor and greenhouse culture, and also can be grown outdoors during the growing season. As in their natural habitats, these species are seasonal plants with flowering, fruiting, and dormant period; they flower easily every year. Grown as indoor potted plants, they normally go into dormancy during the darkest winter months. During this period when growth ceases, soil should be kept slightly moist; plants will not lose their leaves even without extra lighting. In the greenhouse, plants normally go into semi dormancy in the winter with very slow growth even under good growing lights. When grown outdoors in temperate climates, plants should be cut before the freeze and corms stored in a cool basement without soil totally dry. However, corms can be potted and stored as indoor plants.

REFERENCES

Baker, J.G. 1892. Scitamineae. In: J.D. Hooker (ed.), Fl. Brit. Ind. (J.D. Hooker) 6:225-264.

Baker, J.G. 1893. A synopsis of the genera and species of Museae. Ann. Bot. (Oxford) 7:189-222.

Carreel, F. 1994. Etude de la diversité des bananiers (genre *Musa*) à l'aide des marqueurs RFLP. Thèse de l'Institut National Agronomique Paris-Grignon.

Cheesman, E.E. 1931. A note on *Musa ornata*. Kew Bull. XLIV:297-299.

Cheesman, E.E. 1947. Classification of the bananas. II. The Genus *Musa*. Kew Bull. 2:106-117.

Cheesman, E.E. 1949. Classification of the bananas. III. Critical Notes on Species. Kew Bull. 3:265-267.

Hooker, J.D. 1872. *Musa sanguinea*. Bot. Mag. 98:Table 5975.

Hooker, J.D. 1893. *Musa mannii*. Bot. Mag. 119:Plate 7311.

Hooker, J.D. 1895. *Musa rubra*. Bot. Mag. 121:Plate 7451.

Häkkinen, M. 2001. *Musa laterita*: An ornamental banana. Fruit Gardener 33(4):6-7.

Häkkinen, M. 2003. Taxonomic history and identity of *Musa rubra* Wall. ex Kurz. Philipp. Agr. Sci. 86(1):92-98.

Häkkinen, M. 2005. Ornamental bananas: Notes on the section *Rhodochlamys* (Musaceae). Folia Malaysiana 6:49-72.

Häkkinen, M. 2006. A taxonomic revision of *Musa rosea* (Musaceae) in Southeast Asia. Novon 16(4):492-496.

Jarret, R.L. and Gawel, N. 1995. Molecular markers, genetic diversity and systematics in *Musa*. p.67-83. In: S. Gowen (ed.), Bananas and Plantains, Chapman & Hall, UK.

Kurz, S. 1865/1866. Note on the plantains of the Indian archipelago. J. Agr. Hort. Soc. India XIV:295-301.

Roxburgh, W. 1814. *Musa ornata*. Hort. Bengal. p.19.

Roxburgh, W. 1824. *Musa ornata*. Fl. Ind. (Carey & Wallich ed.) 2:488.

Sagot, P. 1887. Sur le genre bananier. Bul. Soc. Bot. France 34:328-330.

Wendland, H. and Drude, C. 1875. *Musa velutina*. Gartenflora 65-68:Plate 823.

Wong, C., Kiew, R., Lamb, A., Ohn, S., Lee, S., Gan, L. and Gan, Y. 2001. Placement of three Bornean species of *Musa* (Musaceae) based on amplified fragment length polymorphism (AFLP). Gard. Bul. Singapore 53:327-341.

Wong, C., Kiew, R., Argent, G., Ohn, S., Lee, S. and Gan, Y. 2002. Assessment of the validity of the sections in *Musa* (Musaceae) using AFLP. Ann. Bot. (Oxford) 90:231-238.

Wong, C., Argent, G., Kiew, R., Ohn, S. and Gan, Y. 2003. The genetic relations of *Musa* species from Mount Jaya, New Guinea, and a reappraisal of the sections *Musa* (Musaceae). Gard. Bull. Singapore 55:97-111.

ABOUT THE AUTHOR

Markku Häkkinen

Markku Häkkinen is a researcher specializing in wild banana at the Botanic Garden of the University of Helsinki, Finland. During the past decade he has conducted 10 exploration and field missions to Southeast Asia and has authored over 35 articles on wild banana. Email: markku.hakkinen@kymp.net

HORTICULTURAL SCIENCE NEWS

Loquat: An Ancient Fruit Crop with a Promising Future

Shunquan Lin, Xuming Huang, Julián Cuevas and Jules Janick

Loquat (*Eriobotry japonica* Lindl., syn. *Mespilus japonica* Thunb., Rosaceae. Maloideae), despite its name is indigenous to southern China (Lin et al., 1999). The species is subtropical, evergreen, and blooms in fall or early winter. The handsome tree is cold-hardy to -10°C but fruits freeze at minimum temperatures of about -3°C. The fruit in longitudinal cross section is round, obovate, or elliptical (Fig. 1); diameter is about 2-5 cm and average weight is about 30 to 40 g but some large fruited cultivars average 70 g and can reach 170 g. The thin peel is white or orange. Flesh is white or orange and soluble solids content varies from 7 to 20%. The seeds, usually about 3 to 4 per fruit, are relatively large, each about 1.2-3.6 g, and are annoying when the fruit is consumed fresh. The flesh, not exceeding 70% of the fruit, is aromatic, juicy, and delicious, and can be consumed fresh or processed in various forms including wine. Loquat is the first fruit to ripen in the spring and has been a favorite in China since it bears close to a significant holiday (Spring Festival). The name in China is *"Pipa"* or *"Luju"*; the English name "loquat" takes the Cantonese pronunciation of *"Luju"*. In the US it has also been known as Japanese plum or Japanese medlar; in Italy as nespola, in France as neflier du Japon, in Germany as Japonische Mispel, in Spain as Nispero and in Portugal as ameixa do Japao.

HISTORICAL

Loquat has been cultivated for over 2000 years (Sima, 100 BCE). The loquat cultivated in Japan was introduced from China in ancient times and loquat cultivation in Japan was described

Figure 1. Loquat fruit: 'Zaozhong No.6' (left), 'Dawuxing' (right).

as early as 1180 (Ichinose, 1995). People beyond eastern Asia first learned of the loquat from the German traveler and physician Englebert Kaempfer, who observed it in Japan and described it in *Amoenites Exotica* in 1712, while the Swedish botanist, Carl Peter Thunberg, in *Flora Japonica* (1784), provided a more ample description of loquat under the name *Mespilus japonica*. In 1784, the loquat was introduced from Guangdong, China into the National Garden at Paris, and in 1787 was introduced into the Royal Botanical Gardens at Kew, England. From this beginning, loquat was distributed around the Mediterranean to various countries, including Algeria, Cyprus, Egypt, Greece, Israel, Italy, Spain, Tunisia, and Turkey. Sometime between 1867 and 1870, loquat was introduced to Florida from Europe and to California from Japan. Chinese immigrants are assumed to have carried the loquat to Hawaii (Morton, 1987). By 1915, it had become quite well established in Florida and southern California and several new cultivars had been named. Cultivation spread to India and southeastern Asia, the East Indies, Australia (Goubran and El-Zeftawi, 1988), New Zealand (Burney, 1980), Madagascar, and South Africa. Loquats are now distributed in many Asian countries, for example, Laos, Nepal, Pakistan, South Korea, and Vietnam; in Armenia, Azerbaiian and Georgia (Safarov, 1988); and in the Americas including Argentina, Brazil, Chile, the mountains of Ecuador, Guatemala, Mexico, and Venezuela (Endt, 1979).

Japan has contributed greatly to the development of loquat. Japanese horticulturists selected two important cultivars, 'Mogi' and 'Tanaka', from the offspring of seedling introduced from China. 'Tanaka' has been introduced to many countries due to its large fruit size; it was introduced prior to 1900 to the United States and Israel, and later spread to Algeria (Lupescu et al., 1980), Brazil (Godoy and Rodrigues Amaya, 1995), India (Testoni and Grassi, 1995), Italy (Monastra and Insero, 1991), Spain (López-Gálvez et al., 1990) and Turkey, as well as China. Before World War II, Japan used to be the largest loquat producing country in the world. After the war, the area under loquat in Japan reduced gradually because development of food crops became more important and loquat cultivation was too labor-consuming.

Figure 2. Distribution of loquat in China.

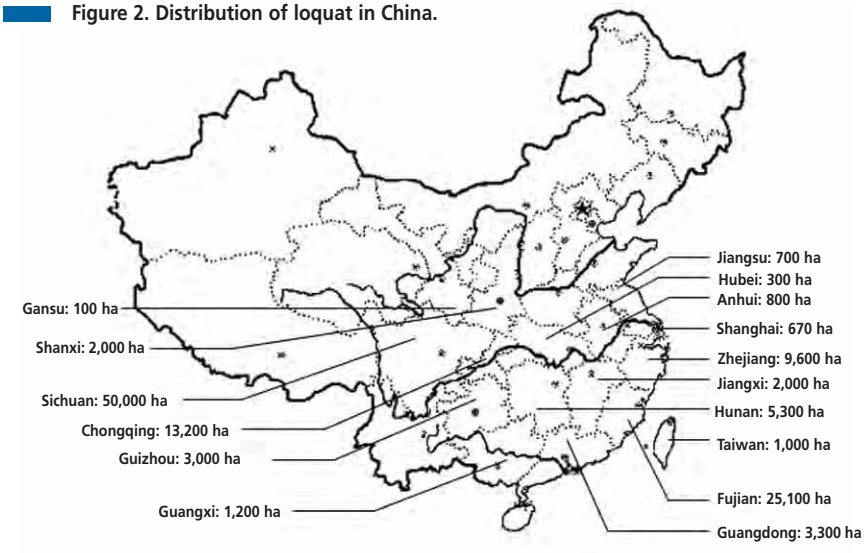


Figure 3. Fruit bagging is an important practice to produce high quality fruit in China. Fruit bagging is done cluster by cluster by hand across the orchard.

LOQUAT INDUSTRY

China

From the 1970s, loquat production in China witnessed a rapid increase from 2000 ha to 26,000 ha in 1995 and to 120,000 ha with an output of 460,000 tonnes (t) in 2005. Commercial activities are concentrated in central to south China (Fig. 2). The increase was due to new technology including: genetic improvement that resulted in new cultivars such as 'Zaozhong No.6' and 'Dawuxing' (Fig. 1), the widespread use of grafting to seedling rootstocks, an improved planting technique called the planting ditch (1 m^3 pits), flower and fruit thinning, and fruit bagging (Fig. 3). These practices enable production of large-sized high-quality fruit with high profit.

Spain

Spain is the second world producer of loquat with more than 40,000 t per year, and the leading exporting country with around 83% of worldwide exports, with the main destination being EU countries: Italy, Portugal, and France

Figure 4. Seedless selection of triploid loquat compared with seeded 'Pelluches' loquat (right). Fruit are the same relative size. (Seedless loquat by courtesy of Dr. Liang Guolu, seeded loquat by courtesy of Dr. Xuming Huang).

(Caballero and Fernández, 2004). Fruit size and earliness are the most important parameters in the commercialization of loquat in Europe. Commercial size is usually achieved by means of heavy thinning either at bloom (removing the upper two-thirds of the panicle), or in January (leaving 4-5 fruits per inflorescence). Due to the high cost of labor in Spain a chemical alternative has been developed using naphthalene acetic acid (NAA) and its derivates (Agustí et al., 2000; Cuevas et al., 2004). NAA is not yet registered for loquat in Spain. Girdling and the application of the synthetic auxins have also been proved effective for increasing fruit size and advancing maturity (Agustí et al., 2003; Amorós et al., 2004). Earliness improvement can also be achieved by protected cultivation (López-Gálvez et al., 1990) and by means of regulated deficit irrigation (Cuevas et al., 2007). Loquat in Spain occupies around 3,000 ha, mainly in the Mediterranean Coasts of Comunidad Valenciana and Andalusia regions. In the Comunidad Valenciana, the most important cultivar is the tasty 'Algerie' and its mutations, whereas in Andalusia 'Golden Nugget' is preferred due to its beautiful orange color, rounded shape, and tolerance to purple spot. Most loquat in Spain is grafted on unselected loquat seedlings leading to vigorous trees. A large size of the tree is a clear disadvantage due to the high number of hand operations in the crop such as thinning, pruning, harvesting, and bagging. Advanced farmers graft loquat on semi-dwarfing 'Provence' quince. Dwarfing rootstocks such as 'Quince C' are under evaluation (Hueso et al., 2007) to reduce spacing and management cost and therefore increase loquat profitability. High density orchards use modified central leader training instead of the most common vase training usual in standard plantations. Production is now increasing in India, Pakistan, and Turkey.

NEW TECHNOLOGY IN CHINA

Cultivation Practices

Labor accounts for 63% of total production costs in China. With the labor in China becoming more and more expensive, loquat development has to turn to new techniques to replace the high labor-intensive practices in order to increase returns. Major selection and breeding efforts have uncovered adapted cultivars such as 'Dawuxing' and 'Zaozhong No.6'. Seedling rootstocks of cultivated loquat cultivars produce a shallow root and as a result, large planting pits (1 m^3) have to be excavated. Even so, some trees are uprooted by typhoons. Studies and evaluation trials are being conducted using rootstocks of other *Eriobotrya* species to replace seedling rootstocks in South China Agricultural University and over 10 species have been tested. They all showed good compatibility and normal fruit set except narrow leaf loquat (*E. henryi*). These rootstocks are under evaluation for a stronger root system. A selection program for dwarfing rootstocks or interstocks has been launched in the Fruit Research Institute of Fujian Academy of Agricultural Science, and promising dwarfing rootstocks such as 'Mina's No.1' and 'Daduhe' have been found.

Seedless Loquat

The relatively large and numerous seed of loquat reduce flesh recovered, which is not larger than 70%, and make loquat somewhat difficult to consume fresh out of hand. Professor Liang Guolu and his colleagues in Northwest University have selected natural triploids, which occur from non-reduced gametes in a frequency of about 0.5%, from open populations of various cultivars. Some of these clones appear to be parthenocarpic while others may require pollinizers. Many triploids were obtained from a program of chromosome counts of seedlings and promising seedless clones are now being evaluated (Fig. 4). Breeding seedless loquat cultivars is also possible from diploid x tetraploid crosses, or from endosperm culture. It is anticipated that the selection of promising seedless loquat could have a profound effect on the loquat industry.

Medicinal Uses

Leaves and fruits of loquats have traditionally been considered to have high medicinal value

Figure 5. Loquat paste: a traditional medicine for releasing cough.

(Duke and Ayensu, 1985; Wee and Hsuan, 1992) and there is evidence of pharmaceutically active compounds (Morton, 1987; Noreen et al., 1988; De Tommasi, 1992). The ether-soluble fraction of the ethanolic extract of the leaves showed anti-inflammatory activity when applied topically to rats. Ursolic acid, maslinic acid, methyl maslinate, and euscaphic acid were isolated from this fraction. Maslinic acid was shown to be at least partly responsible for the anti-inflammatory activity of the extract. Seven glycosides, five of which are new natural products, were isolated from the methanol extract of leaves collected in Italy (De Tommasi, 1992). For at least 40 years, Chinese food stores in the United States have sold a product imported from Hong Kong and recommended for chronic bronchitis, coughs, and lung congestion (Fig. 5). Contents are listed as loquat leaves with other herbs (Duke and Ayensu, 1985; Wee and Hsuan, 1992). The traditional medical uses of loquat and relevant research involve the common cultivated loquat species. In China, there are 20 other species in the genus *Eriobotrya* and the potential medical use of these species replacing cultivated loquat is under study in South China Agricultural University. The study has found that fragrant loquat (*E. fragrans* Champ) contains far higher ursolic acid, the cough-easing component in loquat, than cultivated species. Hence, it is expected that the raw materials for processing of Chinese traditional medicine will come from the wild loquat instead of the cultivated loquat. With no more leaves taken for medical processing, fruit quality and yield of cultivated loquat will not be reduced.

Figure 6. Loquat wine.

THE FUTURE

Loquat, an ancient oriental crop, is expected to experience further development in the future. Loquat fruit attracts a premium price in Chinese fresh markets because consumers love it and there are almost no competitors during loquat season in late winter and early spring. Hence, there is huge room for the development of loquat as a profitable industry in China. Shortage of fresh fruit in spring is also seen in other countries. On a world scale, loquat is still a very minor fruit in spite of the fact that loquat is adapted to various subtropical climates and can be grown in many countries and should prove to be a profitable industry in countries other than China, Japan, and Spain. Furthermore, with the introduction of new technology, such as new cultivars, dwarfing rootstocks, fertigation, and improved postharvest handling, higher quantity and quality of loquat with better marketability will be produced at lower labor cost. Loquat industry could be a profitable fruit industry in many areas of the world. Finally, more diversified uses of loquat and advanced processing techniques will generate higher added value to the crop. Apart from fresh consumption and traditional medical uses, new processing techniques are being tested with success in making juice, tea, paste, or wine (Fig. 6). Germplasm with richer functional substances is being uncovered and new technology to purify these active compounds will upgrade the medical industry based on loquat. Developing processing industries are bound to demand a larger tonnage of loquat for raw materials further expanding production.

REFERENCES

Agustí, M., Juan, M., Almela, V. and Gariglio, N. 2000. Loquat fruit size is increased through the thinning effect of naphtaleneacetic acid. Plant Growth Reg. 31:167-171.

Agustí, M., Gariglio, N., Castillo, M., Juan, A., Almela, V., Martínez-Fuentes, A. and Mesero, C. 2003. Effect of the synthetic auxin 2,4-DP on fruit development of loquat. Plant Growth Reg. 41:129-132.

Amorós, A., Zapata, P., Pretel, M.A., Botella, M.T., Almansa, M.S. and Serrano, M. 2004. Role of naphthalene acetic acid and phenotiol treatments on increasing fruit size and advancing fruit maturity in loquat. Scientia Hort. 101:387-398.

Burney, B. 1980. Exotics: A guide to some that may be grown in New Zealand. Part I New Zealand Agr. 140:58-59, 62.

Caballero, P. and Fernández, M.L. 2004. Loquat, production and market. Options Méditerranéennes Serie A 58:11-20.

Cuevas, J., Moreno, M., Esteban, A., Martínez, A. and Hueso, J.J. 2004. Chemical fruit thinning in loquat with NAAm: dosage, timing, and wetting agent effects. Plant Growth Reg. 43:14-151.

Cuevas, J., Cañete, M.L., Pinillos, V., Zapata, A.J., Fernández, M.D., González, M. and Hueso, J.J. 2007. Optimal dates for regulated deficit irrigation in 'Algerie' loquat (*Eriobotrya japonica* Lindl.) cultivated in Southeast Spain. Agric. Water Management 89:131-136.

De Tommasi, N. 1992. Constituents of loquat - a study of their antiviral properties. J. Nat. Prod. 55:1067-1073.

Duke, I. and Ayensu, E.S. 1985. Medicinal plants of China. Vol. 2. Reference Publ, Algonae, MI. p.544.

Endt, R. 1979. Observations on fruit growing in Ecuador and Chile. Orchardist New Zealand 52:347-349, 351, 353.

Goubran, F.H. and El-Zeftawi, B.M. 1988. Assessment of some loquat cultivars. Austral. Hort. Res. Newsl. 55:125.

Godoy, H.T. and Rodrigues Amaya, D.B. 1995. Carotenoid composition and vitamin A value of Brazilian loquat. Archivos Latinoamericanos Nutricion 45:336-339.

Hueso, J.J., Cañete, M.L. and Cuevas, J. 2007. High density loquat orchards: plant selection and management. First results. Acta Hort. (in press).

Ichinose, L. 1995. The origin and development of loquat (in Japanese). Series Agr. Tech. 4(suppl):I-5.

Lin, S., Sharpe, R.H. and Janick, J. 1999. Loquat: Botany and horticulture. Hort. Rev. 23:233-276.

López-Gálvez, J., Gallego, J., López-Hernández, I. and Tellez, M.M. 1990. Influence of plastic cover in the ripening of loquat in south eastern Spain. p.141-148. In: A.A. Balkema (ed.), Proc. 1st Int. Congr. Use of Plastics in Agr., Rotterdam, Netherlands.

Lupescu, P., Lupescu, T., Khels, A. and Tanislav, G. 1980. Agro-biological performance of some loquat varieties grown at the horticultural station of the National Agronomic Inst. Algiers. Fruits 35:251-261.

Monastra, F. and Insero, O. 1991. Loquat industry in Italy: Varieties investigation. Annali dell'Ilstituto Sperimentale Frutticoltura 19:87-91.

Morton, J.F. (ed.). 1987. Loquat. p.103-108. In: Fruits of Warm Climates, Creative Resource Systems, Winterville, FL.

Noreen, W., Wadeod, A., Hidayat, H.K. and Wahid, S.A.M. 1988. Effect of loquat on blood glucose levels of normal and alloxan-diabetic rabbits. Planta Medica 54:196-199.

Safarov, L.S. 1988. The present state and prospects for the development of subtropical fruit growing in the Azerbaiim SSR. Rastitel'nye Resursy 24:161-157.

Sima, Q. 100 BCE. Record of History (in Chinese). 117:3028-3029.

Testoni, A. and Grassi, M. 1995. Quality aspects and storage life of some cultivars of loquats. Riv. Frutticolture Ortofloricoltura 57:33-88.

Wee, Y.C. and Hsuan, K. 1992. An illustrated dictionary of Chinese Medicinal Herbs. GRC5 Pub. Box 1460, Sebastopol, CA.

Shunquan Lin

Xuming Huang

Julián Cuevas

Jules Janick

ABOUT THE AUTHORS

Dr. Shunquan Lin is the Dean of College of Horticulture and the Director of Institute of Biotechnology in Horticultural Crops, South China Agricultural University. He was the Convener of the 2nd International Symposium on Loquat. His expertise is in the area of germplasm resources and biotechnology in loquat and other subtropical fruits. Email: loquat@scau.edu.cn

Dr. Xuming Huang is a Professor of Fruit Science at South China Agricultural University (SCAU). His expertise is in the physiology of subtropical fruits including litchi, longan, loquat and citrus. He played an active role in organizing the 1st International Symposium on Litchi and Longan and the 2nd International Symposium on Loquat held in Guangzhou 2000 and 2006, respectively. He is currently the Director of Physiological Lab for South China Fruits at SCAU. Email: huangxm@scau.edu.cn.

Dr. Julián Cuevas is a Professor at the Department of Crop Production, University of Almería, Spain. His research is devoted to the study of Mediterranean and subtropical fruit trees including olive, grape, cherimoya, avocado, and loquat. He has published more than 20 papers on the physiology of flowering and fruiting in loquat. Email: jcuevas@ual.es

Dr. Jules Janick is James Troop Distinguished Professor of Horticulture at Purdue University, USA, and Director of the Indiana Center for New Crops and Plant Products. Email: janick@purdue.edu

Remembrance of Things Past: The Photographs of Antonio Cezar d'Abrunhoza

Maria Inês d´Abrunhosa Mansinho

Antonio Cezar d'Abrunhoza.

Pruning the vineyard and removing prunings.

Antonio Cezar d'Abrunhoza, (1881-1941) was a farmer in Beira Baixa, a region in the middle east of Portugal and while he considered himself an amateur photographer, his work indicates that he was an artist. His work is both very personal and historical. d'Abrunhoza, born to a prosperous family with Jewish roots, was a deaf mute and his disability heightened his interest in the visual world, a world that he captured with rare beauty recording not only the scenes from his farm but creating a social documentary of his times.

In the 1920s and 1930s Portugal underwent one of its strongest demographic surges. Its population, formerly kept in check by migration flow to Brazil, America, South Africa, and the African Portuguese colonies as well as the 1918/19 flue epidemics, increased about 1.7 millions, with one third of the population less than 14 years old. The illiteracy rate was high and about half of the active population worked

Excavating and fertilizing the vine.

Filling up the knapsack sprayer with fungicide.

Spraying the vineyard with Bordeaux mixture.

Grape harvester.

Women exhibiting clusters of grapes.

Loading grape harvest on the oxcart.

Transporting wine casks to the cellar.

in agriculture with only one fifth in the manufacturing sector. Life expectancy in 1930 was 45 years for men and 49 years for women. This resulted in a mass of seasonal workers without alternative jobs. The remarkable photographs of grape production presented here indicate the high availability of hired labor. In the small villages, employment expectations were limited with most all family members working in agriculture during the production cycle. The social aspect in the rural areas could be described as "a sad paradise" using an expression that the French poet Saint Exupéry once wrote.

Artistically, the images of d'Abrunhoza are modern in concept brought about in some cases by close framing such as of a woman handling grapes or by the composition of groups creating a dynamic assemblage that in some cases appears choreographed, yet surrealistic. His use of light is wonderful. In one image, a group of workers holding grapes appears as in a "family photo". In viewing his entire works, some images are over- or under-exposed, and sometimes there are focusing errors; but it is clear that d'Abrunhoza attempts to search for the extraordinary image. The power of his photography is to paralyze all senses except vision, create the illusion of totality, self-sufficiency, and complete absorption of the subject.

D'Abrunhoza's passion for photography – he left a collection of 10,000 glass plates – and his devotion to horticulture and agriculture were all consuming with little time for social contact. The "Casa Abrunhoza" frequently won many medals in national and international agricultural fairs and exhibitions. In numerous occasions he contributed his photographs in regional and national publications. After his death, numerous photographs were reproduced but without allusion to his name.

About the author

Maria Inês d'Abrunhosa Mansinho

Maria Inês d'Abrunhosa Mansinho is a Professor in the Department of Agricultural Economics and Rural Sociology, Instituto Superior de Agronomia, Universidade Técnica de Lisboa. Maria Inês is the granddaughter of the artist.

Strawberry Production in Turkey

Ece Turhan and Sevgi Paydas Kargi

Strawberry (*Fragaria Xananassa*) is an economically important world berry fruit whose production continues to increase throughout the world (Table 1). Although the United States rank first in the world in strawberry production, about 38.3% of the world's production is in Europe. In 2005 strawberry production in Turkey was about 160,000 tonnes (t) on 10,500 ha, almost a 35 fold increase from 1965, making Turkey one of the most important strawberry producing countries in Europe after Spain, Russian Federation, and Poland. Strawberry yield/ha is generally low in Turkey (Paydas and Kaska, 2006). Under farmers' conditions yield per hectare was about 4.5 t in 1965, increased to 9.5 t in 1990, and 15.2 t in 2005 (Fig. 1), but reached 50 t under various experimental conditions at Cukurova University. There remains substantial room for improvement (Paydas and Kaska, 2006).

Figure 1. Strawberry production (top), production area (center) and average yield (bottom) in Turkey between 1965 and 2005.

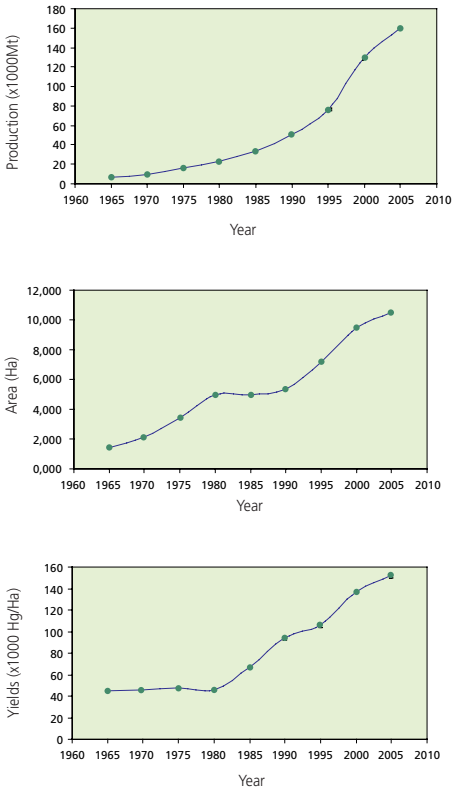


Figure 2. The main strawberry producer cities in Turkey.

STRAWBERRY GROWING REGIONS IN TURKEY

Although strawberry has been grown in almost all parts of Turkey, the leading strawberry-producing regions are Mediterranean (62%), Marmara (20%), and Aegean (12%). Other regions combined account for only 6% of Turkey's production. The main strawberry producing cities in Turkey are shown in Fig. 2.

Mersin is the main province for strawberry production in the Mediterranean Region producing about 72,000 t on 2,770 ha, accounting for 46% of Turkey's total production (Anon., 2005a). Silifke county in Mersin Province is one of the most important strawberry production areas. Most of the growers here use runners from their own strawberry field as propagation material. The industry was started here as a result of the development of the frozen fruit industry that exported to countries such as Russian Federation and Poland in 2005. The volume exported was 4,500 t. It is expected that in the next few years, these volumes will continue to increase, allowing an increase in local production (Anon., 2006b). The second strawberry producing county in Mersin is Anamur. The first strawberry plantation was established by Paydas et al. in 1989 (Paydas et al., 1992). In this region, 90% of production is under plastic tunnels. There is some annual hill systems production in field plantings using black plastic mulch. Summer planting is done

Table 1. World strawberry production by country in terms of area and production (Anon., 2006a).

Country	Area (ha)	Production (t)
USA	21,120	1,053,280
Spain	7,600	308,000
Russian Federation	36,000	217,000
Japan	7,300	200,000
Korea	7,000	200,000
Poland	53,700	180,000
Turkey	10,500	160,000
Mexico	5,414	150,261
Italy	6,226	147,049
Germany	12,254	146,500
Morocco	2,780	106,100
Others	81,824	73,914
World	251,718	3,616,865

Table 2. Geographical origin of the cultivars cultivated in Turkey.

Cultivar	Origin
Camarosa	USA, California
Chandler	USA, California
Cruz	USA
Diamante	USA, California
Douglas	USA, California
Fern	USA, California
Gaviota	USA, California
Maya	Italy
Miranda	Italy
Oso Grande	USA, California
Ottoman	Turkey
Paros	Italy
Pocahontas	USA, Maryland
Seascape	USA, California
Selva	USA, California
Sweet Charlie	USA, Florida
Tioga	USA
Yalova 110	Turkey
216 (Dorit)	Israel, Volcani

using cold stored plants (frigo), but tray plants to some extent are now being used. The tray plants are fresh seedlings that are produced in specialized trays. Runners are cut from the mother plant and then are transplanted in trays. This allows having the same plantation date and equal development of the planted runners. A wide range of cultivars with different origins is available. Among the most important are 'Oso Grande', 'Camarosa', 'Chandler' from California; and 'Sweet Charlie' from Florida. Hill filled plantings use day-neutral cultivars such as 'Selva', 'Seascape' and 'Fern' (Kaska, 2002). During the last three years important developments have occurred in strawberry production in Gazipasa (Antalya), in the Mediterranean region (Anon., 2005a); 80% of the production in Gazipasa is in walk-in high tunnels using 'Camarosa' and 'Chandler' (Anon., 2005b).

In the Marmara Region, Bursa is the leading province for strawberry producing 30,000 t

Abundant fruiting of 'Cal Giant-3' strawberry. Photograph by courtesy of Yaltir Company, Mersin, Turkey.

(Anon., 2005a). The most commonly used production system is matted-row culture and plants are cropped for up to 4 years, and then renovated. 'Tioga' is the most planted cultivar because of its suitability for the frozen fruit industry. It is grown on the slopes of the Uludag Mountain together with some very old and degenerated cultivars. Research is underway to find suitable industrial cultivars and evaluate their performance in this region.

In the Aegean Region, Sultanhisar (Aydin) is an important strawberry production area supplying 7.2% of total strawberry production with 11,161 t (Anon., 2005a). The annual hill systems are typical; plantings are fruited once and renovated, and usually intensively managed under plastic tunnels for early ripening. 'Camarosa' is the main cultivar followed by 'Chandler', 'Sweet Charlie' and 'Miranda'. Plants were obtained from some private company in Adana (Onal et al., 2003). Emiralem (Menemen) is another intensive strawberry production area in Izmir; production is carried out either on open fields or under covers. Plastic tunnels are used for early production and increased yield. Mulching with black plastic is used. All soil is preplant fumigated with methyl bromide injection for nematode, soilborne fungal pathogen, and weed control. Fertilizer and trickle irrigation line is set into the soil as the planting beds are being formed. Most plantings are fruited for one season only. The principal cultivars in Emiralem are 'Chandler', 'Camarosa', 'Sweet Charlie', '216', Pocahontas', 'Yalova 110' and 'Cruz' and 81% frigo plants are used of which 63% were obtained from stock plant beds belonging to the Agricultural Ministry and the rest from a private company. About 65% of producers sell their fruit to wholesalers (Yildirim and Turhan, 2003).

In Eregli (Zonguldak) on the western coast of the Black Sea strawberry production is conventional matted-row culture and a local cultivar, 'Ottoman', is used for marmalade and jam processing. 'Ottoman' is male sterile and very rich in aromatic substances (Serce et al., 2005). Around 1975, 'Tioga', 'Douglas', 'Pocahontas' and 'Yalova hybrids' were introduced (Kaska, 2002). Strawberry growing is still developing on the eastern part of the Black Sea coastal area and in the mountains and forests where aromatic small fruited wild strawberries are grown. These soils are acidic and suitable for strawberry growing but a shortage of agricultural land limits production (Kaska, 2002).

In the eastern part of Anatolia, Elazig Province is one of the promising strawberry production areas, with annual yields about 2020 t per ha (Anon., 2005a) with traditional strawberry growing techniques. In the southeastern part of Anatolia, strawberry production will satisfy local demand but research is underway with different planting systems and cultivars (Kaska, 1997).

Strawberry harvest in high tunnels. Photograph by courtesy of Yaltir Company, Mersin, Turkey.

CULTIVARS

The strawberry cultivars used in Turkey are shown in Table 2. Recently 'Camarosa' has become more popular in Turkey but testing is underway with 'Gaviota', 'Maya', 'Paros' and 'Diamante'. Hybridization is being carried out between local and foreign cultivars at Cukurova University (Paydas and Kaska, 2006). However, there are diploid species (*Fragaria vesca* and *Fragaria viridis*) in Turkey's flora and these wild species are considered genetic resources sources available for the improvement of the octoploid *F. Xananassa* (Serce et al., 2005). At the east of Marmara, Bolu Province and Eastern Black sea area, the wood strawberry (*Fragaria vesca*) is collected to produce jams that are very rich in aroma and are sold at very high prices (Kaska, 1997; Serce et al., 2005). Production from wild harvest is estimated at 400-500 t per year and are exported frozen. These fruits are also used fresh as well as in medical and cosmetic industries (Serce et al., 2005).

After 1980, production of local cultivars was abandoned because of new high yielding American strawberry cultivars (especially those from California). However, local cultivars have been missed for their excellent flavor. Therefore, cross-breeding is underway at Cukurova University (Serce et al., 2005; Paydas and Kaska, 2006).

Packed strawberries in plastic trays. Photograph by courtesy of Yaltir Company, Mersin, Turkey.

Packed trays of strawberries. Photograph by courtesy of Yaltir Company, Mersin, Turkey.

PLANTING SYSTEMS

After 1972 experiments were started in different locations with frigo plants for summer and winter plantings. Summer planting proved to be superior to winter planting (Kaska, 2002; Paydas and Kaska, 2006) and has become more popular in most of the strawberry producing regions of Turkey (Paydas and Kaska, 2006).

Most of the strawberry production is in unheated, walk-in, high tunnels, plastic houses and to a small extent, in glasshouses of the Mediterranean and Aegean coastal areas. However, there are places where the traditional open field growing is also carried out. In Central and South East Anatolia strawberries are grown in open culture (Kaska, 1997). Soil fumigation and solarization is applied and in all the strawberry growing areas of Turkey black plastic mulch is commonly used. Trickle irrigation is carried out everywhere.

CONCLUSION

Strawberry production has been developing well in Turkey during recent years and is expanding throughout almost all of the country because of favorable climatic conditions. However, there are difficulties in runner plant production. Tray plants are used in a small scale and are necessary in order to get early fruits in October, November or December.

Presently the yield is low but we anticipate continued expansion chiefly through increases in yield by proper technique and high yielding cultivars. 'Camarosa' is a good cultivar for Turkey because in long distance transport, firm fruited types are needed. Current research studies are emphasizing planting systems and new cultivars.

REFERENCES

Anon. 2005a. Republic of Turkey, Prime Ministry Turkish Statistical Institute.

Anon. 2005b. Antalya Agricultural Province Management's Reports.

Anon. 2006a. FAOSTAT - Agricultural Statistic. http://www.fao.org

Anon. 2006b. Silifke Agricultural County Management's Reports. http://www.silifketarim.gov.tr/tarimsalyapi.asp

Kaska, N. 1997. Strawberry growing in Turkey. Acta Hort. 439(1):385-391.

Kaska, N. 2002. Present and future projection of strawberry production in Turkey. Acta Hort. 567(2):539-541.

Onal, M., Babaeren, F., Dolgun, O., Akaroglu, S.N. and Yildirim, E.M. 2003. General conduction of strawberry culture of Aydin Province (in Turkish). Proc. National Kiwifruit and Small Berries Symp., 23-25 Oct., Ordu. p.226-229.

Paydas, S. and Kaska, N. 2006. La fragolicoltura in Turchia. Riv. Frutticoltura Ortofloricoltura 4(Aprile):37-41.

Paydas, S., Gubbuk, H. and Aydin, A. 1992. Adaptations of 5 strawberry cvs to Anamur ecological conditions by using summer and winter plantings (in Turkish). Derim 9(3):108-116.

Serce, S., Gunduz, K., Ozdemir, E., Bakan, M., Paydas, S. and Kaska, N. 2005. Genetic resources of Turkish strawberry varieties (in Turkish). GIDA-TARIM Cine Tarim A.S. Nisan-Mayis 68:60-64.

Yildirim, I. and Turhan, E. 2003. The problems of pesticides usage and recommendations in strawberry growing in Turkey (in Turkish). Proc. National Kiwifruit and Small Berries Symp., 23-25 Oct., Ordu, p.259-265.

ABOUT THE AUTHORS

Ece Turhan

Sevgi Paydas Kargi

Dr. Ece Turhan is a specialist in strawberry growing techniques, soilless culture, and oxidative stress and physiological disorders in vegetable fruit crops. She teaches at Bayramic Vocational College, Canakkale Onsekiz Mart University, Turkey, email: eturhan@comu.edu.tr

Prof. Sevgi Paydas Kargi is a specialist in strawberry, apricot, banana, and loquat and has long experience in strawberry breeding. She teaches at the Department of Horticulture, Faculty of Agriculture, Cukurova University, Adana, Turkey, email: sevpay@mail.cu.edu.tr

Fruit Production in India

C. Ravindran, Anshuman Kohli and B.N. Srinivasa Murthy

INTRODUCTION

India is gifted with a wide variety of agro-climatic conditions and soils and enjoys a prominent position in world horticulture. Almost all tropical, subtropical, and temperate fruits are being grown in the country. India is now the second largest producer of fruits in the world next only to China. Total production of fruits in India has been reported to be 45.203 million tonnes (t) as of 2002-2003 from an area of 3.788 million ha (Jain, 2004). However, almost 20-30% of the fruits are lost at postharvest stage (Krishnamurthy and Rao, 2001). Only about 0.1% of the fruits are processed against a demand of about 0.5%. Although India is the largest producer of fruits in the world, the production per capita is only about 100 g per day. However, it is estimated that more than 20-22% of the total production of fruits is lost due to spoilage at various postharvest stages, thus the per capita availability of fruits is further reduced to around 80 g per day in comparison to a requirement of 92 g for a balanced diet as prescribed by the Indian Council of Medical Research. Thus, the fruit industry has a great opportunity for expansion.

The share of fruits in horticultural crop production in India (country wise percent share of fruit production is also highlighted in Fig. 1) is slightly over 30% (Pathak, 2002). Recently there has been a significant increase in area and production of fruits in India (Table 1). Fruit production in India as of 2002-03 had increased 8 times since the 1980s and 1.6 times since 1991. The country is the world leader in production of banana (11%), mango (65%), sapota (9%), and acid lime (10%) (Ghosh, 2001). These fruits are cultivated across the country. The states of Maharashtra, Tamil Nadu, Andhra Pradesh, Bihar, Uttar Pradesh, and Gujarat are the important fruit growing states of India.

As of 2003, productivity of fruits in India had increased from 10 to 12 t/ha in almost one decade. However, wide variations in average productivity are prevalent in different agro-ecological zones of the country. Except for grapes, the productivity of most fruit crops is far below their average productivity in many fruit growing countries of the world.

As many as 190 species of economically important crops are indigenous to the Indian center of origin of which 109 are fruits (Arora and Nayar, 1984). These include *Citrus indica* var. *latipes, Feronia linonia, Garcinia indica, Manilkara hexandra, Mangifera indica, Musa* species (AB, AAB group), *Syzygium cumini* and *Sizyphus maurtiana* (Arora, 1987). Their gene pool has been enriched as a result of the conquests of Alexander the Great, and from intrusions to India by the Persians, Turks, Moguls, Portuguese, Dutch, French, and the British.

HISTORY OF FRUIT CULTURE IN INDIA

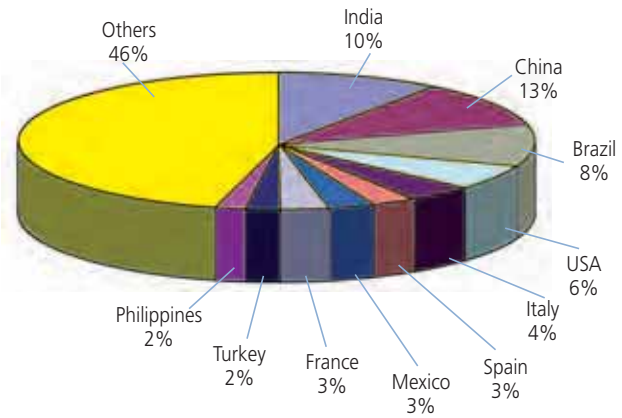
Growing and utilization of fruits has been inherent to the Indian way of life for ages. The fruits are traditionally processed into various products such as jams, jellies, preserves, dehydrated fruit, pickles, fruit cream, pudding and other dessert items. In India, the generations of people are closely linked to farming. Almost 80% of the population lives in rural areas and the livelihood of more than 65% of people is dependent on agriculture. Scattered farm trees including fruit trees, fodder trees and shade trees are a common sight on traditional Indian farms. Most of the Indian population is at the most a couple of generations away from farming and has at least some close relatives associated with farming. Although traditional Indian farms have had fruit trees as an integral part of agricultural diversity, the fruit trees are of seedling origin and not high yielding. Hence the availability of fruits is strongly seasonal and perennially in short supply.

South India was associated with the domestication of mango, citrus, and black pepper. King Ashoka (247-237 BCE) promoted planting of fruit trees including mango, banana, grapevine, jackfruit, Palmyra palm, and wild dates. Road side plantation of fruit bearing trees has been considered to be an act of high virtue in the Indian society, be it for the benefit of the local population, travelers or even birds and wild animals. The Epics like the *Ramayana* mention the use of fruits like ber (*Zizyphus jojoba*) by the people in the wild.

Medicinal uses of fruits such as acid lime (*Citrus aurantifolia*), almond (*Prunus amygdalus*), aonla (*Emblica officinalis*), bael (*Aegle marmelos*), banana (*Musa sapientum*), ber (*Zizyphus mauritiana*), dates (*Phoennix dactylifera*), fig (*Ficus carica*), grapes (*Vitis vinifera*), hog plum (*Spondias cytherea*), jackfruit (*Artocarpus heterophyllus*), jamun (*Syzygium cumini*), karonda (*Carissa carandas*), khirni (*Manilkara hexandra*), lemon (*Citrus limon*), mango (*Mangifera indica*), monkey jack (*Artocarpus lakoocha*), mulberry (*Morus alba*), orange (*Citrus sinensis*), phalsa (*Grewia subinaequalis*), pomegranate (*Punica granatum*), pistachio nut (*Pistacia vera*), walnut (*Juglans regia*), and woodapple (*Feronia limonia*) have been mentioned in *Charka Samhita* and *Sushrut Samhita* (written around 300 BCE by Vag Bhatta, these ancient Indian medicinal texts are considered the founders of *Ayurveda*, a traditional system of Indian medicine). Fruit culture has been dealt with in Kautilya's *Artha shastra* (a classical Indian treatise on economics) written in the 4th century BCE and in the *Virksha Ayurveda* (an Indian medicinal text composed in 1392). Mango (*Mangifera indica*), banana (*Musa sapientum*), bael (*Aegle marmelos*), aonla (*Emblica officinalis*) and coconut (*Cocos nucifera*) have been associated with Indian festivals and rituals. Indian traditional songs for marriages and other festivals find a mention of fruits like mango (*Mangifera indica*), banana (*Musa sapientum*), fig (*Ficus carica*), dates (*Phoennix dactylifera*), lemon (*Citrus limon*), and coconuts (*Cocos nucifera*).

Fruits such as bael (*Aegle marmelos*), custard apple (*Annona squamosa*), jackfruit

Figure 1. Country-wise percent share of fruit production (2001-2002).



Custard apple (*Annona squamosa* cv. Arka Shahan).

(*Artocarpus heterophyllus*), Indian gooseberry (*Emblica officinalis*), sea buckthorn (*Hippophae rhamnoided*), tamarind (*Tamarindus indiaca*) and wild pomegranate (*Punica granatum*) are traditional Indian fruits hitherto underutilized, closely linked to the cultural heritage of India and contribute to the traditional Indian taste. These fruits are mainly found as local traditional crops on marginal lands with no formal seed supply system and little or no external inputs. These fruits have multiple uses but have received little attention from researchers.

The early development in the Indian fruit industry was brought about largely by selection from both indigenous and introduced germplasm. These activities performed by the local growers, often patronized by rulers, continued over the years and resulted in the development of several popular types of different fruits.

TROPICAL AND SUBTROPICAL FRUITS

Mango

Mango (*Mangifera indica*) is the most important fruit crop of India having great socio-economic significance. It is known as the "king of fruits" owing to its delicious quality and richness in vitamins and minerals. Mango is widely grown in India ranging from tropical to subtropical and humid to semi-humid areas and contributes significantly to total volume of fresh fruit export. India is the largest producer and exporter of mangoes in the world; producing 12.7 million t annually, 52% of world output. Mango occupies 1.62 million ha out of the 3.8 million ha under fruit cultivation in India.

Mango (*Mangifera indica* cv. Arka Neelkiran).

Mango fruits are extensively utilized in processing in both the unripe and ripe stages. Pickles are the most common product from unripe fruit while squash (concentrated canned juice), pulp, puree, paapad (a dehydrated preparation of sweet and sour slices), jam, and preserve are commonly made from ripe mangoes.

Banana

Banana (*Musa sapientum*), sometimes called "apple of paradise" is one of the oldest fruits known to humankind. Banana is frequently mentioned in the great Indian epics, *Ramayana* and *Mahabharata*. India is now the largest banana producing country in the world followed by Brazil, contributing about 15% of the total world production. Banana holds first position in production and productivity in India but ranks second in area after mango. Tamil Nadu, Maharashtra, Kerala, Gujarat and Karnataka are the leading banana producing states. Banana is produced on 475,000 ha with production of 13.3 million t. In recent years, attempts have been made in India to orient India's banana production for export.

Banana is an excellent commodity for processing. A number of products have been developed and commercially exploited including puree, powder, ketchup, flour, chips, dried banana, fritter, vinegar and wine. Banana is also used in jams, juice and milk shakes, either alone or with other fruits.

Citrus

In India, citrus is the third most important fruit crop with an area of about 563,000 ha and an estimated production of 5.7 million t. The most important commercial citrus species grown in India is mandarin (*Citrus reticulata*) followed by sweet orange (*Citrus sinensis*) and acid lime (*Citrus aurantifolia*). In India citrus is processed into a number of products: acid lime - pickles, squash, cordials; sweet orange - juice, squash, marmalade, and jams; mandarin - juice, marmalade, and squash.

Acid lime (*Citrus aurantifolia* cv. Rasraj).

Guava

Guava (*Psidium guajava*), one of the most popular fruits of India, is a New World introduction that arrived in India from the Philippines as

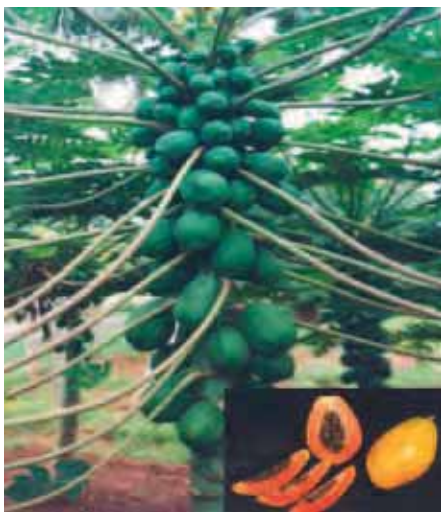
Guava (*Psidium guajava* cv. Arka Mirdula).

a result of the Spanish conquest and from Portuguese incursions in India. Some of the cultivars developed in India are considered to be the best in the world. Guava is cultivated throughout the country and occupies an area of 155,000 ha with a total production of 1.8 million t. Guava is grown in the states of Uttar Pradesh, Uttaranchal, Bihar, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, Karnataka, Gujarat and Rajasthan. In northern India, two crops (rainy and winter season) are harvested and in Maharashtra and Tamil Nadu, a third crop is occasionally harvested in October (HasthaBhar - it is a type of crop regulation in which the irrigation during September and October is withheld to force the tree to take rest and produce profuse flowering and fruiting). Guava is normally consumed fresh as a dessert fruit but jelly is the most common product. Guava juice is now becoming popular.

Papaya

India is the leading producer of papaya (*Carica papaya*), a New World fruit, but the average productivity is only 31.6 t/ha, whereas its potential is much higher. Average productivity in the state of Karnataka is 40 t/ha. In India, papaya is cultivated on an area of 68,000 ha with a total production of 2.15 million t. This fruit is very popular with farmers because it

Papaya (*Carica papaya* cv. Surya).



requires less area per tree, fruits in a year, is easy to cultivate, and provides high income per hectare. Papain, a proteolytic enzyme produced from the milky latex, is commercially produced in the states of Maharashtra and Gujarat. Mature fruits are being utilized on a commercial scale in the preparation of candy or tutti-frutti, a product in great demand in bakeries and confectionaries. Ripe fruits can be utilized in the manufacture of "ready-to-serve" papaya juice drink and mixed jam.

Grapes

Grapes (*Vitis vinifera*) were well known in India since the 11th century BCE. A number of cultivars were introduced mostly by invaders from Iran and Afghanistan. Commercial viticulture dates only to the 1930s in south India and the 1950s in north India. Total area under grape cultivation is estimated at 52,000 ha with an estimated annual production of 1.25 million t. Commercial grape cultivation in India is confined to the states of Andhra Pradesh, Haryana, Karnataka, Maharashtra, Punjab and Tamil Nadu. In Maharashtra alone there are 20,000 ha under grape cultivation and production exceeds 300,000 t with productivity averaging 15 t/ha. India is fast emerging as one of the major grape growing countries in the world. Per capita availability is about 750 g/year. Since grapes are grown in varied agro-climatic regions; they are available almost throughout the year except in November and December. Approximately 90% of grapes are consumed fresh with at least 25% subjected to postharvest losses; 5% are used for raisins and 5% for wine. There is often a glut of fresh grapes in the market during February-April. Only 10,000 t are exported as table grapes. Opportunities exist to increase exports of fresh grapes since the harvesting season is often different from temperate countries provided postharvest technology is developed.

Grape (*Vitis vinifera* cv. Arka Neelamani).

Pineapple

This New World fruit, *Ananas comosus*, is extensively grown in Assam, Meghalaya, Tripura, Miziram and West Bengal and grown on a smaller scale in Gujarat, Maharashtra, Tamil Nadu, Andhara Pradesh, Orissa, Bihar and Uttar Pradesh. The total area under pineapple is 74,000 ha with production of over 1 million tonnes, providing an average productivity of 13.60 t/ha, a dismally low level against a potential of 50-60 t/ha. Pineapple is consumed as a dessert fruit throughout the tropics and subtropics and can be processed as juice, squash, jam, jelly, and canned in chunks and slices. The fruit core is used for preparing candy.

Sapota

Sapot, sapodilla or chiku (*Manilkara sapota*), a delicious tropical fruit from the New World, is now popular in India. It is not known when this fruit was first introduced in India (Singh et al., 1963), but sapota cultivation was taken up for the first time in Maharashtra in 1889 in a village named Gholwad (Cheema et al., 1954). Immature fruits are astringent, while ripe fruits are sweet and tasty. The pulp is used in preparation of a sweet paste known as *halwa* and dried. The bark of the tree is used for preparation of tonics and as a febrifuge while the sap is used for the preparation of chicle used in chewing gum. Sapota is grown commercially in Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal.

Litchi

The earliest known monograph of this subtropical Asian fruit is a treatise written by Tsai Hsing in 1059 BCE. Litchi (*Litchi chinensis*) reached Myanmar by the end of the 17th century and was introduced in India about 100 years later. In India, litchi is cultivated on 5000 ha with a total production of 429,000 t. This crop is mainly cultivated in the states of Bihar, Utaranchal, West Bengal, Uttar Pradesh, Punjab, Assam and Tripura with Bihar accounting for 70-80% of total production. Litchi is consumed mostly as fresh fruit, but dried fruit and canned litchies are also popular. A highly flavored squash is also prepared from its fruits.

Aonla

Aonla (*Emblica officinalis*) has been cultivated in India since time immemorial and is frequently mentioned in the ancient literature of India (*Vedas, Ramayana, Charak Samhita, Sushrut Samhita, Kalidas, Kadambari*). It is a popular backyard fruit throughout the country but commercial orcharding can be found in Uttar Pradesh, Rajasthan, Gujarat and Maharashtra. Fruits of aonla are very extensively utilized by processing industry. It is an essential ingredient of *Chyawanprash*, a popular *ayurvedic* medicine. Other products are preserves, pickles, candy, jelly, jam and squash. Fruits can also be dried and powdered to be used subsequently in the preparation of oils, hair dyes and hair oils. In traditional medicine it is considered a health and vitality restorer.

Aonla (*Emblica officinalis*).

Ber

The Ber or the jujube (*Zizyphus muritiana*) is one of the ancient fruits of India and China. Its fruits are consumed fresh as well as dried and processed into delicious candy. Although ber plantations in the country are widespread, systematic cultivation is sporadic. The exact area under cultivation is unknown, but has been estimated at about 20,000 ha. The major growing states are Maharashtra, Rajasthan, Gujarat, Haryana, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh, and Punjab. In recent years there has been a lot of enthusiasm about ber orcharding in the arid regions of Andhra Pradesh, Maharashtra and Gujarat, but enthusiasm is waning due to inappropriate marketing infrastructure.

Some of the xerophytic characters of ber include a deep root system, leaf fall in summer, glossy upper leaf surface and presence of thorns. It is considered an excellent tree for wasteland development. Several products can be prepared from ber including candy, preserve, dehydrated ber pulp, jam, jelly and ready-to-serve beverages, but commercial exploitation is lacking.

Indian ber (*Ziziphus mauritiana*).

Pomegranate

Pomegranate, an ancient fruit with fine table and therapeutic values, is extensively cultivated in India. Its adoptability, hardy nature, and ability to enter into rest during the dry season makes it a valued crop under semiarid and arid areas of India and in recent years it has attained a significant place in the fruit industry. Until 1985 it was considered a minor fruit crop cultivated only in the states of Maharastra, Gujarat, Karnataka, Andhra Pradesh, Tamil Nadu and

Rajasthan, but it is now being cultivated on a large scale and has attained the status of a major fruit for India. Total area under this fruit crop is now 88,600 hectares with production of 518,700 t. Maharashtra accounts for 85% of the pomegranate growing area of the country where it has great socio-economic importance among tribal people. *Anardana* (sun dried wild pomegranate seeds used as a condiment) is made from wild pomegranate; fruit juice and squash are common processed products made from pomegranate.

Date Palm

Although date palm (*Phoenix dactilifera*) originated near India and became naturalized in this country in ancient times, at present there are no commercial plantations of high quality dates. Attempts are now being made to grow dates in Rajasthan, Punjab, and Haryana. This tree has potential for the arid zone of Rajasthan if irrigation is provided.

The dates are eaten at different stages of maturity depending upon the varieties and thus harvested at different stages according to local demand, customs and climate. In India where maturity coincides with monsoon, fruits are harvested at the doka stage (fruits contain 70-80% moisture) to avoid spoilage due to rains and high humidity. Such fruits can successfully be processed to make a dry fruit known as chhuhara in local parlance. Date juice and sugar have been successfully utilized as sweetening and flavoring agents in ice cream. Recently, attempts have also been made to can date pulp and khalal (a type of product) fruits in 10-40% sugars syrup.

Date palm (*Phoenix dactylifera*).

UNDERUTILIZED FRUITS

Underutilized fruit species, which are reputed to have high medicinal value, include custard apple, karonda, bael, jamun, and wood apple. Jack fruit is also cultivated in India and needs to be exploited for commercial cultivation.

Bael

Bael (*Aegle marmelos* L.) is also called Bengal quince. It is well adaptable to tropical and sub-

Bael (*Aegle marmelos*).

tropical conditions of plains and submontane regions of the country. Fruits possess aromatic pulp, eaten as such or as sherbets, squash, have medicinal value and cure for chronic diarrhoea and dysentery.

Jamun

Jamun (*Syzygium cuminii* L.) is indigenous to India. Its tree is tall and evergreen. It is generally grown as avenue or as wind break. It is widely grown from the Indo-Gangetic plains in the north to Tamil Nadu in the south. It is also found in the lower range of the Himalayas and Kumaon hills. The refreshing and curative properties of jamun make it one of the useful medicinal plants of India. Fruits are a good source of iron, used as an effective medicine against diabetes, heart and liver trouble. The seed powder of jamun reduces the quantity of sugar in the urine very quickly.

There is no improved cultivar for commercial cultivation. The most common type grown in north India is known as Rajamun. Another type found in Varanasi has no seed. A selection known as Narenda Jamun 6 has been identified with desirable traits at Faizabad (Uttar Pradesh).

Jamun fruits can be processed into excellent quality fermented beverages such as vinegar and cider, and non-fermented ready-to-serve beverages and squashes. A good quality jelly can also be prepared from its fruits. The seeds can be processed into powder that is very useful to cure diabetes.

Jamun (*Syzygium cuminii*).

Jackfruit

Jackfruit (*Artocarpus heterophyllus*) is popularly known as the poor man's food in the eastern and southern parts of India. A rich source of vitamin A, C, and minerals, it also supplies carbohydrates. Tender jackfruits are popularly used as vegetable. The skin of the fruit and its leaves are excellent cattle feed. Its timber is valued for furniture making since it is rarely attacked by white ants. The latex from the bark contains resin. Pickles and dehydrated leather are its preserved delicacies. Jackfruit is commonly propagated through seeds.

Jackfruit (*Artocarpus heterophyllus*).

Karonda

Karonda (*Carissa carandas*) is a hardy, evergreen, spiny and indigenous shrub. Widely grown in India, it is found wild in Bihar, West Bengal and south India. It is grown commonly as a hedge plant. Regular plantations of karonda are very common in the Varanasi district of Uttar Pradesh. Fruits, sour and astringent in taste, are a rich source of iron and contain good amount of vitamin C. Very useful to cure anaemia, its fruits have anti-ascorbic properties too. Raw or mature fruits are most suitable for making an excellent quality pickle, jelly or candy. Ripe fruits can be processed into ready-to-serve squash and syrup.

Karonda (*Carissa carandas*).

Table 1. Area and production of fruits in India (Jain, 2004).

Year	Area (million ha)	Production (million t)
1991-92	2.87	28.63
1992-93	3.20	32.95
1993-94	3.18	37.25
1994-95	3.24	38.60
1995-96	3.35	41.50
1996-97	3.58	40.45
1997-98	3.70	43.26
1998-99	3.72	44.04
1999-00	3.79	45.49
2000-01	3.86	43.13
2001-02	4.01	43.00

Wood Apple *(Feronia limonia)*

The wood apple (*Feronia limonia*) is also called elephant apple, a rutaceous species, which is well adapted to subtropical conditions and is distributed all over India but prefers dry climate. Fruits have sweet and aromatic pulp, eaten fresh or used in drinks, chutneys, jelly, etc. The wood apple induces early flowering in citrus when used as rootstock.

Wood apple (*Feronia limonia*).

TEMPERATE FRUITS

The North West Hill Region states, Jammu & Kashmir, Himachal Pradesh, Uttaranchal, and Arunachal Pradesh, are the major producers of temperate fruits, with substantial production in Jammu & Kashmir and Uttaranchal (Table 2). Apple is the principal fruit accounting for over 60% of area under temperate fruits; national production of apple is about 900,000 t. Jammu and Kashmir contributes more than 85% of walnut production in India. Out of about 86,000 ha under walnut more than 61,000 ha is in Jammu and Kashmir, which produces more than 86,000 t of fruits out of a national production of 102,000 t. Jammu and Kashmir is also the principal producer of cherry and almond.

Apple

Apple (*Malus* x *domestica*) is found wild in the hills of north India. The earliest plantation must have been established in Kashmir by the turn of the 16th century while a number of cultivars were introduced by Europeans in the 19th century. Credit for commercial plantations of apple is given to Captain R.C. Lee as well as Mr. S.N. Stocks who introduced 'Red Delicious' from the USA and planted them in Himachal Pradesh. Commercial plantings of apple have increased in the last 30 years through strengthening of the marketing system. Present cultivation is mainly confined to Jammu and Kashmir, Himachal Pradesh and Uttaranchal, which account for about 95% of total production. Apple cultivation has also extended to Arunachal Pradesh, Sikkim, Nagaland in the North-East region and Neelgiri hills in Tamil Nadu. Total crop area is now 231,000 ha producing 1,348,000 t. The apple growing in India is technically not in the temperate zone but the prevailing temperate climate of the region is achieved by high altitudes and the snow-covered Himalayan ranges, which help meet the chilling requirement during the winter season extending from mid November to mid March. In India apples are chiefly utilized as fresh fruit, however, cull fruits are being extensively utilized for canning, dehydration, and the preparation of cider, juice, jam, jelly, preserve and wine.

Apple (*Malus* x *domestica* cv. Ambri).

Pear

Pear (*Pyrus communis*) is the second most important temperate fruit in India. Its cultivation has been extended to the subtropics due to availability of low chilling types especially in Punjab where 'Parharnakh' is the most common cultivar. Pear is mainly cultivated in Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Punjab and Arnachal Pradesh. Total area under this crop is estimated to be only 38,600 ha with a total production of 176,000 t and a productivity of 4.6 t/ha. This low value is a result of insufficient attention by growers because of lower commercial value, and poor shelf life as compared to apple.

Peach

Peach (*Prunus persica*) is the third most important temperate fruit cultivated in India. The credit for introducing good cultivars of this crop belongs to foreign missionaries, who in the 19th century grew this crop in Himachal Pradesh, Jammu and Kashmir, and the hilly regions of western Uttaranchal. Recently, with the introduction of low chilling cultivars the crop has increased in popularity in north India but quality is still poor. Presently, this crop is being cultivated in Uttaranchal, Jammu and Kashmir, and Himachal Pradesh but peach is also grown to a lesser extent in the hilly areas of Tamil Nadu and the northeastern states. Besides its use as a table fruit, peach is utilized for canning. Poor quality fruits are also being used for preparation of wine.

Peach (*Prunus persica* cv. Local).

EPILOGUE

Despite the fact that India is one of the major fruit producing countries of the world, there is a great opportunity to increase and improve the production of tropical, subtropical, and temperate fruits. Underutilized fruits also have a huge potential waiting to be exploited. This will only be possible with a concerted effort by researchers and growers to improve quality and increase production based on consumer demand and export potential. Postharvest losses are one of the major concerns that need to be addressed to make horticulture more remunerative and attractive for growers and the industry.

Table 2. Production and productivity of fruits in north western hill region of India (1999-2000).

State	Area (000 ha)	Production (thousand t)	Productivity (t/ha)
Himachal Pradesh	207.1	448.0	2.2
Jammu and Kashmir	136.0	881.1	6.5
Uttranchal	187.9	520.4	2.8

References

Arora, R.K. and Nayar, E.R. 1984. Wild relatives of crop plants in India. NBPGR Sci. Monogr. 7.

Arora, R.K. 1987. The Indian gene centre: Principle and prospects for collection. p.66-75. In: Plant Genetic Resources, An Indian perspective, Symposium Proceeding.

Cheema, G.S., Bhat, S.S. and Naik, K.C. 1954. Commercial fruits of India. Macmillan & Co. publication.

Ghosh, S.P. 2001. Fruit research: Present status and future thrusts. Indian J. Hort. 58(1&2):7-15.

Jain, A.K. 2004. Indian horticulture database - 2004. National Horticultural Board, Ministry of Agriculture, Govt. of India.

Krishnamurthy, S. and Rao, D.V.S. 2001. Status of post harvest management of fruits. Proceedings of National Seminar on the Tropical and Subtropical Fruits, IARI, New Delhi. p.152-162.

Pathak, R.K. 2002. Present status, constraints and future strategies of fruit production in India. Proc. Summer school on production, protection and post harvest management of subtropical fruits, CISH, Lucknow, India. p.1-17.

Singh, S., Krishnamurthy, S. and Katyal, S.L. 1963. Fruit culture in India. ICAR publication, New Delhi. p.192-198.

About the authors

C. Ravindran

Anshuman Kohli

B.N. Srinivasa Murthy

C. Ravindran is a Jr. Scientist (Pomology) at the Regional Agricultural Research Station, SKUAST-Jammu (J&K), India, email: ravi_hort@yahoo.com

Anshuman Kohli is a Junior Scientist (Soil Science) at the Regional Agricutural Research Station, SKUAST-Jammu, Rajouri (J&K), India, email: anshuman_kohli@hotmail.com

B.N. Srinivasa Murthy, grape breeder and geneticist, is a senior scientist of the Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bangalore, India, email: bnsmurthy@yahoo.com

AIPH and ISHS Sign Memorandum of Understanding

The International Association of Horticultural Producers (AIPH) and ISHS recently signed a Memorandum of Understanding.

AIPH, founded in 1948, and ISHS share a common objective of strengthening and serving the economic and professional interests of horticultural industry worldwide. Both organizations have a broad international membership base and organizational structures that confer broad decision making authority to a Council of country representatives, thus ensuring a degree of international consensus on important decisions.

AIPH plays an international key role in sanctioning and coordinating national and international horticultural expositions that present to millions of people the wealth of products of the ornamental horticultural industry and the beauty and genius of interior and exterior landscape design. The member organizations of AIPH encounter, from time to time, specific issues that can usefully be addressed by scientists of the ISHS Sections and Commissions.

AIPH and ISHS recognize the need to better educate the general public about the nature and scope of horticultural science and its importance to humankind everywhere. Both AIPH and ISHS recognize that combining international scientific symposia on specific ornamental horticulture topics with some of the large AIPH-sanctioned exhibitions could strengthen these exhibitions and help ensure the success of these ISHS symposia.

AIPH and ISHS will strengthen their relationship by committing to the following principles and practices:

AIPH President Dr. Doeke Faber and ISHS Vice-President Prof. Ian Warrington met at the ISHS booth in Chiang Mai at Royal Flora Ratchaphruek 2006 to agree on a common memorandum.

AIPH President Dr. Doeke Faber and ISHS Treasurer Dr. Robert Bogers signing the Memorandum of Understanding.

- Stronger communication links between AIPH and ISHS
- Linking ISHS symposia with AIPH-sanctioned expositions
- Promoting horticultural research and university level horticultural education at AIPH sanctioned exhibitions

Suzanne Lux

New Books, Websites

The books listed here 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

BOOK REVIEWS

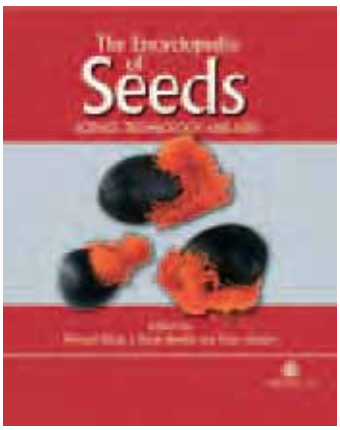
The Encyclopedia of Seeds: Science, Technology and Uses. Edited by Michael Black, J. Derek Bewley and Peter Halmer. 2006. CABI International. 828p. ISBN 978-085199-723-0. £185/$350/€225.

This one volume, two column encyclopedia claims to be the first comprehensive reference embracing all major facets of seeds. It is composed of contributions from 112 contributors with article of various lengths and depths from ABA to zygotic embryo and presents an overview of current understanding on seeds rather than in depth coverage. The book includes a useful crop atlas, two indices, an "index of species" (binomials and common names) and a general index (called "index"), which strangely also referenced botanical families; and 16 pages of stunning colored inserts, mostly of seed images. Many of the entries are illustrated with black and white images, and these were very well done. The references in the body of the work are cross indexed.

The articles are arranged alphabetically, but the index will be necessary to integrate plant species and subject matter. When the book first arrived I checked it out by a test search using four topics that I was interested in at the moment: seed size, arugula, *Artemisia annua*, and gravitropism. For seed size I started with the index: one indexed term (Size, seed) told me to see entries from individual species, the next indexed term (Size, seed, analysis, p. 598) had a brief reference to seed size of scarlet runner bean. However, going directly to "size" in the book directed me to entry on size of seed, which was a short article but contained excellent information on the subject (just what I wanted) plus some useful references. Going to the index for "arugula" sent me to rocket, which directed me to page 42, an article on "Brassica - horticultural" followed by "Brassica - oilseeds." These entries were general; the first included a mention of arugula, but unfortunately had nothing specific on arugula seed. For *Artemisia annua*, the species index referenced four *Artemisia* species but none on *Artemisia annua*. The index contained a citation for "gravitropism", which led to p.481 and p.519 and indeed there were two mentions of the term. There were many index references for gravity table(s), which are used to separate seeds.

The encyclopedia is information dense and those interested in seeds and seed technology will find many fascinating, unexpected entries such as "History of seed research," and "Pharmaceutics and pharmacologically active compounds." There are many references to seeds of horticultural interest. Unfortunately the high price will prohibit many individuals from buying the book, but I would suggest you attempt to get your library to purchase a copy.

Reviewed by Jules Janick, Purdue University, USA



Knott's Handbook for Vegetable Growers. 5th edition. Donald N. Maynard and George J. Hochmuch. 2007. John Wiley & Sons, Hoboken NJ, USA. 620p. ISBN 978-0471-73828-2. $75.

This valuable handbook in a spiral bound format is the fifth edition of a handbook that has dominated the field for over half a century. It is divided into eight parts: Vegetables and the Vegetable Industry, Plant Growing and Greenhouse Vegetable Production, Field Planting, Soils and Fertilizers, Water and Irrigation, Vegetable Pests and Problems, Weed Management, Harvesting, Handling and Storage, Vegetable Seeds, and an Appendix with sources of information and conversion factors. The book is chock full of tables and information for the grower, extension agent, and teacher. It is aimed primarily for the American market and although it has conversion factors, all of the units are English rather than metric, which will reduce its usefulness outside of the US. It does not provide recommendations for herbicides, fungicides or insecticides but merely refers to approved pesticides. I found nothing on soil fumigation but there was a section on solarization. This handbook will be most useful for mainline growers; there is minimum information on minor vegetable crops. The traditional commercial grower of major vegetable crops will find this an invaluable resource.

Reviewed by Jules Janick, Purdue University, USA

Invernaderos de Plástico: Tecnología y Manejo. (Plastic Greenhouses: Technology and Management.) Nicolás Castilla. 2004. Mundi Prensa Libros S.A., Madrid, Spain. 463p. ISBN 84-8476-221-1. € 48.00. www.mundiprensa.com

This book is a comprehensive revision of the state-of-the-art of plastic-covered greenhouses predominant in the major producing areas of the world, viz. Asia and the Mediterranean basin. While several other books have focused on high-technology production systems, like the ones existing in Northern climates, this book is unique in the sense that it is centred on simple or passively ventilated greenhouses with medium technology. The author has a long standing international experience on greenhouse technology and production, mainly in the Spanish coastal areas, which is summarized meticulously in this broad volume.

It is not a treatise on the cultural practices of the main horticultural crops, but a comprehensive book on greenhouse technology and climate management. After an introduction on the importance of protected cultivation and the types of plastic-covered structures, the author discusses the main concepts related to the effect of external climate on greenhouse environment. Relevant concepts are very well explained with the help of carefully selected figures and photos. It is more a book of concepts than a book of equations, though some important equations are given in the abundant (and handy) appendix provided at the end of the volume.

Greenhouse climate-control through passive ventilation is discussed later. As mentioned before this is a subject that is difficult to find in previous books. Different heat transfer mechanisms in the greenhouse are explained, and after examining different plastic glazing materials, very practical recommendations are given for the selection and construction of greenhouses under a wide variety of climates.

Plant physiology and plant response to environmental factors such as light, temperature, humidity, and CO_2 concentration are also explained in detail as a prelude to subsequent chapters on climate control. Greenhouse heating and energy saving techniques are discussed, but more attention is paid to greenhouse cooling. Among the cooling techniques, natural ventilation has been given special attention. The latest findings on the subject are presented with the aid of detailed images showing the velocity and temperature fields in relevant greenhouse sections.

The book is completed with a number of chapters on air movement, CO_2 enrichment, soils and substrates, irrigation and fertilization, computer climate control, and post harvest techniques and marketing among others, making it a sort of brief encyclopaedia of protected cultivation. Each chapter ends with a summary and recommendations on the main points covered.

This much needed book provides a wealth of information on the principles and practices of passive ventilation and greenhouse technology, and would be especially useful to technical staff of horticultural operations, advanced growers with good specialised knowledge and university students.

Reviewed by Juan Ignacio Montero, IRTA, Barcelona, Spain

NEW TITLES

Benkeblia, Noureddine and Shiomi, Norio (eds.). 2006. Advances in Postharvest Technologies for Horticultural Crops. Research Signpost Publisher, Kerala, India. 393p. ISBN 81-308-0110-8. $133 (individual). $163 (institutional). www.ressign.com

Chincholkar, S.B. and Mukerji, K.G. (eds.). 2007. Biological Control of Plant Diseases. Food Products Press, The Haworth Press, Inc., New York. xviii + 426p. ISBN 978-1-56022-327-6 (hardback). $69.95. ISBN 978-1-56022-328-3 (paperback). $49.95. www.haworthpress.com

Dixon, G.R. 2006. Vegetable Brassicas and Related Crucifers. Crop Production Science in Horticulture Series, 14. CABI Publishing, Wallingford, UK. 327p. ISBN 978 08 5199 395 9 (paperback). £35.00/$70.00/€55.00. www.cabi.org

Jarvis, D., Mar, I. and Sears, L. (eds.). 2006. Enhancing the use of crop genetic diversity to manage abiotic stress in agricultural production systems. Proceedings of a workshop, 23-27 May 2005, Budapest, Hungary. International Plant Genetic Resources Institute, Rome, Italy. v + 97p. ISBN 978 92 9043 722 2. $20. www.bioversityinternational.org

Rao, N.K., Hanson, J., Dulloo, M.E., Ghosh, K., Nowell, D. and Larinde, M. 2006. Manual of Seed Handling in Genebanks. Handbooks for Genebanks No. 8. Bioversity International, Rome, Italy. xiv + 147p. ISBN 978 92 9043 740 6. $30. www.bioversityinternational.org

Sasidharan, N. 2004. Biodiversity documentation for Kerala: Flowering plants (Part VI). Akhil Books Pvt. Ltd., New Delhi, India. vi+726p. ISBN 8185041571 (hardback). $52.20. www.akhilbooks.com

Verheij, Ed 2006. Fruit Growing in the Tropics. 3rd edition. Agrodok-series No. 5. Published by Agromisa Foundation and CTA, Wageningen, The Netherlands. 90p. ISBN Agromisa 90-8573-056-2. ISBN CTA 978-92-9081-344-6. www.agromisa.org or www.cta.int

Info

INTERNATIONAL TROPICAL FRUITS NETWORK

The International Tropical Fruits Network (TFNet) is an autonomous and self-financing global network established under the auspices of the Food and Agriculture Organisation of the United Nations (FAO). It is both inter-governmental and inter-institutional in nature.

The mandate and role of TFNet is to promote sustainable development of the tropical fruit industry globally in relation to production, processing, marketing, consumption and international trade.

The objectives of TFNet are:

- To serve as a repository and to exchange information on tropical fruits;
- To promote, co-ordinate and support research and development as well as transfer of technology;
- To facilitate the expansion of international trade of tropical fruits;
- To enhance human resource development;
- To organize generic market promotion and strengthen consumer knowledge on the nutritional value of tropical fruits;
- To sensitize and facilitate implementation of international and regional agreements on tropical fruits;
- To promote technical and economic exchanges in the tropical fruit sector.

CONTACT

International Tropical Fruits Network (TFNet), Box 334, UPM Post Office, 43400 Serdang, Selangor Darul Ehsan, Malaysia, Phone: (603) 8941 6589 / 6590, Fax: (603) 8941 6591, email: info@itfnet.org, web: www.itfnet.org

INTERNATIONAL SYMPOSIUM ON PLANTS FOR PEOPLE AND PLACES

London (United Kingdom), 27 April - 2 May 2008

A major multidisciplinary ISHS Symposium considering the roles of plants in the creation of social health and welfare will convene in London during late spring 2008. Key themes include: 1. Creating sustainable environments and the conservation of biodiversity; 2. Educational opportunities and community involvement; 3. Managing urban, peri-urban and rural green space; 4. Designing landscapes for health, recreation, sport and therapy. Located in the Royal Horticultural Society's Lindley Conference Centre, Westminster this Symposium offers participation at the leading edges of environmental and social horticulture. Set against the backdrop of a major capital where history, business, arts and sciences converge within a green city-scape you are offered unique opportunities for engagement with experts of international stature and excellence.

CONTACT

Mr. Tim Hughes, Royal Horticultural Society, RHS Wisley Garden, Woking, Surrey GU23 6QB, United Kingdom, Phone: (44)01483212335, Fax: (44)01935816684,
email: timhughes@rhs.org.uk,
web: www.plantsforpeopleandplaces.org.uk

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

Instituto Agronómico Mediterráneo de Zaragoza (IAMZ) Courses 2006-07 / 2007-08. Info: Instituto Agronómico Mediterráneo de Zaragoza (IAMZ), Apartado 202, 50080 Zaragoza, Spain, Phone: +34 976 716000, Fax: +34 976 716001, email: iamz@iamz.ciheam.org, web: www.iamz.ciheam.org

2nd International Society for Seed Science (ISSS) Workshop on Molecular Aspects of Seed Dormancy and Germination, 1-4 July 2007, Salamanca, Spain. Info: Dr. Dolores Rodriguez, email: mdr@usal.es, web: www.usd.edu/isss/meetings/Salamanca/SalamancaProgram.doc or www.seedscisoc.org

Seed Ecology II 2007 - 2nd International Society for Seed Science (ISSS) Meeting on Seeds and the Environment, 9-13 September 2007, Perth, Australia. Info: Seedecology2007@bgpa.wa.gov.au, www.seedecology2007.com.au or www.seedscisoc.org

11th International Symposium on PreHarvest Sprouting in Cereals, 5-9 November 2007, Mendoza, Argentina. Info: Dr. Roberto Benech Arnold and/or Lic. Guillermina M. Mendiondo, email: sprout07@agro.uba.ar, web: www.agro.uba.ar/epg/sprout2007/ or www.seedscisoc.org

Third International Scientific Conference – Rural Development 2007, 8-10 November 2007, Kaunas, Lithuania. Info: Prof. Dalia Jatkūnaitė, Vice-dean, Faculty of Economics and Management, Lithuanian University of Agriculture, Universiteto 10-426, Akademija, LT-53361, Kaunas r., Lithuania, Phone: +370-37-752277, Fax: +370-37-752362, email: rural.development@lzuu.lt or dalia.jatkunaite@lzuu.lt, web: www.lzuu.lt/rural_development

XXIII Congress of the Latinamerican Potato Association (ALAP 2008), 30 November - 5 December 2008, Mar del Plata, Argentina. Info: Dr. Marcelo Huarte, President Latinamerican Potato Organization, EEA INTA Balcarce, Ruta Nac. 226, km 73,5 cc 276, 7620 Balcarce, Argentina, Phone: 54 2266 439100 Int 279, Fax: 54 2266 439101, email: huarte@balcarce.inta.gov.ar, web: www.papalatina.org

9th International Society for Seed Science (ISSS) Conference on Seed Biology, 6-11 July 2008, Olsztyn, Poland. Info: info@seedbio2008.pl, www.seedbio2008.pl or www.seedscisoc.org

Opportunities

Five Research Positions (Graduate or Postgraduate): Irrigation of Tree Crops and Vines, Valencia, Murcia, Lleida, Zaragoza and Cordoba, Spain

Director of Research, The Honduran Foundation for Agricultural Research, Honduras

Executive Director, UC Davis Seed Biotechnology Center, USA

Assistant Professor in Coffee Crop Production, University of Puerto Rico, Mayagüez, Puerto Rico

Assistant Professor Viticulture, Pontificia Universidad Catolica de Valparaiso, Chile

Various Employment Opportunities, Aboureyhan Agriculture University College, University of Tehran, Iran

Cooperative Extension Specialist in Diseases of Vegetable and Ornamental Crops, University of California, Riverside, USA

Assistant/Associate Professor, Floriculture, Purdue University, West Lafayette, Indiana, USA

Assistant/Associate Professor, Organic Pest Management, Michigan State University, East Lansing, USA

For more information visit www.ishs.org/general

Symposia and Workshops

Royal Flora Ratchaphruek 2006

The horticultural exhibition, Royal Flora Ratchaphruek 2006, recently hosted in Thailand was one of the largest of its type ever held. The exhibition covered 80 hectares and hosted 3.4 million visitors in the three months that it was open - attendance of over 50,000 each day in a weekend and 30,000 on a week day was typical. It existed as a showplace for Thai horticulture and horticultural research and hosted international gardens from 30 countries including Belgium, Bhutan, Brunei, Bulgaria, Burundi, Cambodia, Canada, China, India, Indonesia, Iran, Japan, Kenya, Laos, Malaysia, Mauritania, Morocco, Nepal, Nigeria, Pakistan, Qatar, South Africa, South Korea, Spain, Sudan,

ISHS booth staffed by Thai graduate students.

Prof. Jung-Myung Lee, ISHS Secretary, with staff of the National Horticultural Research Institute.

AIPH President Dr. Doeke Faber and ISHS Vice-President Prof. Ian Warrington met at the ISHS booth.

Royal Flora Ratchaphruek 2006

Chiang Mai, Thailand

International Horticultural Exposition
for His Majesty The King
Royal Flora Ratchaphruek 2006

Lakes, landscaped mounds, bedding plants and fountains provided contrast and interest within the main grounds of the exhibition.

Colourful modern sculptures and contour plantings provided interesting vistas across the landscape.

The main concourse leading up to the Royal Pavilion - bedding plants provided striking colours and patterns to the site.

The Netherlands, Trinidad and Tobago, Turkey, Vietnam, and Yemen. These countries provided unique displays that blended classic features of the culture of each country with iconic elements of their landscapes.

The prime purpose of the Royal Flora Ratchaphruek 2006 was to honour King Bhumibol Adulyadej's 80th birthday and the Diamond Jubilee of his accession to the Thai throne. The King, revered by many in Thailand, has had a strong affiliation with agriculture, has encouraged conservation, and has strongly advocated stewardship of the land during his reign. Ratchaphruek is the Thai name for the golden shower tree (*Cassia fistula*) - a tree bearing bright yellow flowers - symbolic of the essential colour in Buddhism and the Buddhist colour for Monday - the day on which the King was born.

ISHS INVOLVEMENT

The ISHS, with the World Flower Council, were the two main "supporters" of the exhibition. ISHS had a staffed booth (graduate students from King Mongkut's University of Technology), was featured on all publicity material and was at the forefront of all official events including the elaborate opening and closing ceremonies (attended respectively by Prof. Ian Warrington and Prof. Jung-Myung Lee). Three ISHS workshops were run in parallel with the exhibition – one on tropical and subtropical fruit, one on ornamental plants and one on medicinal and aromatic plants. The proceedings will be published in *Acta Horticulturae*.

ISHS's involvement with Royal Flora Ratchaphruek 2006 was a means of promoting, to the general public, the importance of horticulture and the ongoing contributions that science makes to the horticultural sector. It was also a chance to increase the profile of the ISHS to industry leaders and to policy makers. ISHS generated a high profile at many different events during the exhibition and interacted with the organisers, officials and participants.

POPULAR EXHIBITS

The most popular single display was undoubtedly the orchid "house" with over 50,000 plants on display covering nearly 10,000 different species. Some of the individual plants were breathtaking while others were marvellous in their diversity. High in the popularity stakes were the greenhouse displays of vegetable production including large-scale examples of hydroponic and aeroponic techniques. Clearly, the Thai public was greatly fascinated by how their food is produced, interested in how horticulture can enhance landscapes, and entranced by the beauty and diversity of ornamental species.

Thai school children displaying the ISHS balloons that were handed out during the exhibition.

One of the magnificent displays in the main orchid pavilion.

SCIENTIFIC DISPLAYS

Horticultural science was strongly promoted across the exhibition in a number of ways. Thai companies, government agencies and universities all exhibited in the biotechnology pavilion with a strong representation of full-scale modern tissue culture facilities. Science in many different forms was also a key element in the displays that were held in the two main indoor exhibition halls. These often highly technical displays were changed every three weeks and included examples of the contributions of modern plant breeding, the relevance of soil science, the diversity of germplasm across many fruit, vegetable and flower species, and even the roles that aquatic plants play in improving water quality. All of these displays attracted considerable public interest.

THE LANDSCAPE

The grounds of the exhibition were a major attraction for visitors. From the life size elephant fountains at the front entrance to the Royal Pavilion at the apex of the site, the overall landscaping was unique and inspiring. It seemed that every aspect of the beauty and functionality of the plant kingdom had been captured and displayed by the exhibition's creators. These outdoor displays included colourful vistas of bedding plants covering large areas, orchards of trees representing the fruit species grown in Thailand, hills planted with shrubs arranged in various geometric patterns, all interspersed with large areas of water, complete with fountains, that provided contrast in the overall landscape.

The profile of the ISHS was enhanced by having a presence at this event. Our display was largely a passive one and we need to consider the option of being more actively involved in future such events. To learn more about the Royal Flora Ratchaphruek 2006 visit http://www.royalfloraexpo.com.

Ian Warrington

Int'l Workshops held at Royal Flora Ratchaphruek

As part of Royal Flora Ratchaphruek, held to commemorate the auspicious occasion of His Majesty the King of Thailand's 60th Anniversary of His Accession to the Throne and His 80th Birthday Anniversary, three workshops were organised. These were the International Workshop on Tropical and Subtropical Fruits, the International Workshop on Ornamental Plants and the International Workshop on Medicinal and Aromatic Plants.

INT'L WORKSHOP ON TROPICAL AND SUB-TROPICAL FRUITS

The International Workshop on Tropical and Subtropical Fruits was held at Chiang Mai, Thailand from 27-30 November 2006 at the Lotus Pang Suan Kaew Hotel. The workshop was organized by the Horticulture Science Society of Thailand (HSST) under the auspices of the ISHS Section Tropical and Subtropical Fruits. The symposium attracted 257 researchers and delegates from different organizations from 10 countries (Australia, New Zealand, India, Thailand, Malaysia, Taiwan, Oman, Brazil, Japan and United States).

There were nine technical sessions on global production, biotechnology, genetic resources, cultural practices and physiology, post harvest, processing and product development, plant

Dr. Izham Ahmad, CEO of TFNet, Malaysia, presenting an overview of the world production and marketing of tropical and subtropical fruits.

Display of tropical and subtropical fruit.

protection and policy, trends and networking for research. There were 11 keynote speakers, 35 oral and 45 poster presentations in different technical sessions. Dr. I. Ahmad, CEO, TFNet, Malaysia presented an overview of the world production and marketing of tropical and subtropical fruits. Dr. Rod Drew (Australia) spoke about applications of biotechnology on tropical fruit crops. Current status and prospects of conservation and sustainable use of tropical fruits were discussed by Dr. P. Sajise, IPGRI-APO, Malaysia. Dr. B. Fife, USA presented coconut and its healing properties. Status of tropical fruit production in Thailand was presented by Dr. S. Vichitrananda, Thailand. Prof. S.K. Mitra (India) presented two papers on guava production and improvement in India – an overview and a paper on tropical and subtropical fruits globalization, trends and networking for research and development in Asia. Dr. Y.K. Chan (Malaysia) spoke about breeding of papaya and pineapple. Dr. N. Chomchalow

Fruit orchard at Royal Flora Ratchaphruek 2006. Specimen trees of a vast array of different fruits were planted out for the public to see what these different species look like.

Flowers and fruit of *Syzygium samarangense* var. *samarangense* (Myrtaceae). Several common names include Java apple, wax apple, wax jambu, "chompu" (in Thai).

(Thailand) presented two interesting lectures on curd coconut and banana bunch anomaly while Dr. S. Somsri (Thailand) discussed the three decades of durian breeding programme in Thailand. Professor Dr. I. Warrington, ISHS Vice President and Professor Dr. S.K. Mitra, Vice Chairman of the ISHS Section Tropical and Subtropical Fruits represented the ISHS at the workshop.

The technical sessions were completed in the first two days of the workshop. On the third day (29 November), the participants visited Suan Som Sai Thong Packing House, Suan Som Sai Thong Citrus farm and Doi Pahompok National Park. On 30 November participants visited the exciting Royal Flora Ratchaphruek 2006 covering across 7.2 km. There were 22 corporate gardens, 33 international gardens from 4 continents, Royal Pavillion, Thai Tropical garden, Expo Center, Orchid Pavillion having 10,000 orchid species and many more miracles of Ratchaphruek. All participants agreed that the workshop, tours and cultural events (at Khumkhantoke) were a great success.

The Proceedings of the Workshop will be published by the ISHS in *Acta Horticulturae*.

S.K. Mitra

Contact

Prof. S.K. Mitra, B-12/48, Kalyani 741 235, Nadia, West Bengal, India, email: sisirm@vsnl.net

INT'L WORKSHOP ON ORNAMENTAL PLANTS

The International Workshop on Ornamental Plants was organized by the Department of Agriculture with co-sponsorship by the International Society for Horticultural Science, various Thai national institutes, and the private sector. It was held on 8-11 January 2007 at Pang Suan Kaeo Hotel, Chiang Mai, Thailand. There were 220 participants from eight countries, 15 of which were from foreign countries. There were three keynote lectures, 12 invited papers, 12 contributed papers and 30 poster papers.

Issues and Outcomes

The Workshop was explored through oral and poster presentations. Due to the rather limited number of papers, it was not possible for the Organizers to group them into themes. This was true for the keynote addresses, invited papers and contributed papers. For the poster papers, three themes have been assigned, namely, (i) Plant Production, (ii) Genetic Resources, Breeding and Biotechnology, and (iii) Plant Protection.

Highlights

It is impossible for the author to bring out the salient points of all papers in this short document. Thus, only the highlight of the keynotes and invited papers will be briefly presented as follows:

According to Richard Criley, ornamental plants play a huge role in enhancing the quality of life of urban dwellers and growers must be able to choose among the many new plants introduced each year to produce enough plants for the demand. Keys to this include knowing the customer better and keeping up with the trends that influence plant selection and use.

VIPs on stage during the International Workshop on Ornamental Plants.

According to Surawit Wannakrairoj, Thailand is one of the leading export countries of tropical floriculture crops, mainly based on the cut-flower dendrobium orchid, a number of tropical pot and landscape plants, and many indigenous ornamental plants. The core competency of the industry is rapid propagation as well as breeding new cultivars.

Pimchai Apavatjrut summarized the amazing activities of the Thai Royal projects on floriculture, which have been carried out extensively for over three decades to find and improve suitable varieties, and appropriate technologies for their cultivation and post harvest, while the results have been extended to the hill tribes to enable them to produce high-quality temperate and subtropical flowers.

The Chairman and Secretary of the Plenary Session.

Viewing poster papers.

Anders Lindstom warned us of the danger of destruction of the worlds' natural habitat and resources, which has reached such an extent that many plant species are now extremely hard to find or even extinct in the wild. Fortunately, large germplasm collections still exist in both private and government facilities. It is of utmost importance that these living treasures be publicized and preserved for our own future, whether for ornamental, scientific or for the sake of preserving species. Anders also outlined horticultural research and development of tropical ornamental plants in Nong Nooch Tropical Botanical Garden, which has a very large collection of ornamental plants. The garden has worked on hybridization of several of them.

Charuphant Thongtham enlightened us with an idea that flower and foliage preservation by drying could be a good source of income for the rural people as well as the exporters. He also explained the different methods of processing and preservation conducted by various factories in Thailand.

A striking display of cymbidium orchids at the indoor Japanese exhibit of Royal Flora Ratchaphruek 2006.

Yuthana Tanavijasit, a civil engineer turned orchid grower, informed us about the secrets of growing orchids in order to make them healthy and freely flowering. Through his innovative idea of growing orchids in specialized containers like baskets, wine bottles, etc., he has demonstrated how to make value addition to the orchid plants.

Uthai Charanasri enlightened us with *Curcuma* genome breeding through interspecific hybridization and backcrossing, and the resultant F_1 amphidiploid hybrids from spontaneous chromosome doubling in tissue culture propagation were found to have higher fertility than their original F_1 counterparts. He concluded that chromosome doubling of F_1 interspecific diploid hybrids of *Curcuma* could overcome hybrid sterility, and triploid trigenomic and tetraploid tetragenomic hybrids could be obtained in the F_2 generation through hybridization, utilizing amphidiploids.

Weerachai Nanakorn revealed that at present, the orchid's natural habitat of Thailand has been heavily disturbed, while forest degradation and over-exploitation for commercial and agricultural practices have made a severe impact on the orchid population of the country, especially the terrestrial species. The beautiful and economically important species are increasingly becoming difficult to find in the wild where they used to be abundant.

In her paper on "Wild Orchids Conservation for Ecotourism in Thailand", Chitraphant Piluek highlighted her project in Mae Hong Son in which surveys were first made to examine wild orchids in the forests. Altogether, 172 species in 61 genera were identified. Most of them are epiphytes. Conservation measures were attempted through the training on easy method of seed germination. Seedlings were first transplanted and nursed at the residence of the villagers and later, the vigorous seedlings were chosen to implant on forest trees along the tourist trail aiming for flower attraction.

Kanchit Thammasiri outlined his approach to conserve Thai wild orchids through cryopreservation. Recent methods used were: vitrification, encapsulation-dehydration and encapsulation-vitrification. Cryopreserved seeds and protocorms were able to develop into normal seedlings. These methods appear to be promising techniques for cryopreservation of some Thai orchid germplasm.

Yuan Chuan-Hsiao told us about the interesting "*Paphiopedilum* Production and Marketing in Taiwan" by learning from the experience in growing and exporting of *Paphiopedilum* from Thailand. It became possible since 1999 for Taiwan to export *Paphiopedilum* plants all over the world. In 2005, there were 24 nurseries propagating two million seedlings. Shortening the time of propagation, hybridization to improve the quality for marketing, and promoting the concept of using, are their main focuses.

Setapong Lekawatana outlined a pilot project on *Spathoglottis*, which is native to the Southeast Asian region and has good potential as potted plants both for domestic and export market. The project covers production situation, market survey, effects of environmental factors on plant growth, taxonomy, new variety development, growing media, water and fertilization management, and crop protection.

Chen-Chung Chen informed us that domestic growers mostly use the standard greenhouse to cultivate *Phalaenopsis* in Taiwan. Its export is of three types: seedlings, live plants and fresh flowers. The biggest importer is Japan. *Phalaenopsis* is the main export item of orchids in Taiwan.

Paisan Rattanasathien explained his IPM technology applied to orchid production, which consisted of using economic threshold to control decision-making, insect-pest scouting, installation of sticky traps, and application of bio-agents, neem extract and pesticides.

Traditional northern-style farewell dinner at Khum Khan Tok.

Task Ahead

The Scientific Committee is now in the process of compiling and screening all papers presented at the International Workshop on Ornamental Plants. Together with his Editorial Board, the author will edit selected papers for publication in the Proceedings of the Workshop to be published by the ISHS in *Acta Horticulturae*.

Narong Chomchalow, Chairman Scientific Committee, International Workshop on Ornamental Plants

Contact

Narong Chomchalow, Editor, AU Journal of Technology, Assumption University, Hua Mak, Bangkok, 10240, Thailand. Phone: (662) 300-4543 Ext. 1350, Mobile: 081-172 3245, email: narongchc@au.edu

INT'L WORKSHOP ON MEDICINAL AND AROMATIC PLANTS

The International Workshop on Medicinal and Aromatic Plants was organized by the Department of Agriculture with co-sponsorship by the International Society for Horticultural Science, various Thai national institutes, and the private sector. It was held 15-18 January 2007 at Pang Suan Kaeo Hotel, Chiang Mai, Thailand. There were 346 participants from 20 countries, 54 of which were from foreign countries. A total of 148 papers was presented, of which 10 were invited papers, 41 were contributed papers and 97 were poster papers.

VIPs during the Opening Ceremony of the Workshop.

Issues and Outcomes

The Workshop was explored through oral and poster presentations. In addition to the ten invited papers, which could not be grouped into themes, there were six themes for the contributed papers, namely:

- Pharmaco-Dynamics of Natural Substances
- Production and Economic Analysis
- Natural Products and Their Potential Therapeutic Properties
- Isolation and Characterization of Natural Products
- Production and Cultural Practices

The poster papers have been grouped into eight themes as follows:

- Agronomy
- Biotech Cell Culture
- Biodiversity
- Pharmaceutical Technology
- Isolation and Charcaterizatuion
- Products
- Pharmaco-Dynamics
- Biotechnology

Highlights

It is impossible to put the salient points of all 148 papers in this short document. Thus, only the highlights of the ten invited papers, which cover quite diverse disciplines, will be briefly presented as follows:

Lyle Craker stated that through the advancement of medical science, traditional medicine using MPs suffered a set back. However, traditional medicines that have been validated through chemical trials are becoming integrated with conventional, chemically-synthesized drugs for medical treatments within populations where use of MPs was formerly rejected. To participate in the expanding markets of integrated medicine, growers will need to produce crops that meet cultural and medical expectations of consumers and healthcare providers for botanical medicines.

According to Narong Chomchalow, coconut oil contains a high amount of saturated fats but they are very different from other saturated fats in that they also contain high amounts of medium chain fatty acids (MCFA). Recent medical studies have shown that MCFA can help protect against many common illnesses including heart disease, cancer, diabetes and numerous infectious diseases including influenza, HIV/AIDS and avian flu.

Participants performing "Ram Wong" dance at the Welcome Party.

Development of medicinal plants in Germany has been described by Michael Popp using Bionorica AG as a model. The works include growth and cultivation, quality assurance and control, engineering, environmentally production, and pharmacological and toxicological studies. Plant-based pharmaceuticals have been found to be superior to synthetic chemical drugs. They also have fewer side effects. Their excellent efficacy and safety are based on the large number and combination of highly-potent active substances.

Karmal Pava enlightened the participants with the new phenomenon of "herb and drug interaction", which is the latent effect of herbs with modern medicine on pharmaco-kinetic and pharmaco-dynamic activities that could enhance or reduce modern drug action. The risks of herb-drug interaction are those narrow-therapeutic index drugs, the herbs that have influence on cytochrome P450, herbal formula, high alcohol concentration of herbal spirit, patients with chronic disease, post operation patients, and the elderly.

Asian MPs have been evaluated by Rudolf Bauer based on several new techniques, such as TLC, HPLC, coupled with spectroscopic techniques such as UV, MS and NMR, in order to identify bioactive compounds such as leukotriene biosynthesis inhibitory activity, anti-cancer compounds, and active principles towards multi-drug resistant leukemia cells.

Nario Aimi described the current situation at Kampo traditional medicine in Japan. Kampo medicines are prescribed by practitioners who have Japanese national license of medical doc-

Lyle Craker releasing a fire balloon during the Welcome Party at Khum Khan Tok.

Narong Chomchalow (top left) and Lyle Craker (bottom right) at the edible insect food stoll

tors. Kampo formulations are dispensed as over-the-counter drugs by pharmacists. They are manufactured at factories that conform to Kampo GMP and the qualities are standardized by authorized qualifications. Each of the herbal medicines composing Kampo formulae is listed in Japan Pharmacopoeia or Japanese Standards of Herbal Medicine.

De-Zhu Li described development and sustainable use of MAPs in China. Of the total of 6,000 species of MPs, many have been used as an anti-malarial drug, and as a drug to cure brain and cardio-vascular diseases. Of the 400 species of AP, more than 120 natural perfumes have been produced from such plants as cassia, star anise, peppermint and Japanese mint. Cultivation and modern biotechnology made it possible to use MAP resources sustainably.

According to Surapote Wongyai, there are two approaches in the production of herbal drugs in Thailand. One is to develop combination drugs through the process of selection, production, import/export, and distribution of the products according to Thai Traditional Medicine Texts. The other is to develop single-herb products. A large number of institutions are engaged in R&D of MAPs and transfer of technology to the private sector. There are also a large number of factories that have been established for the commercial production of essential oil and herbal formulae.

Adolf Nahrstedt described pharmaco-kinetic interactions concerning bioavailability of an active compound that is positively influenced by co-effectors, which are non-active accompanying constituents. The crucial point of bioavailability is solubility and absorption. Compounds of low molecular weight should fulfill Lipinski's "Rule of Five" for acceptable bioavailability. Therapy extracts are superior to the purified same compound.

Vuth Vutithamavej described his experience of using Thai traditional medicine, which is based principally on MPs, including the use of herbal saunas, herbal medicines, herbal steam baths, hot compresses, traditional massages, acupuncture and reflexology. The strongest point of Thai traditional medicine is its health prevention role. But it can be used to complement the curative systems of modern medicine.

Visit to the medicinal plant product pavillion at Royal Flora Ratchaphruek 2006.

Task Ahead

The Scientific Committee is now in the process of compiling and screening all papers presented at the International Workshop on Medicinal and Aromatic Plants. Together with his Editorial Board, the author will edit selected papers for publication in the Proceedings of the Workshop to be published by the ISHS in *Acta Horticulturae*.

Narong Chomchalow, Chairman Scientific Committee, International Workshop on Medicinal and Aromatic Plants

Contact

Narong Chomchalow, Editor, AU Journal of Technology, Assumption University, Hua Mak, Bangkok, 10240, Thailand. Phone: (662) 300-4543 Ext. 1350, Mobile: 081-172 3245, email: narongchc@au.edu

Fourth Int'l Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops

Participants of the Symposium.

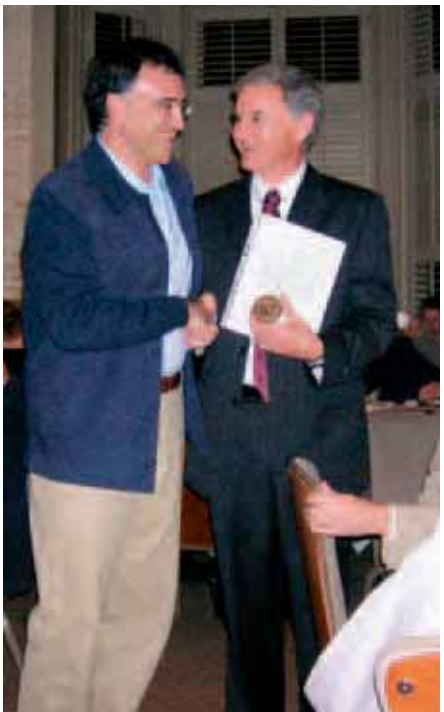
The 4th International Symposium on Seed, Transplant and Stand Establishment of Horticultural Crops, "Translating seed, transplant and seedling physiology into technology" was held in San Antonio, Texas, USA, 3-6 December 2006. The event was organized by the Texas Agricultural Experiment Station, Vegetable and Fruit Improvement Center and the Texas Water Resource Institute, Texas A&M University. More than 110 participants from 22 countries attended the Symposium, which had a technical program with 32 oral and 48 poster presentations.

The symposium covered eight areas: seed biotechnology and genetics, seed germination and vigor, seed technology, conventional transplant production and technology, organic seed/transplant production, abiotic/biotic stress, grafting, stand establishment and field performance. The symposium included two tours, a half-day visit to a vegetable and ornamental nursery in San Antonio, and an all-day tour to the Wintergarden region, the main vegetable production area in southwest Texas.

Improvement of stand establishment requires basic and applied understanding of seed and seedling performance under stressful environments. Genetic and molecular analyses such as phenotyping – survey of gene expression under an array of stressors – are new tools to understand physiological regulation of seeds/seedlings that will ultimately lead to improved seedling vigor and stand establishment. New concepts involved in the repression of developmental programs in seeds were presented. The development of image systems that objectively determine vigor index was highlighted together with seed coating technologies that use systemic insecticides for crop protection. A special session on economics, genetics, physiology, nutrition, and field performance of grafted vegetables provided ample interactions in the audience. Presentations on conventional/organic transplant production to improve root and shoot growth and ultimately the quality of transplants gave new insights into the complex and interactive morphological, physiological and hormonal mechanisms associated with nursery strategies (e.g. tray and/or media selection, phosphorus fertilization, biological amendments, antitranspirants, osmotic solutions, species).

In the opening remarks, the ISHS representative Dr. Juan A. Fernández, Technical University of Cartagena, Spain, welcomed the symposium participants and outlined the scope of ISHS in international meetings. Three keynote speakers addressed seed biotechnology and genetics. Dr. Kent Bradford, University of California, Davis, USA, emphasized the genetic analyses and variation of thermodormancy in lettuce and related wild type species. He discussed specific quantitative trait loci (QTL) identified in recom-

Dr. Juan Fernández presenting the ISHS medal and certificate to Dr. Daniel Leskovar, convener SEST 2006.



Participants evaluating early emergence in ornamental species.

Question and answer panel session in seed biology and technology.

The Spanish delegation celebrating the candidature of Murcia for the next 2009 Symposium.

binant inbred lines developed from crosses with the known cultivar 'Salinas' as well as the expression of candidate genes, particularly gibberellin and abscisic acid (ABA) in relation to genotype and germination temperatures. Dr. Mitch McGrath, USDA-ARS, Michigan, USA, discussed the application of molecular phenotyping in predicting seedling vigor, particularly under excess moisture stress, using sugar beet as the plant model system. He further presented evidence of a germin-like protein that explained the enhanced germination of sugar beet. The next keynote speaker, Dr. Hiro Nonogaki from Oregon State University, USA, addressed new concepts in seed biology and morphological and molecular aspects in the regulation of seed germination and stand establishment. He elegantly presented in-depth theory on the 'repression' of germination, a mechanism for seeds to prevent germination under unfavourable conditions.

Dr. Robert Geneve of the University of Kentucky, USA, presented an overview of seed vigor testing applicable to small-seeded horticultural crops and provided specific examples for seed vigor assessment. Dr. Miller McDonald, Ohio State University, USA, described in detail an objective vigor test known as the Seed Vigor Imaging Testing (SVIS), a digital image system that derives a seed lot vigor index value based on seedling length and uniformity. Dr. Alan Taylor from Cornell University, USA, discussed film coating technologies and new chemistry insecticide seed treatments used in horticultural crops, with special emphasis on treatments against below- and above-ground insects and soil-borne diseases (e.g. onion maggot). His talk was complemented by Dr. Gordon Jamieson, Germain's Technology Group, UK, who gave an industry perspective on large-scale seed enhancement methods for conventional and organic seeds. He emphasized the development of crop protection agents and 'functional' treatments within strict health/safety regulatory environments.

Peterson Nursery describing transplant management strategies.

In the abiotic stress session, Dr. Daniel Leskovar, Texas A&M University, USA, gave an overview of the morphological and physiological seedling mechanisms underlying tolerance to water deficit stress on vegetable species. He demonstrated the effectiveness of ABA as an antitranspirant and to modulate growth and stress tolerance necessary to reduce transplant shock and enhance field establishment. Dr. Beny Aloni, Volcani Center, Israel, gave a lecture on the mechanisms of grafting incompatibility using squash rootstocks grafted with melon (*Cucumis melo*) scions. The studies from his group reveal that a basipetally translocated auxin from the scion may cause root growth suppression in incompatible rootstocks. Dr. Nicolas Tremblay, Agriculture and Agri-Food, Canada, described the production of a new transplant system for lettuce in Quebec, known as the 'cubic plug system'. He presented evidence for this system to allow transplanting younger plants while reducing transplant shock as compared to conventional production methods.

Finally, at the business meeting and closing banquet Drs. Jose A. Pascual and Francisco Perez Alfocea accepted the task to host the next symposium in the Murcia region, Spain, in 2009.

Technical visit to fresh market spinach field established at high plant populations in the Wintergarden of Texas.

Daniel I. Leskovar and Juan A. Fernández

Contact

Dr. Daniel I. Leskovar, Vegetable Physiology - Horticulture, Texas Agricultural Experiment Station, Texas A&M University, 1619 Garner Field Rd. Uvalde, TX 78801, USA, email: d-leskovar@tamu.edu

Dr. Juan A. Fernández, Dept. Producción Vegetal, Technical University of Cartagena, Paseo Alfonso XIII, 30203, Cartagena, Spain, email: juan.fernandez@upct.es

First Int'l Conference on Indigenous Vegetables and Legumes: Prospects for Fighting Poverty, Hunger and Malnutrition

Participants of the conference.

The conference was successfully held at the recently established AVRDC - Regional Center for South Asia (RCSA), ICRISAT Campus, India. It was jointly organized by AVRDC - The World Vegetable Center, Bioversity International (BI), the International Crops Research Institute for Semi-Arid Tropics (ICRISAT), the International Society for Horticultural Science (ISHS) and the Global Horticulture Initiative (GHI) from 12 to 15 December 2006.

271 participants representing 42 countries attended this event. A total of 101 oral papers and an equal number of posters covered topics of health, nutrition and medicinal uses, socio-cultural and economics issues, biodiversity, germplasm collection and conservation, genetics, breeding and biotechnology, seed production technology, crop production and technology transfer, plant protection, high value technology, value addition and marketing, and research strategies and policy issues.

The ceremonies started with opening remarks from Dr. Dyno Keatinge, DDG-R, ICRISAT, on behalf of Dr. Jackie Hughes, Chair, International Organizing Committee and DDG-R AVRDC. Dr. Thomas A. Lumpkin, DG, AVRDC - The World Vegetable Center, spoke on "Indigenous Vegetables - A Priority Area of Global Horticulture Initiative". He introduced ISHS and presented a medal of appreciation from ISHS to Dr. M.L. Chadha, Director, AVRDC-RCSA, for his efforts in organizing the joint conference. Keynotes were presented on "Nutrition, Diversity and Health" by Dr. Kwesi Atta Krah, DDG, BI, and on "Diversity in Indigenous Legumes" by Dr. William D. Dar, DG, ICRISAT. Dr. G. Kalloo, Ex DDG, Indian Council of Agricultural Research (ICAR), gave special remarks on behalf of Dr. Mangla Rai, Secretary, Department of Agricultural Research and Education (DARE) & DG, ICAR.

Chief Guest address on "Designing Farming System on Nutritional Security" was presented by Dr. M.S. Swaminathan, Chairman, National Commission on Farmers and MS Swaminathan Research Foundation, India. The session ended with the vote of thanks by Dr. Chadha, Organizing Secretary.

Inauguration ceremony.

Health, Nutrition and Medicinal Uses

The session was chaired by Dr. Dyno Keatinge, and the lead lecture was given by Dr. Timorty Jones, McGill University, Canada, on indigenous vegetables (IVs) and legumes local responses to nutritional and health challenges in the global food system. Dr. Bhimanaguda Patil, USA, emphasized challenges and opportunities of exploring health promoting properties of IVs and Dr. Ray-Yu Yang, AVRDC, presented variation of edible plants for nutraceutical values. Dr. Iteu M. Hidayat, Indonesia, and Dr. E. van den Heever, South Africa, gave an overview on promotion and conservation of IVs for better nutri-

tion. Dr. A. Oelofse, South Africa, presented recommendations of the symposium held at Pretoria. Dr. H.H. Fonseka, Sri Lanka, and Dr. J.H. Hong, Korea, spoke on antioxidant activity of IVs. Dr. Silvana Nicola, Italy, and Dr. W.H. Schnitzler, Germany, described vegetable herbs for a healthy diet.

Socio-Cultural and Economics Issues

Prof. H.P.M. Gunasena, Sri Lanka, chaired the session on Socio-Cultural and Economics Issues, in which Dr. K. Weinberger, AVRDC, presented a paper on underutilized crops evidences from Eastern Africa and South East Asia. Dr. D. Pasternak, ICRISAT, emphasized on the role of IVs in daily diet and rural and urban economy of Niger. Dr. M.W. Pasquini, University of Wales, UK, described networking to promote the sustainable production and marketing of IVs through urban and peri-urban agriculture. Other papers were presented by Dr. Agnes Nyomora, Tanzania, Dr. M.K. Wadhwani, India, Dr. J. Allemann, South Africa, Dr. J.E. Eusebio, Philippine Council for Agriculture, Forestry and Natural Resources R&D (PCARRD), and Dr. M.A. Rahim, Bangladesh.

Biodiversity in Indigenous Vegetables and Legumes

This session chaired by Dr. Kwesi Atta Krah started with a lead paper by Prof. Dr. K.L. Chadha, President, Horticultural Society of India, on prospects of indigenous perennial plants as source of vegetables. Strategy for promoting IVs as new vegetable crops was presented by Dr. George Kuo, AVRDC. The other presentations on crop genetic divergence were by Dr. V. Prakash, India, Dr. Said Silim, ICRISAT, Kenya, Dr. P.K. Ghosh, ICAR, and Dr. M. Diouf, Senegal.

The next day session was chaired by Dr. G. Kalloo, ICAR. Dr. Michael Boehme, Institute for Horticultural Sciences, Berlin, Germany, Dr. A.K. Sureja, India, Dr. W.S.J. van Rensburg, Pretoria, South Africa, Dr. Carity Irungu, Kenya, Dr. B. Brueckner, Institute of Vegetable and Ornamental Crops, Erfurt, Germany, Dr. V.A. Celine, India, and Dr. I.B. Maurya, India, presented papers on the use and conservation of underutilized IVs.

Germplasm Collection and Conservation

A lead paper on conserving the IVs germplasm of Southeast Asia was presented by Dr. L.M. Engle, AVRDC, in the session chaired by Dr. A.N. Murthy, India. Dr. H.D. Upadhyaya, ICRISAT, India, described the importance of indigenous legumes germplasm conservation, diversity and utilization in crop improvement. Dr. D.K. Singh, G.B. Pant University of Agriculture and Technology, India, Dr. Luu Ngco Trinh, Plant Genetic Resources Center, Hanoi, Vietnam, Dr. Iteu M. Hidayat, Indonesian Vegetable Research Institute, Dr. K.B. Wahundeniya, Horticultural Crops Research and Development Institute, Sri Lanka, and Dr. C.L. Wegiriya, Southern Development Authority, Sri Lanka, presented papers on characterization, conservation and utilization of IVs.

The next day session was chaired by Prof. L.J.G. van der Maesen, Wageningen University, The Netherlands, and papers were presented by Dr. Obaidul Islam, Bangladesh Agricultural Research Institute, Dr. S. Mitra, India, Dr. Sudhaker Pandey, Indian Institute of Vegetable Research, Dr. D. Prasath, Indian Institute of Spices Research, and Dr. Pritam Kalia, Indian Agricultural Research Institute (IARI).

Lively discussion during poster presentation.

Dr. Thomas Lumpkin (right) presenting the ISHS certificate to Dr. M.L. Chadha (left).

Genetics, Breeding and Biotechnology

The session was chaired by Dr. S. Balaravi, MS Swaminathan Foundation, India. Dr. B.B. Singh, India, presented a paper on recent progress on cowpea genetics and breeding. Dr. A.S. Sidhu, IARI, presented the current status of brinjal research in India. Dr. M. Pandiyan, India, spoke on interspecific hybridization in *Vigna radiate*, Dr. Dr. M.C. Palada, AVRDC, on introduction and varietal screening of drumstick for horticultural traits and adaptation and Dr. D.S. Cheema, India, on genetic variability and correlation in yield and quality traits in aravi.

Seed Production Technology

In this session chaired by Dr. L. Fondio, Abidjan, Côte d'Ivoire, the lead paper presentation by Dr. R.B. Jones, ICRISAT, Nairobi, Kenya, was on supporting the development of sustainable seed systems for non-hybrid crops. Dr. S.K. Rao, India, described genetic x environment interactions in the development of seed size and seedling vigour in mungbean. Dr. M.M. Haque, Bangladesh, Drs. P.K. Katiyar and P. Hazra, India, presented papers on mungbean and vegetable cowpea.

Crop Production and Technology Transfer

The session chaired by Dr. George Kuo included the lead paper by Dr. B.S. Ahloowalia, Vienna, Austria, on IVs - the challenge for sustaining production and enhancing quality in Asia, followed by Dr. P. Mapfumo, Harare, Zimbabwe, on N_2-fixing indigenous legumes. Dr. Slabbert, Pretoria, South Africa, Dr. Peter O. Onyango, Kenya, Dr. L. Fondio, Abidjan, Côte d'Ivoire, Dr. C.M. Navaratne, Sri Lanka, Dr. R.K. Siag, India, Dr. D. Pasternak, ICRISAT, Niger, and Dr. Mel O. Oluoch, Tanzania presented papers on performance and low cost techniques for IVs.

Plant Protection

The session was chaired by Dr. Johannes Ketelaar from FAO, Bangkok, Thailand. Dr. D.B.

James, International Institute of Tropical Agriculture (IITA), spoke on extending IPM research in vegetable production in Benin. Dr. Harpreet K. Cheema, India, spoke on mungbean screening against mungbean yellow mosaic virus (MYMV). Dr. Ranjeet Chatterjee, India, Dr. A. Onzo, IITA, Benin, Dr. M.M. Waiganjo, Kenya, Dr. B. Singh, Indian Institute of Vegetable Research, and Dr. S. Pande, ICRISAT, India, spoke on IPM/ICM. Dr. J. Renugadevi, India, Dr. E. van den Heever, Vegetable and Ornamental Plant Institute, South Africa, Dr. M. Prabhakar, Indian Institute of Horticultural Research, and Dr. M. Meerabai, India, talked on organic IVs production technologies.

High Value Technology

A lead paper on the importance of underutilized indigenous legumes in the Asia-Pacific region was presented by Dr. C.L.L. Gowda, ICRISAT, India, in the session chaired by Dr. W.H. Schnitzler. Dr. Pooran Gaur, India, Dr. Mel O. Oluoch, Arusha, Tanzania, and Dr. Y.Y. Hsiao, AVRDC, spoke on high value technologies for poor farmers. The session was concluded with the remarks of Dr. George Kuo and a paper on national economy and poverty alleviation in Bangladesh by Dr. M.A. Kabir.

Value Addition and Marketing

The session was chaired by Dr. M.C.S. Bantilan, ICRISAT, India. Dr. S. Shanmugasundaram, USA, talked on the exploitation of mungbean with value added products. The next lectures on the use and marketing of IVs were delivered by J.M. Tembe, Mozambique, Dr. K.V. Peter, India, and Dr. P. Jansirani, India. The last presentation was on past, present and future of IVs by S. Shanmugasundaram.

Poster Sessions

101 posters were displayed on the second and third day, and a committee comprising Drs. K.L. Chadha, S. Shanmungasundaram, S. Nicola, I. Hoeschle-Zeledon, B.S. Ahloowalia, Jong-Gyo Woo, V.B. Patel, and S.K. Sain evaluated the posters. Two posters entitled "Healthy diet gardening kit - For better health and income" by Drs. M.L. Chadha and Mel Olouch, and "Pattern of IVs and legumes consumption in rural India" by Drs. N. Arlappa, N. Balakrishna, A. Laxmaiah and G.N.V. Brahmam were awarded the first and second best poster prize, respectively.

Field visit.

Research Strategies and Policy Issues

Dr. M.W. Pasquini chaired the session and Dr. I. Hoeschle-Zeledon, Global Facilitation Unit for Underutilized Species, Rome, Italy, spoke on a strategic framework for global research and development of IVs and legumes. Dr. G. Kalloo described a strategy for improving and promoting cultivation and consumption of IVs and legumes. Dr. H.P.M. Gunasena spoke about IVs and legumes in Sri Lanka. Papers on survey, regional strategies and policies were presented by Dr. J.A.N. Asiwe, South Africa, Dr. Ravza Mavlyanova, Uzbekistan, Dr. L.J.G. van der Maesen, The Netherlands and Dr. M.A. Rashid, Bangladesh.

Plenary Session

The plenary session was chaired by Dr. Thomas Lumpkin. There was an open discussion with the participants regarding past, present and future needs and strategies for research and development of IVs and legumes. All the participants unanimously came up with final recommendations for future R&D of IVs and legumes.

M.L. Chadha

Contact

Dr. M.L. Chadha, Organizing Secretary IVs 2006 & Director, AVRDC - Regional Center for South Asia, ICRISAT Campus, Patancheru, 502324 Hyderabad, India, Phone: +91 40 30713755, Fax: +91 40 30713074/75, email: Mchadha@cgiar.org

Third Int'l Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation (HORTIMODEL2006)

Participants of the Symposium.

From October 29 until November 2, 2006, HORTIMODEL2006 was held in Wageningen, The Netherlands. Modern, on-demand agricultural production requires a high degree of control of the whole process with respect to timing, quantity and quality of production. Greenhouse horticulture is the sector where such control is possible, in view of the ever more high-tech means for environmental management, the use of innovative sensors and the increasing application of ICT. Full advantage of these tools, however, can be gained only by improving on present knowledge about plant processes and environment. The present socio-political consensus on reducing environmental impact of production imposes the additional constraints of reduction of resource consumption and emissions. In view of the wealth of crops, cultivars, cultivation systems, aims and constraints in greenhouse horticulture, comprehensive models and decision support algorithms are needed to generalize knowledge and to evaluate conflicting priorities that may arise.

HORTIMODEL2006 provided the opportunity for disciplinary and interdisciplinary exchange of scientific and technological information structured around 9 topics: crop models, methodology, models and sensors, energy saving, climate management, decision support systems, water and nutrients, crop physiology and product quality. Three days of oral and poster presentations were followed by a one-day excursion to high-tech greenhouses. 136 participants from 25 countries attended the symposium and 79 refereed papers were published in *Acta Horticulturae* 718, which was presented at the symposium.

Some developments and trends seen in this symposium are:

1. The use of models in horticultural research has increased. Often research projects consist of an experimental and a modeling part. The modeling and simulation work makes it possible to generalise the results from the experiment(s). Models have become standard equipment for scientists.
2. There were many participants from greenhouse horticultural industry, especially advisory bureaus, providers of production and process automation solutions, substrate producers, breeding companies and energy companies. This shows the interest greenhouse horticultural industry has in the application of models and in obtaining up-to-date knowledge on developments related to models.
3. Despite the increased use of models in research and the interest from the horticultural industry, there are still only few examples

Visit to a *Phalaenopsis* grower, with large scale automation.

The Organising Committee at work: Leo Marcelis, Cecilia Stanghellini, Wim Voogt, Ep Heuvelink and Susana Carvalho. Not in this picture: Prof. Gerrit van Straten and Wim van Meurs.

of models applied in practice. A large input from both scientists and the greenhouse sector is needed to see more application of models and decision support systems in practice in the near future.

4. In the past decade a new field has developed: 3D modeling or virtual plants (e.g. L-systems). These models simulate the architecture of plants. Creative ideas and a lot of input is needed to combine process-based models with architectural models into truly Functional-Structural Plant Models (FSPMs). Such combined models are especially of importance for ornamental crops, where the influence of climate and management on plant shape is very relevant for ornamental quality and hence product price.
5. The incorporation of genetic information in crop growth models is still in its childhood, although some preliminary examples were presented during HORTIMODEL2006. Such models would provide valuable breeding tools, predicting effects of genetic changes on plant growth, development and yield and allowing definition of "ideal gene combinations".

We found the high-quality presentations and the fruitful discussions during the symposium stimulating and we hope that the proceedings will stimulate and help not only scientists working on simulation models but all those working in the broad area of greenhouse horticulture.

Ep Heuvelink, Convener

Contact

Ep Heuvelink, Wageningen University, Department of Plant Sciences, Horticultural Production Chains group, Marijkeweg 22, 6709 PG Wageningen, The Netherlands, email: ep.heuvelink@wur.nl

From the Secretariat

New ISHS Members

ISHS is pleased to welcome the following new members:

NEW INSTITUTIONAL MEMBERS:

Canada: Kwantlen University College, Richmond, BC

Kenya: International Centre of Insect Physiology and Ecology (ICIPE) - African Insect Science for Food&Health, Nairobi

NEW INDIVIDUAL MEMBERS:

Australia: Mr. Chris Bennett, Dr. Wayne Boucher, Terry Hatch, Mr. Vigneswaran Kumaran, Dr. John Mason, Gregory R. McPhee, Prof. Michelle Waycott, Mr. Bruce West, Ms. Angelika Ziehrl; **Austria:** Prof. Dr. Gerald Kastberger, Dr. Bianca Maria Rinaldi; **Belgium:** Mr. Filip Debersaques, Marcel Schers; **Brazil:** Mr. Jose Luiz Marchesan; **Canada:** Mr. Robert Baerg, Dr. Laila Benkrima, Mr. Brian French, Ms. Margaret Ingratta, Doug Justice, Helen Mills, Mr. Ian Smith, Mr. Jimmy Turcotte; **Chile:** Mr. Felipe Gonzalo Armengolli Ferrer, Mr. Martin Richter, Sergio Toro; **Costa Rica:** Dr. Fabrice Vaillant; **Denmark:** Nils Wihlborg; **Ecuador:** Ms. Maria Amores; **France:** Mr. Stéphane George, Dr. Inge Van den Bergh; **Germany:** Indera Sakti Nasution, Dr. Rudolf Rapp; **Greece:** Dr. Thomas Bartzanas, Mr. Christos D. Katsanos, Dr. Ioannis Moungolias; **Hungary:** Mr. István Somogyi; **India:** Mr. Vikas Agarwal, Seetharam Annadana, Mr. Jagdish Belwal, Dr. Kamal Singh Kirad, Mr. Prakash Kulkarni, Mr. Vishal Malik, Mr. Sanjay Pandit; **Indonesia:** Anton Waloejo; **Iran:** Mr. Ali Haghiry, Dr. Habibollah Mirzaei; **Ireland:** Mr. Daire Cleary; **Italy:** Mr. Vincenza Ilardi, Roberto Pinton, Dr. Valentina Scariot; **Japan:** Dr. Daisuke Hamanaka, Mr. Kenjiro Sumi; **Korea (Republic of):** Dr. Seon Ki Kim, Dr. Huijune Shin; **Malta:** Dr. Marica Gatt, Ms. Melanie Gatt; **Mexico:** Prof. Marcelino Cabrera de la Fuente, Prof. Alejandro Carreon Perez, Mr. Jose Gurtubay, Carlos Núñez-Colín, Mr. Cesar Ocana, Dr. Luz Evelia Padilla Bernal, Mr. Pedro Plancarte; **Netherlands:** Ms. Dian Heryanto, Mr. Jon Wittendorp; **New Zealand:** Dr. Nigel Banks, Grant Hayman, Ray Lawson, Steve Potbury, Mr. Murray Simpson; **Norway:** Mr. Kai Henriksen; **Philippines:** Jullie Rivera; **Portugal:** Dr. Brigitte Nowakowsky; **Romania:** Prof. Dr. Nicolae Atanasiu, Prof. Dr. Liviu Coriolan Dejeu, Dr. Delian Elena, Prof. Dr. Diana Vasca- Zamfir; **Singapore:** Ms. Lee Moi Choo; **Slovakia:** Dr. Bohus Obert; **South Africa:** Ms. Rykie de Villiers, Jac Duif, Ms. Natalie Feltman, Ms. Lindile Kunene, Ms. Adri Veale; **Spain:** Dr. Angjelina Belaj, Mr. David Giné Falguera, Julian Herraiz; **Sweden:** Ulf Hagner, Mr. Lennart Johnsen, Ms. Peta McDornan, Dr. Renate Mueller, Assist. Prof. Ingegerd Sjöholm; **Switzerland:** Marceline Brodmann; **Taiwan:** Ms. Yun-Yin Hsiao, Ms. Li-ju Lin; **Thailand:** Dr. Tom Burns, Dr. Sayan Sdodee; **Turkey:** Ms. Aysun Hüseyin; **United Arab Emirates:** Mr. Anwar Kadhim; **United Kingdom:** Alisdair Aird, Mr. John Baxtear, Peter Bingham, Ms. Heather Griggs, David Hide, Ms. Sophie Loftus, Mr. David Mair, Mr. David McCullagh, Dr. Philip Morley, Ms. Isobel Park, Ms. Kakolee Roy, Laurence Smith, Mr. Thanaraj Thiruchelvam, Mr. Pijaya Vachajitpan, Ms. Katherine Young; **United States of America:** Mr. Alan Asadoorian, Dr. Maurice Averner, Mr. Defaru Ayu, William Barr, Ms. Margaret Brown, Mr. Boris Chan, Ms. Melissa Clifton, Mr. Brian Driscoll, Mr. Sage Finch, Connie Ms. Fisk, James D. Gilbert, Mr. Mahindra Goguri, Dale Goldy, Teresa Gruss, Dr. Rosemarie Hammond, David W. Hanning, Joyce C Havstad, Charles W. Heuser, Willis Hilker, Jonathon Hocut, Katharina Holzapfel, Ms. Jiyoung Hong, Dr. Andrew Huber, James Johnson, Alan Jones, Norman Keene, Ruben Koch, Dr. Elwood Longenecker, Mr. Juan Marcano, Michelle Marcotte, Ms. Elizabeth Park, Bob Sanderson, Mr. Henry Sanguinetti, Mr. Paulo Santos, Lucas Schmidt, Kurt Schwartau, Ms. Whitney Slaybaugh, Jon Stephan, Mr. Dennis Tarry, Eelco H. Tinga Jr., Dr. A. Amilcar Ubiera, Susan Whitakerhill, Kevin Williams.

Calendar of ISHS Events

For updates and more logon to www.ishs.org/calendar. Do always mention your ISHS membership number or attach copy of your ISHS membership card when registering. A reduced ISHS members registration fee applies.

YEAR 2007

- June 11-15, 2007, Funchal (Portugal - Madeira): **VI International Symposium on New Floricultural Crops.** Info: Maria João Oliveira Dragovic M.Sc., Caminho das Voltas 11, 9060-329 Funchal, Madeira, Portugal. Phone: (351)291211260, Fax: (351)291211234, email: joaodragovic.sra@gov-madeira.pt web: www.sra.pt/nfc2007

- June 24-29, 2007, Beijing (China): **II International Conference on Turfgrass Science and Management for Sports Fields.** Info: Prof. Dr. Liebao Han, Institute of Turfgrass Science, Bejing Forestry University, No. 35 Qinghua East Road, Beijing 100083, China. Phone: (86)1062337982, Fax: (86)1062322089, hanlb@tom.com web: www.bfuturf.com

- NEW June 25, 2007, Brussels (Belgium): **Awareness Raising Conference on Horticulture for Development.** Info: Ir. Jozef Van Assche, Executive Director ISHS, PO Box 500, 3001 Leuven 1, Belgium. Phone: (32)16229427, Fax: (32)16229450, jozef@ishs.org web: www.globalhort.org

- July 1-5, 2007, Einsiedeln/Wädenswil (Switzerland): **VIII International Symposium on Modelling in Fruit Research and Orchard Management.** Info: Dr. Joerg Samietz, Agroscope FAW Wädenswil, Schloss, PO Box 185, 8820 Wädenswil, Switzerland. Phone: (41)447836193, Fax: (41)447836434, email: joerg.samietz@acw.admin.ch web: www.hortplus.com/ISHSmodel

- August 6-8, 2007, Bangkok (Thailand): **International Conference on Quality Management of Fresh Cut Produce.** Info: Dr. Sirichai Kanlayanarat, King Mongkut's University of Technology Thonburi, Thongkru, Bangkok 10140, Thailand. Phone: (66)24707720, Fax: (66)24523750, email: sirichai.kan@kmutt.ac.th web: www.kmutt.ac.th/QMFCP2007/

- NEW August 12-17, 2007, Portland, OR (USA): **XI International Workshop on Fire Blight.** Info: Dr. Virginia Stockwell, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331, USA. Phone: (1)5417384078, Fax: (1)5417384025, email: stockwev@science.oregonstate.edu or Dr. Kenneth B. Johnson, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331, USA. Phone: (1)5417375249, Fax: (1)5417373573, email: johnsonk@science.oregonstate.edu web: oregonstate.edu/conferences/fireblight2007/

- September 2-9, 2007, Nottingham (United Kingdom): **International Symposium on Growing Media and Hydroponics.** Info: Dr. Bill Carlile, Chief Horticultural Scientist, Bord na Mona, Main Stree, Newbridge, Co. Kildare, Ireland. email: bill.carlile@bnm.ie web: www.ntu.ac.uk/science/school_news/ishs

- NEW September 10-14, 2007, Greenway Woods, White River (South Africa): **International Symposium on Novel Approaches to Disease and Pest Management in Banana and Plantain.** Info: Dr. Altus Viljoen, Department of Plant Pathology, University of Stellenbosch, Private Bag X1, Matieland 7600, South Africa. Phone: (27)21-8084797, Fax: (27)21-8084956, email: altus@sun.ac.za or Dr. Inge Van den Bergh, Bioversity International, 1990 Boulevard de la Lironde, Parc Scientifique Agropolis II, 34397 Montpellier, France. Phone: (33)467611302, Fax: (33)467610334, email: i.vandenbergh@cgiar.org Symposium Secretariat email: k.lehrer@cgiar.org web: www.promusa.org

- September 12-15, 2007, Faro (Portugal): **III International Symposium on Acclimatization and Establishment of Micropropagated Plants.** Info: Dr. Anabela Romano, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal. Phone: (351)289800910, Fax: (351)289819419, email: aromano@ualg.pt web: www.ualg.pt/aemp2007

- September 16-20, 2007, Aas (Norway): **International Symposium on Genetic Modification - Challenges and Opportunities for Horticulture in the World.** Info: Dr. Trine Hvoslef-Eide, Norwegian University of Life Sciences, PO Box 5003, 1432 Aas, Norway. Phone: (47)93433775, Fax: (47)64966024, email: trine.hvoslef-eide@umb.no

- September 20-21, 2007, Keszthely (Hungary): **IV International Phylloxera Symposium.** Info: Dr. László Kocsis, Deák F. u. 16, 8360 Keszthely, Hungary. Phone: (36)83545058, Fax: (36)83545058, email: kocsis-l@georgikon.hu web: www.georgikon.hu/phylox

- September 23-27, 2007, Hanoi (Vietnam): **International Symposium Improving the Performance of Supply Chains in the Transitional Economies - Responding to the Demands of Integrated Value Chains.** Info: Dr. Peter J. Batt, Horticulture, Curtin University of Technology, GPO Box U1987, Perth, WA 6845, Australia. Phone: (61)892667596, Fax: (61)892664422, email: p.batt@curtin.edu.au web: www.muresk.curtin.edu.au/conference/ishsvn

- October 4-6, 2007, Naples (Italy): **International Conference on Sustainable Greenhouse Systems - GREENSYS2007.** Info: Prof. Dr. Stefania De Pascale, Department of Agricultural Engineering and Agronomy, University of Naples Federico II, Via Universita 100, 80055 Portici (Naples), Italy. Phone: (39)0812539127, Fax: (39)0817755129, email: depascal@unina.it web: www.greensys2007.com

- October 8-12, 2007, Kusadasi (Turkey): **II International Symposium on Tomato Diseases.** Info: Dr. Hikmet Saygili, Ege University, Faculty of Agriculture, Department of Plant Protection, Bornova 35100, Izmir, Turkey. Phone: (90)2323886857, Fax: (90)2323881864, email: hikmet.saygili@ege.edu.tr web: www.2istd.ege.edu.tr

- October 9-13, 2007, Houston, TX (USA): **II International Symposium on Human Health Effects of Fruits and Vegetables.** Info: Dr. Bhimanagouda Patil, Texas A&M University, Department of Horticulture, 1500 Research Parkway Ste A120, College Station, TX 77845, USA. Phone: (1)9798624521, Fax: (1)9798624522, email: b-patil@tamu.edu web: favhealth2007.tamu.edu

- October 15-19, 2007, Wageningen (Netherlands): **V International Symposium on Taxonomy of Cultivated Plants.** Info: Dr. Ronald van den Berg, Wageningen UR, Building No. 351, Gen. Foulkesweg 37, 6703 BL Wageningen, Netherlands. email: ronald.vandenberg@wur.nl or Mrs. N. Groendijk-Wilders, Gen.Foulkesweg 37, 6703 BL Wageningen, Netherlands. email: info.istcp2007@wur.nl web: www.istcp2007.wur.nl

- October 21-25, 2007, Santa Catarina (Brazil): **VIII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics.** Info: Dr. Gabriel Berenhauser Leite, EPAGRI - Caçador Experimental Station, C. Postal 591, 89500-000 Caçador, SC, Brazil. Phone: (55)4935612000, Fax: (55)35612010, email: gabriel@epagri.rct-sc.br or Dr. Flavio Gilberto Herter, EMBRAPA, C. Postal 403, 96001-970 Pelotas, RS, Brazil. Phone: (55)32758120, Fax: (55)32758220, email: herter@cpact.embrapa.br web: www.cpact.embrapa.br/eventos/2007/VIIITZFTS/

- NEW October 22-26, 2007, João Pessoa - Paraíba (Brazil): **VI International Congress on Cactus Pear and Cochineal and the VI General Meeting of FAO-CACTUSNET.** Info: Juliana Rossignol,

Executive Secretariat VI Int'l Congress on Cactus Pear and Cochineal, Brazil. Phone: (55)8332225144, email: congressopalma@senarpb.com.br web: www.cactuspera-congress2007.com

- October 23-25, 2007, Bursa (Turkey): **International Workshop on Chestnut Management in Mediterranean Countries: Problems and Prospects.** Info: Prof. Dr. Arif Soylu, Uludag University, Faculty of Agriculture, Department of Horticulture, Görükle, 16059 Bursa, Turkey. Phone: (90)2244428970, Fax: (90)2244429098, email: arif-soylu@yahoo.com web: www.chestnut2007turkey.org

- October 29-31, 2007, Lelystad (Netherlands): **V International Symposium on Edible Alliaceae.** Info: Ir. J.H.J. Haarhuis, World Allium Association, Laan ven Beek en Royen 41, 3701 AK Zeist, Netherlands. Phone: (31)306933489, Fax: (31)306974517, email: info@worldalliumassociation.com web: www.worldalliumassociation.com

- November 18-23, 2007, João Pessoa, Paraiba (Brazil): **VI International Pineapple Symposium.** Info: Dr. Domingo Haroldo Reinhardt, EMBRAPA, PO Box 7, Cruz das Almas, BA, Brazil. Phone: (55)7536218002, Fax: (55)7536218097, email: dharoldo@cnpmf.embrapa.br web: www.ipsbrasil2007.com.br

- NEW December 3-6, 2007, Bangkok (Thailand): **International Conference on Quality Management of Ornamentals (QMSCO 2007).** Info: Dr. Sirichai Kanlayanarat, King Mongkut's University of Technology Thonburi, Thongkru, Bangkok 10140, Thailand. Phone: (66)24707720, Fax: (66)24523750, email: sirichai.kan@kmutt.ac.th web: www.kmutt.ac.th/QMSCO2007

- December 3-6, 2007, Bangkok (Thailand): **Europe-Asia Symposium on Quality Management in Postharvest Systems (EURASIA2007).** Info: Dr. Sirichai Kanlayanarat, King Mongkut's University of Technology Thonburi, Thongkru, Bangkok 10140, Thailand. Phone: (66)24707720, Fax: (66)24523750, email: sirichai.kan@kmutt.ac.th web: www.kmutt.ac.th/EURASIA2007

YEAR 2008

- January 6-9, 2008, Orlando, FL (USA): **International Symposium Application of Precision Agriculture for Fruits and Vegetables.** Info: Dr. Reza Ehsani or Dr. Gene Albrigo, University of Florida Citrus Research and Education Center, 700 Experiment Station Rd., Lake Alfred, FL 33850, USA. Phone: (1)8639561151 ext. 1228 and 1207, Fax: (1)8639564631, email: ehsani@ufl.edu or albrigo@ufl.edu web: www.precisionag2008.com

- February 17-20, 2008, Wien (Austria): **I International Symposium on Horticulture in Europe.** Info: Dr. Gerard Bedlan, AGES, Spargelfeldstrasse 191, 1226 Wien, Austria. Phone: (43)5055533330, Fax: (43)5055533303, email: gerhard.bedlan@ages.at web: www.she2008.eu

- March 3-7, 2008, Huelva (Spain): **VI International Strawberry Symposium.** Info: Dr. José López Medina, EPS LA Rábida, 21819 Palos de la Frontera, Huelva, Spain. Phone: (34)959217522, Fax: (34)959217304 or (34)959217560, email: medina@uhu.es web: www.iss2008spain.com

- NEW March 3-7, 2008, Arusha (Tanzania): **I International Symposium on Underutilized Plant Species.** Info: Dr. Hannah Jaenicke, Director International Centre for Underutilized Crops, PO Box 2075, Colombo, Sri Lanka. Phone: (94)112787404ext3307, Fax: (94)112786854, email: h.jaenicke@cgiar.org or Dr. Irmgard Hoeschle-Zeledon, GFU Underutilized Species, Via dei Tre Denari, 472/a, 00057 Maccarese (Rome), Italy. Phone: (39)066618292/302, Fax: (39)0661979661, email: i.zeledon@cgiar.org

- April 6-11, 2008, Antalya (Turkey): **International Symposium on Strategies Towards Sustainability of Protected Cultivation in Mild Winter Climate.** Info: Prof. Dr. Yüksel Tüzel, Ege University, Faculty of Agriculture, Department of Horticulture, 35100 Bornova - Izmir, Turkey. Phone: (90)2323881865, Fax: (90)2323881865, email: yuksel.tuzel@ege.edu.tr web: www.protectedcultivation2008.com

- April 20-24, 2008, Haarlem (The Netherlands): **International Symposium of Virus Diseases in Ornamentals.** Info: Dr. Ellis T.M. Meekes, Naktuinbouw, P.O. Box 40, 2370 AA Roelofarendsveen, The Netherlands. Phone: (31)7103326236, Fax: (31)71033260366, email: e.meekes@naktuinbouw.nl or Ir. A.F.L.M. Derks, Applied Plant Research, P.O. Box 85, 2161 DW Lisse, The Netherlands. For inquiries mail to: ISVDOP12@wur.nl

- April 27 - May 1, 2008, Westminster, London (United Kingdom): **International Symposium Plants, People and Places.** Info: Mr Tim Hughes, Royal Horticultural Society, RHS Wisley Garden, Woking, Surrey GU23 6QB, United Kingdom. Phone: (44)01483212335, Fax: (44)01935816684, email: timhughes@rhs.org.uk

- April, 2008, Palermo (Italy): **IX International Symposium on Plum and Prune Genetics, Breeding and Pomology.** Info: Prof. Francesco Sottile, Dipartimento di Colture Arboree, University of Palermo, Viale delle Scienze 11, 90128 Palermo, Italy. Phone: (39)0917049000, Fax: (39)0917049025, email: fsottile@unipa.it

- May 19-21, 2008, Faro (Portugal): **VI International Symposium on Mineral Nutrition of Fruit Crops.** Info: Dr. Pedro José Correia and Maribela Pestana Correia, FERN, Universidade do Algarve, Gambelas, 8005-139 Faro, Portugal. Phone: (351)289800900, Fax: (351)289818419, email: pcorreia@ualg.pt or fpestana@ualg.pt

- May 21-26, 2008, Pruhonice (Czech Republic): **I International Symposium on Woody Ornamentals of the Temperate Zone.** Info: Dr. Frantisek Sramek, VUKOZ, Research Institute for Landscape and Ornamental Gardening, Kvetnove Namesti, 25243 Pruhonice, Czech Republic. Phone: (420)296528336, Fax: (420)267750440, email: sramek@vukoz.cz

- June 9-11, 2008, Madrid, (Spain): **IV International Symposium on Applications of Modelling as an Innovative Technology in the Agri-Food Chain - Model-IT 2008.** Info: Prof. Pilar Barreiro, Universidad Politécnica de Madrid, ETSI Agrónomos, Avda. Complutense s/n, 28040 Madrid, Spain. Phone: (34)913363260, Fax: (34)913365845, email: pilar.barreiro@upm.es web: www.model-it2008.upm.es

- June 9-11, 2008, Toronto, (Canada): **XI International Symposium on the Processing Tomato.** Info: Dr. Jane Graham or Dr. John Mumford, Ontario Food Processors Association, c/o Janisse Routledge, 7660 Mill Road, Guelph, Ontario N1H 6J1, Canada. Phone: (1)5197675594, Fax: (1)5197634164, email: ofpa@sentex.net

- NEW June 16-20, 2008, Matera (Italy): **XIV International Symposium on Apricot Breeding and Culture.** Info: Dr. Cristos Xiloyannis, Dipartimento di Scienze dei Sisterni Colturali, Forestali e dell'Ambiente, Universita degli Studi della Basilicata, Campus di Macchia Romana, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy. Phone: (39)3293606262, Fax: (39)0971205378, email: cristos.xiloyannis@unibas.it or contact the Symposium Secretariat at apricot2008@unibas.it web: www.unibas.it/apricot2008/home.htm

- June-July, 2008, Viterbo, (Italy): **VII International Congress on Hazelnut.** Info: Prof. Leonardo Varvaro, Hazelnut Research Center, CeFAS, viale Trieste 127, 01100 Viterbo, Italy. Phone: (39)0761357461, Fax: (39)0761357473, email: varvaro@unitus.it

- July 14-18, 2008, Corvallis, OR (USA): **IX International Symposium on Vaccinium Culture.** Info: Prof. Dr. Bernadine Strik, Department of Horticulture, Oregon State University, 4017 ALS, corvallis, OR 97331, USA. Phone: (1)5417375434, Fax: (1)5417373479, email: strikb@hort.oregonstate.edu or Dr. Chad Finn, USDA-ARS Hort Crops Research Lab, 3420 NW Orchard Ave., Corvallis, OR 97330, USA.

Phone: (1)5417384037, Fax: (1)5417384025, email: finnc@science.oregonstate.edu web: oregonstate.edu/conferences/vaccinium2008

- August 4-8, 2008, Geneva, NY (USA): **International Symposium on Integrated Canopy, Rootstock, Environmental Physiology in Orchard Systems.** Info: Dr. Terence Robinson, Departement of Horticultural Sciences, NY State Agricultural Experiment Station, Cornell University, 630 W. North Street, Geneva, NY 14456, USA. Phone: (1)3157872227, Fax: (1)3157872216, email: tlr1@cornell.edu

- August 25-28, 2008, Lima (Peru): **International Symposium on Soilless Culture and Hydroponics.** Info: Dr. Alfredo Rodriguez-Delfin, Universidad Nacional Agraria La Molina, Av. La Molina s/n, La Molina, Lima 12, Peru. Phone: (51)13485359 or 13495669, Fax: (51)13485359 or 13495670, email: delfin@lamolina.edu.pe

- August 25-28, 2008, Fuzhou - Fujian Province (China): **III International Symposium on Longan, Lychee and other Fruit Trees in Sapindaceae .** Info: Prof. Pan Dong-Ming, College of Horticulture, Fujian Agriculture and Forest University, Department of Horticulture, Fuzhou, Fujian Province, China. Phone: (86)59183789299, Fax: (86)59183735681, email: pdm666@126.com

- August 25-29, 2008, Brisbane (Australia): **VI International Symposium on In Vitro Culture and Horticultural Breeding.** Info: Prof. Acram Taji, Agronomy & Soil Science Group, University of New England, Armidale, NSW 2351, Australia. Phone: (61)267732869, Fax: (61)267733238, email: ataji@metz.une.edu.au web: www.une.edu.au

- September 1-5, 2008, Dresden, Pillnitz (Germany): **I International Symposium on Biotechnology of Fruit Species.** Info: Dr. Magda-Viola Hanke, BAZ, Institut fuer Obstzuechtung, Pillnitzer Platz 3a, 01326 Dresden, Germany. Phone: (49)3512616214, Fax: (49)3512616213, email: v.hanke@bafz.de web: www.biotech-fruit2008.bafz.de

- NEW September 3-6, 2008, Stellenbosch (South Africa): **IX International Protea Research Symposium and XIII International Protea Association Conference.** Info: Dr. Hans Hettasch or Dr. Retha Venter, IPA 2008 Conference, PO Box 5600, Helderberg, Somerset West, 7135, South Africa. Phone: (27)218554472 or (27)826567088, Fax: (27)218552722, email: reventer@netactive.co.za web: web: www.ipa2008.co.za

- September 8-12, 2008, Lillehammer (Norway): **V International Symposium on Brassicas and XVI Crucifer Genetics Workshop.** Info: Dr. Magnor Hansen, Norwegian University of Life Sciences, Department of Plant and Environmental Sciences, PO Box 5003, 1432 Aas, Norway. Phone: (47)64965619, Fax: (47)64965615, email: magnor.hansen@umb.no

- September 9-12, 2008, Beijing (China): **IV International Chestnut Symposium.** Info: Dr. Ling Qin, Beijing Agricultural College, No. 7 Beinong Road, Changpin District, Bejing 102206, China. Phone: (86)1080799136 or (86)1080799126, Fax: (86)1080799004, email: qinlingbac@126.com

- September 9-13, 2008, Evora (Portugal): **VI International Symposium on Olive Growing.** Info: Dr. Anacleto C. Pinheiro, University of Evora, Rural Engineering Department, Apartado 94, Evora 7002-554, Portugal. Phone: (351)266760837, Fax: (351)266760911, email: pinheiro@uevora.pt web: olivegrowing.uevora.pt

- September 21-25 , 2008, Baoding (China): **I International Jujube Symposium.** Info: Dr. Mengjun Liu, Research Center of Chinese Jujube, College of Horticulture, Agricultural University of Hebei, Baoding, Hebei 071001, China. Phone: (86)3127521342, Fax: (86)3127521251, email: ijs2008@hebau.edu.cn

- September 22-29 , 2008, Alnarp (Sweden): **IV International Symposium Toward Ecologically Sound Fertilization Strategies for Field Vegetable Production.** Info: Dr. Rolf Larsen, Division of Horticulture, Swedisch University of Agricultural Sciences, PO Box 55, 230 53 Alnarp, Sweden. Phone: (46)40415369, Fax: (46)40460441, email: rolf.larsen@vv.slu.se

- NEW October, 2008, Tbilisi (Georgia): **International Symposium on Current and Potential Uses of Nut Trees Wild Relatives.** Info: Dr. Zviad Bobokashvili, Gelovani 6, Tbilisi, Georgia. Phone (995)93335793 or (995)93524611ext124, email: bobokashvili@hotmail.com or Dr. Maya Marghania, Kostava 41, Tbilisi, Georgia. Phone: (995)99905076, emial: mmarghania@hotmail.com

- November 3-7, 2008, Bogor (Indonesia): **IV International Symposium on Tropical and Subtropical Fruits.** Info: Prof. Dr. Roedhy Poerwanto, Center for Tropical Fruit Studies, Bogor Agricultural University, Kampus IPS Baranangsiang, Jl. Pajajaran, Bogor 16143, Indonesia. Phone (62)251326881, Fax: (62)251326881, email: istsf4@yahoo.com

- November 8-13, 2008, Firenze, Faenza and Caserta (Italy): **IV International Symposium on Persimmon.** Info: Dr. Elvio Bellini, Universita degli studi di Firenze, Dipartimento di Ortoflorofrutticoltura, Viale delle Idee 30, 50019 Sesto Fiorentino (FI), Italy. Phone: (39)0554574053, Fax: (39)0554574017, email: elvio.bellini@unifi.it or Dr. Edgardo Giordani, Universita degli studi di Firenze, Dipartimento di Ortoflorofrutticoltura, Viale delle Idee 30, 50019 Sesto Fiorentino (FI), Italy. Phone: (39)0554574050, Fax: (39)0554574017, email: edgardo.giordani@unifi.it

- NEW December 7-11, 2008, Chiang Mai (Thailand): **XVI International Symposium on Horticultural Economics and Management.** Info: Dr. Peter Batt, Department of Horticulture, Curtin University of Technology, GPO box U1987, Perth WA 6845, Australia. Phone (61)892667596, Fax: (61)892663063, email: p.batt@curtin.edu.au or Prof. Dr. Peter P. Oppenheim, Deakin Business School, Deakin University, 336 Glenferrie Road, Malvern VIC 3144, Australia. Phone: (61)39244549, Fax: (61)392445040, email: email: peter.oppenheim@deakin.edu.au

- NEW December 7-11, 2008, Chiang Mai (Thailand): **V International Symposium on Horticultural Research, Training and Extension.** Info: Dr. Peter Batt, Department of Horticulture, Curtin University of Technology, GPO box U1987, Perth WA 6845, Australia. Phone (61)892667596, Fax: (61)892663063, email: p.batt@curtin.edu.au or Associate Professor Dr. David Aldous, University of Melbourne, Burnley College, Swan Street, Richmond VIC 3121, Australia. Phone: (61)392506800, Fax: (61)392506885, email: email: daldous@unimelb.edu.au

- NEW December 7-12, 2008, Bangalore (India): **IX International Symposium on Acclimatization and Establishment of Micropropagated Plants.** Info: Dr. Jitendra Prakash, In Vitro International Pvt. Ltd., #12/44, Rajiv Gandhi Nagar Bommanahalli, Bangalore 560 068, India. Phone: (91)8041109273, Fax: (91)8025727030, email: email: invitro@bgl.vsnl.net.in

For updates logon to www.ishs.org/calendar

Available Issues of *Acta Horticulturae*

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

Acta Number	Acta Title	Acta Price (EUR)
740	I International Symposium on Papaya	83
739	II International Symposium on Saffron Biology and Technology	101
738	International Symposium on Biotechnology of Temperate Fruit Crops and Tropical Species	163
737	I International Symposium on Organic Apple and Pear	58
736	III International Date Palm Conference	124
735	I International Guava Symposium	138
734	VIII International Symposium on Plum and Prune Genetics, Breeding and Pomology	100
733	III International Grapevine Phylloxera Symposium	52
732	VIII International Symposium on Canopy, Rootstocks and Environmental Physiology in Orchard Systems	140
731	III International Symposium on Cucurbits	108
730	VI International Symposium on Artichoke, Cardoon and Their Wild Relatives	108
729	III Balkan Symposium on Vegetables and Potatoes	104
728	V International Congress on Cactus Pear and Cochineal	75
727	X International Symposium on Plant Bioregulators in Fruit Production	119
726	IV International Symposium on Pistachios and Almonds	146
725	V International Symposium on In Vitro Culture and Horticultural Breeding	174
724	IX International Symposium on the Processing Tomato	82
723	I International Symposium on the Labiatae: Advances in Production, Biotechnology and Utilisation	99
722	XI International Symposium on Virus Diseases of Ornamental Plants	84
721	V International Symposium on Mineral Nutrition of Fruit Plants	84
720	IV International Conference on Quality and Safety Issues Related to Botanicals	58
719	International Symposium on Greenhouse Cooling	137
718	III International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation (HortiModel 2006)	140
717	XIII International Symposium on Apricot Breeding and Culture	88
716	VII International Protea Research Symposium	54
715	VIII International Symposium on Vaccinium Culture	122
714	XXII International Eucarpia Symposium, Section Ornamentals, Breeding for Beauty	63
713	VI International Peach Symposium	110
712	IV International Conference on Managing Quality in Chains - The Integrated View on Fruits and Vegetables Quality	188
711	V International Symposium on Artificial Lighting in Horticulture	99
710	International Symposium on Greenhouses, Environmental Controls and In-house Mechanization for Crop Production in the Tropics and Sub-Tropics	113
709	I International Symposium on Natural Preservatives in Food Systems	51
708	V International Strawberry Symposium	124
707	VII International Symposium on Modelling in Fruit Research and Orchard Management	71
706	IV International Symposium on Brassicas and XIV Crucifer Genetics Workshop	80
705	V International Walnut Symposium	118
704	X International Workshop on Fireblight	121
703	II International Symposium on Sweetpotato and Cassava: Innovative Technologies for Commercialization	69
702	V International Pineapple Symposium	60
701	XII International Symposium on Apricot Culture and Decline	147
700	International Symposium Towards Ecologically Sound Fertilisation Strategies for Field Vegetable Production	74
698	VI International Symposium on Chemical and non-Chemical Soil and Substrate Disinfestation - SD2004	79
696	VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics - Part Two	117
693	III International Chestnut Congress	144
692	II International Symposium on Biotechnology of Tropical and Subtropical Species	54
691	International Conference on Sustainable Greenhouse Systems - Greensys2004	170
690	I International Rose Hip Conference	75
689	VII International Symposium on Grapevine Physiology and Biotechnology	110
687	International Conference Postharvest Unlimited Downunder 2004	89
686	VI International Congress on Hazelnut	132
682	V International Postharvest Symposium	395
674	III International Symposium on Applications of Modelling as an Innovative Technology in the Agri-Food Chain; MODEL-IT	121
673	IX International Symposium on Flower Bulbs	150
671	IX International Pear Symposium	124
670	I International Symposium on Root and Tuber Crops: Food Down Under	57
661	I International Conference on Turfgrass Management and Science for Sports Fields	115
660	V International Congress on Artichoke	119

659 VII International Symposium on Protected Cultivation in Mild Winter Climates: Production, Pest Management and Global Competition 159

658 I International Symposium on Rootstocks for Deciduous Fruit Tree Species 137

657 XIX International Symposium on Virus and Virus-like Diseases of Temperate Fruit Crops - Fruit Tree Diseases 117

656 X International Symposium on Small Fruit Virus Diseases 57

655 XV International Symposium on Horticultural Economics and Management 106

654 International Workshop on Models for Plant Growth and Control of Product Quality in Horticultural Production 77

653 IX International Symposium on Plant Bioregulators in Fruit Production 61

652 I International Symposium on Grapevine Growing, Commerce and Research 108

651 XXI International Eucarpia Symposium on Classical versus Molecular Breeding of Ornamentals - Part II 54

649 Euro Berry Symposium - Cost 836 Final Workshop 77

648 South Pacific Soilless Culture Conference - SPSCC 60

647 International Code of Nomenclature for Cultivated Plants - Code International pour la Nomenclature des Plantes Cultivées 55

645 VII International Mango Symposium 136

644 International Symposium on Growing Media and Hydroponics 117

642 XXVI International Horticultural Congress: Horticulture, Art and Science for Life - The Colloquia Presentations 60

641 XXVI International Horticultural Congress: The Knowledge Business: Horticulture Education and Knowledge Transfer 51

640 XXVI International Horticultural Congress: Viticulture - Living with Limitations 86

639 XXVI International Horticultural Congress: Expanding Roles for Horticulture in Improving Human Well-Being and Life Quality 84

638 XXVI International Horticultural Congress: Sustainability of Horticultural Systems in the 21st Century 105

637 XXVI International Horticultural Congress: Advances in Vegetable Breeding 84

636 XXVI International Horticultural Congress: Key Processes in the Growth and Cropping of Deciduous Fruit and NutTrees 140

635 XXVI International Horticultural Congress: Managing Soil-Borne Pathogens: A Sound Rhizosphere to Improve Productivity in Intensive Horticultural Systems 57

634 XXVI International Horticultural Congress: IV International Symposium on Taxonomy of Cultivated Plants 68

633 XXVI International Horticultural Congress: Protected Cultivation 2002: In Search of Structures, Systems and Plant Materials for Sustainable Greenhouse Production 109

632 XXVI International Horticultural Congress: Citrus and Other Subtropical and Tropical Fruit Crops: Issues, Advances and Opportunities 81

631 XXVI International Horticultural Congress: Issues and Advances in Transplant Production and Stand Establishment Research 70

630 XXVI International Horticultural Congress: Nursery Crops; Development, Evaluation, Production and Use 78

629 XXVI International Horticultural Congress: The Future for Medicinal and Aromatic Plants 107

628 XXVI International Horticultural Congress: Issues and Advances in Postharvest Horticulture 168

627 XXVI International Horticultural Congress: Toward Ecologically Sound Fertilization Strategies for Field Vegetable Production 71

626 XXVI International Horticultural Congress: Berry Crop Breeding, Production and Utilization for a New Century 96

625 XXVI International Horticultural Congress: Biotechnology in Horticultural Crop Improvement: Achievements, Opportunities and Limitations 98

624 XXVI International Horticultural Congress: Elegant Science in Floriculture 110

623 XXVI International Horticultural Congress: Plant Genetic Resources, The Fabric of Horticulture's Future 80

621 XXVI International Horticultural Congress: Horticultural Science in Emerging Economies, Issues and Constraints 46

620 XXVI International Horticultural Congress: Asian Plants with Unique Horticultural Potential: Genetic Resources, Cultural Practices, and Utilization 99

619 XXVI International Horticultural Congress: Potatoes, Healthy Food for Humanity: International Developments in Breeding, Production, Protection and Utilization 99

618 XXVI International Horticultural Congress: Environmental Stress and Horticulture Crops 107

609 International Symposium on Managing Greenhouse Crops in Saline Environment 102

540 I International Conference on Banana and Plantain for Africa 96

532 International Symposium on Chemical and Non-Chemical Soil and Substrate Disinfectation 54

530 International Symposium on Methods and Markers for Quality Assurance in Micropropagation 82

522 XXV International Horticultural Congress, Part 12: Application of Biotechnology and Molecular Biology and Breeding - General Breeding, Breeding and Evaluation of Temperate Zone Fruits for the Tropics and the Subtropics. 55

521 XXV International Horticultural Congress, Part 11: Application of Biotechnology and Molecular Biology and Breeding - Gene Expression and Molecular Breeding, Genome Analysis. 60

512 XXV International Horticultural Congress, Part 2: Mineral Nutrition and Grape and Wine Quality 49

505 VII International Symposium on Rubus and Ribes 76

504 VI Symposium on Stand Establishment and ISHS Seed Symposium 53

503 II WOCMAP Congress Medicinal and Aromatic Plants, Part 4: Industrial Processing, Standards & Regulations, Quality, Marketing, Economics 50

502 II WOCMAP Congress Medicinal and Aromatic Plants, Part 3: Agricultural Production, Post Harvest Techniques, Biotechnology 74

501 II WOCMAP Congress Medicinal and Aromatic Plants, Part 2: Pharmacognosy, Pharmacology, Phytomedicine, Toxicology 66

500 II WOCMAP Congress Medicinal and Aromatic Plants, Part 1: Biological Resources, Sustainable Use, Conservation and Ethnobotany 50

434 Strategies for Market Oriented Greenhouse Production 73

431 Tospoviruses and Thrips of Floral and Vegetable Crops 90

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