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Horticultural Highlights

Biotechnology and Horticulture • The Turfgrass Industry: Australia, New Zealand, and the Asia-Pacific Region • Malatya: World's Capital of Apricot Culture

Symposia and Workshops

Natural Preservatives • Contribution of African Botanica to Humanity • Saffron • Pomegranate and Minor Mediterranean Fruits • EUCARPIA - Section Ornamentals • Irrigation of Horticultural Crops • Managing Quality in Chains

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CHRONICA HORTICULTURAE

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Cover photograph: Apricot genotype 44-2005-1, see article p. 20.

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Miracles

Jules Janick

Jules Janick, ISHS Board Member and Director of Publications

I have two passions: the history of horticulture and listening to the sublime music of Wolfgang Amadeus Mozart and Johann Sebastian Bach. These seemingly disparate interests sometimes intersect. Bach, after all, wrote a Coffee Cantata in honor of a horticultural beverage, and Mozart wrote two operas (*The Marriage of Figaro* and *La Finta Giardiniera*) with horticulturists as part of the plot. In performances of the *The Marriage of Figaro* I may be the only person in the audience who is sympathetic with the feckless gardener Antonio, uncle of the heroine Susanna, who plays a small but crucial role in Act 1I when the mischievous oversexed Cherubino escapes from the bedroom of the Countess, jumps out the window, and lands in a bed of geraniums! The opera, one of the world's masterpieces, has a madcap plot that takes place in a single day, derives from a play by Pierre Beaumarchais (1784) transformed into a libretto by Lorenzo da Ponte, and made immortal through the divine music of Mozart.

Recently, at a significant birthday I received an unexpected present from my two children: a searchable iPod (from the Apple Corporation) containing the complete works of Mozart and Bach that included movies of two complete Mozart operas, *Don Giovanni* and *Cosi Fan Tutti*, plus the movie *Amadeus*, the life of Mozart. It was programmed by my son Peter who managed to obtain the complete works on discs. There are over 6000 pieces of music but only about half of the memory was needed. It probably would take weeks, listening 24 hours a day to hear and see the entire collection.

My iPod weighs 128 g and stores 60 gigabytes (60×10^9) of information (enough to store 60 million pages of text or 30 billion base pairs (at 2 bytes per base pair). More remarkable, the memory is stored in a little hard drive that weights only about 85 g. A miracle, I was overwhelmed.

By coincidence, the very next day I was involved in an experiment to evaluate two lines of the medicinal plant *Artemesia annua* (qinghao or annual wormwood), which has become increasingly important as the source of artemisinin, the most important natural antimalarial after quinine. Artemisinin is a rare sequiterpene lactone endoperoxide that has been found to be efficacious against *Plasmodium* species that cause human malaria, a disease responsible for millions of fatalities per year.

Now the seed of artemesia is exceedingly small, averaging 0.059 mg - 17,000 seed per gram! Put on a weight basis, one iPod would be equivalent to 2.2 million artemisia seed. However, the memory drive of the seed would be contained in a single genome in each cell. If we assume that artemisia genome has at a minimum only the information of *Arabidopsis*, the species with the smallest genome, it would have at least 25,000 genes which is equivalent to about 150 million base pairs (25,000 genes x 6000 base pairs per gene), The weight of a single genome of *Arabidopsis* has been calculated as 0.52 picograms ($1 \text{ pg} = 10^{-12}$ g). Thus, on an information density basis (information unit per gram) the seed of *Arabidopsis* contains information equivalent to at least 150 million base pairs in a 0.52 picograms memory drive making it literally 1 trillion times (10^{12}) more information dense than my iPod (Table 1).

Seeds are truly miraculous. It made me realize that as horticulturists we deal with miracles each day, yet they are ignored because they are so common. Furthermore, there are also many equivalent miracles in production horticulture, miracles that the world takes for granted. Let me briefly review four of them:

The Banana. Consider the common banana, everyone's second favorite fruit. This tropical fruit, selected thousands of years ago from seedy relatives in Southeast Asia, is now produced in countries of the humid tropics, chiefly in Central America and Africa, and shipped by boat to ports all over the world. Unblemished fruit with high quality is now available the world over, every day of the year, at very low prices. In US supermarkets, thousands of miles from production fields, banana averages 49 cents a pound ($1.08/kg) or about 16 cents a banana year round, as compared to 50 cents for a can of soda pop. This delicacy has been achieved from combined research of horticulturists, engineers, and physiologists, plus the efforts of a well organized private sector. A miracle.

Seedless Watermelon. Everyone loves watermelons but the fruit is loaded with seed. The idea of growing a plant from seed that will produce a seedless fruit is a mystifying process. This achievement in watermelon was the result of efforts of Dr. Hitoshi Kihara, a Japanese geneticist, first published in 1947, based on research in polyploidization via colchicine, hybrid breeding, and the physiology of parthenocarpy. Seedless fruit was obtained from planting triploid seed obtained by crossing induced tetraploids with diploids; the triploid plants produced seedless fruit when provided with diploid pollenizers. Subsequent research by many horticultural plant breeders have now made the seedless watermelon ubiquitous in the market, which now has an 80% share of US production, more in some Asian countries.

The Orchid. Once a rare tropical rarity, so expensive as only to be grown by the wealthy in private conservatories, the discovery of mass proliferation by micropropagation is making orchids the largest value floricultural species. Orchids are truly a global crop. In one example, breeding of *Phalaenopsis* was carried out in the United States, micropropagated in Japan, mass proliferated in China, greenhouse grown in the Netherlands, and flowering plants returned to the US. Orchid pot plants, in view of their long life and beautiful blooms, are perceived as good value by the buying public and are clearly the new floricultural miracle plant.

Somatic Embryogenesis. The discovery that cell cultures of carrot could produce embryos was first noted by F.C. Steward's group in 1958. The production of embryos from somatic tissue occurs naturally in a number of species such as citrus and mango, which produce polyembryonic seed. The concept of mass production of somatic embryos is now being used on a commercial scale to propagate coffee. The process of dedifferentiation of complex organs to undifferentiated cells, and the resulting redifferentiation to embryos and mature plants is truly a miracle of horticultural science.

Horticultural scientists deal with miracles every day, many unappreciated as such, perhaps a sign of our success. Horticultural science will continue to produce miracles for the well-being of all. The International Society for Horticultural Science, devoted to all fields of horticultural research, teaching, industry, and human well-being, is a place where miracles are reported, exchanged, archived, distributed, and promoted.

Table 1. Information density (information units per g) of seed and iPod.

Device	Memory drive wt. (g)	Stored information (base pair equivalents)	Information density (base pair units/g)
Seed[1]	0.52×10^{-12}	150×10^6	29×10^{19}
iPod[2]	85	30×10^9	35×10^7

[1] Memory drive of seed is assumed to be equivalent to genome of *Arabidopsis* with weight of 0.52 pg. Stored information is equivalent to 25,000 genes x 6000 base pairs = 150 million bp.

[2] A 60 gigabyte iPod should have information equivalent to 30 billion base pairs assuming 2 bytes required for 4 base pairs (CGAT).

International Horticultural Congress, Lisboa 2010

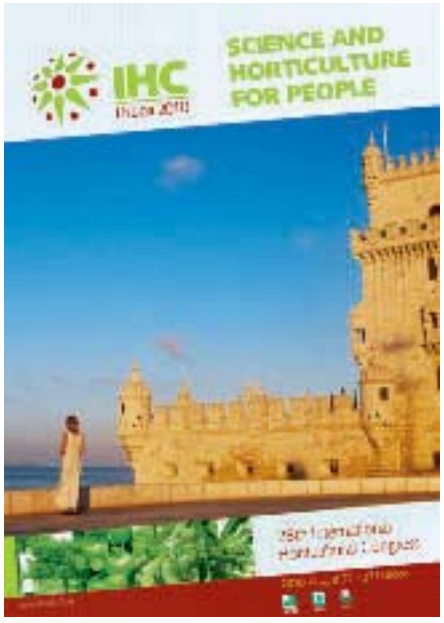
António Monteiro and Víctor Galán Saúco

António Monteiro

Víctor Galán Saúco

The 28th International Horticultural Congress will take place in Lisbon on August 22-27, 2010, jointly sponsored by the Portuguese Horticultural Association (APH) and the Spanish Society for Horticultural Science (SECH). Both Societies are deeply involved in the Congress organization.

The Lisbon congress was launched during the 27th IHC Seoul, Korea. The scientific programme will be discussed with the ISHS Executive Committee, in Albacete, Spain, in April 2007, at the time of the XI Congress of the Spanish Society for Horticultural Science (SECH). The IHC Lisboa 2010 booth in Seoul received many visitors interested in receiving information about the Congress. We used the opportunity to display the congress poster, to distribute congress bookmarkers and pins, and to relay information about Lisbon and horticulture in the Iberian Peninsula. A video highlighting the main features of Spanish horticulture was shown at the closing dinner.



The congress theme is *Science and Horticulture for People*: **science**, because horticultural development and innovation is fuelled by scientific knowledge and the congress is directed to scientists addressing horticulture needs; and **people** - scientists, teachers and students, key players in the development of horticulture; growers and businessmen involved in the horticultural industry; and finally, consumers, who constitute the final objective of the work of scientists, growers and horticulturists. We intend that the congress stresses science and reaches people.

The Congress will interact with the horticultural industry. There will be opportunities for the participants to listen to the industry needs and desires related to research for horticultural innovation. Horticultural science must address horticultural needs and this perspective will be highlighted during the congress. We are expecting that colloquia or workshops sponsored by the industry will deal with themes of current impact and importance.

Lisbon is blessed with a pleasant climate due to its location on the Atlantic coast, and contains excellent hotel and congress facilities. Although located on the western edge of Europe, Lisbon has good flight connections worldwide. The sunny weather with refreshing breezes from the Atlantic makes summer a very pleasant time to enjoy the city. In August air temperature may go up to 30°C during mid-day, but the air is dry and salubrious, and the temperature is very pleasant in the evening. Lisbon is surrounded by horticulture and major production areas of Portugal and Spain can be reached in only a few hours driving. The Iberian Peninsula, shared by Spain and Portugal, is a land nurtured by old civilizations but now features the most modern and innovative of horticultural technologies.

Lisbon, one of the most beautiful and pleasant European cities, awaits you. There is much to enjoy including the monuments related to the discoveries, baroque churches and palaces, museums, old streets, and especially *fado*, the unique music of Lisbon. There is a plethora of wonderful restaurants with a lively atmosphere. Enjoy the monuments, the ambience, the curiosities, the views, and take a break and relax by the Tagus River at the end of the day.

The diversity of the horticultural industry in the Iberian Peninsula is one of the highlights of the congress. In Portugal and Spain, horticulture represents above 50% of the gross agricultural product. Spain is well known for the enormous production and export of fruit, vegetables and ornamentals and is a world leader in citrus and olives. During the post-congress tours the participants will have the opportunity to interact with the latest developments in Mediterranean horticulture, but also to visit places of rare natural beauty, many classified with World Heritage status. History and traditions are still maintained in both Portugal and Spain despite the fast pace of technological development.

Comércio Square, Lisbon.

Horticulture in the Iberian Peninsula is advanced through research and development carried out by universities and research centres. There are over 20 universities offering horticultural degrees in Portugal and Spain, as well as many

The Tagus and the 25th April Bridge, Lisbon.

Congress booth at the 27th IHC in Seoul.

scientific, agriculture-related research centres, mostly public, but some of them belonging to multinational companies involved in breeding and seed production.

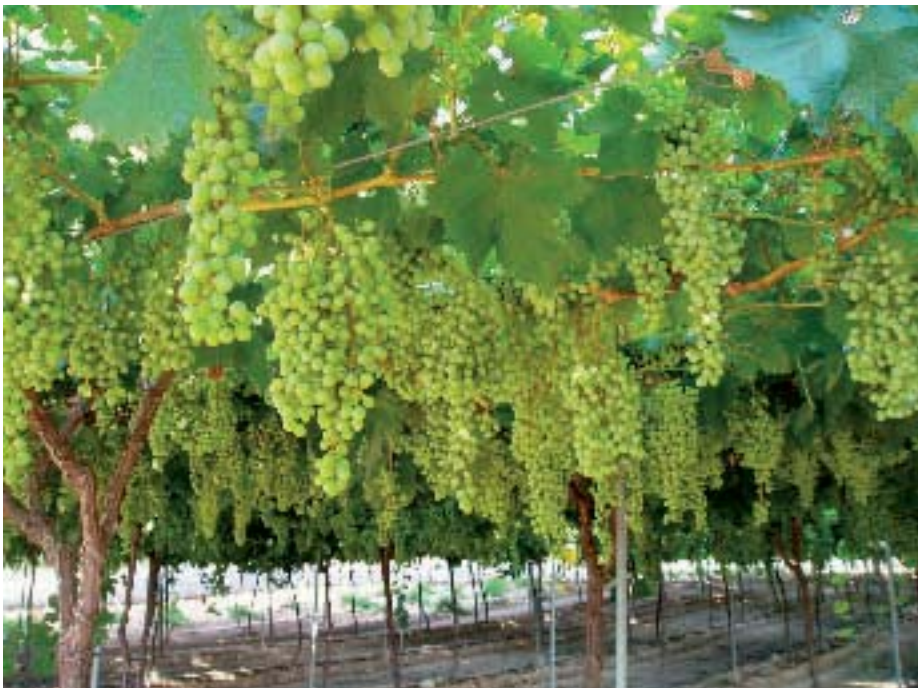
APH and SECH, the two partner Societies in the organisation of the 28th IHC, have a long tradition of collaboration in the organisation of scientific events. The first joint event of the two societies was a meeting on protected cultivation that took place in the Algarve, Portugal, in 1978. Other initiatives followed such as the 1990 Iberian Congress of Horticultural Sciences, which is continued every two years alternating between both countries. These conferences with an average attendance of 500, are a means for increasing the interaction between scientists from both countries. The joint organisation of the IHC is a step further in the co-operation between the two Societies.

Ornamental citrus.

The Congress in Lisbon will follow the models used in Toronto and Seoul and will include colloquia, symposia, workshops, and poster presentations. Thematic sessions including posters will be a novelty of the Congress. The opening ceremony is scheduled for Sunday September 22 and the Congress will last from Monday to Thursday. Friday to Sunday will be used for technical visits in Portugal and in Spain, and one-day workshops are planned.

The Bica lift, Lisbon.

Table grapes.



The congress webpage at *www.IHC2010.org* is already active. It includes general information about the Congress, the provisional programme, and news. There are also links with Lisbon and with relevant horticultural sites in Portugal and Spain. Visit the site to get a perspective of Lisbon and about the horticulture in the Iberian Peninsula. You can pre-register for the congress and automatically receive the information being released.

Biotechnology and Horticulture

Marie-Christine Daunay, Jacques Boccon-Gibod, Alain Cadic and Marianne Mazier

The term "biotechnology," first devoted to in vitro techniques, includes now also a full range of molecular techniques. All of them have been set up on or applied to horticultural plants, which display particularly rich combinations of biological features and uses, offering therefore a wide biological field for testing their workability. Whenever a new technique is initiated, the number of species to which it is experimentally applied increases dramatically, and therefore a very abundant literature becomes available. This paper reviews biotechnological techniques and their applications, within the two major fields of horticulture: (1) production of plants or compounds, and (2) crop improvement.

HISTORICAL REVIEW

Biotechnology applied to plants started in 1902 with the first experiments of Haberlandt in culturing plant cells. In vitro culture was born in 1934 when White succeeded in the unlimited growth of isolated tomato roots in a liquid medium. Identification and knowledge of essential plant growth hormones progressed rapidly: auxins (Kögl et al., 1934), gibberellins (Yabuta et al., 1941), kinetin (Miller et al., 1955), cytokinins (Letham, 1967), and the morphogenetic control by the auxin/kinetin ratio (Skoog and Miller, 1957). In 1962, Murashige and Skoog developed their famous culture medium, which contains a high amount of mineral salts, group B vitamins, sucrose, auxin and cytokinin. In 1963, Okhuma et al. identified abscisic acid (ABA), the first growth inhibitor. In vitro culture progressed rapidly. Milestones included: indefinite culture of carrot callus (Gautheret, 1939); virus elimination by meristem culture of dahlia (Morel and Martin, 1952); cultivation of isolated cells in liquid medium (Muir et al., 1954); somatic embryogenesis obtained from carrot roots (Steward, 1958; Reinert, 1958); micropropagation of *Cymbidium* orchids (Morel, 1960); haploids obtained from anther culture of *Datura inoxia* (Guha and Maheshwari, 1964) and of *Nicotiana tabacum* (Bourgin and Nitsch, 1967); regeneration of plants from tobacco protoplasts (Takebe et al., 1971); regeneration of the first interspecific somatic hybrid from the fusion product of protoplasts of two *Nicotiana* species (Carlson et al., 1972), and from the fusion between tomato and potato protoplasts (Melchers et al., 1978); first uses of *Agrobacterium tumefaciens* Ti plasmid as vector for introducing foreign DNA into plant cells (Herrera-Estrella et al., 1983; Hernalsteens et al., 1983; Zambryski et al., 1983); creation of the first transgenic plants of tobacco (Barton et al., 1983; Caplan et al., 1983); and the establishment of the binary vector system of *Agrobacterium tumefaciens* for genetic transformation (Bevan, 1984).

Genetics progressed rapidly in the 20th century after the rediscovery of Mendel's results in 1900. The mutations studied by T.H. Morgan and H.J. Müller on *Drosophila melanogaster* (fruit fly) gave rise to the concepts of the genetic operational unit (the gene) and of the genetic map. DNA was purified at the end of the 1930s, chemically identified (Avery et al., 1944), and its spatial structure was elucidated (Franklin and Gosling, 1953; Watson and Crick, 1953 a,b; Wilkins et al., 1953). Beadle and Tatum (1941) proposed the hypothesis about a probable link between one gene and one enzyme (later, one polypeptidic chain). In 1955, Grumberg-Manago and Ochoa isolated the enzyme responsible for the catalysis of polyribonucleotides (polynucleotide phosphorylase), and in 1956 A. Kornberg et al. isolated polymerase. The role of messenger RNA as well as the genetic regulations were discovered by Monod et al. (1961) and the genetic code (correspondence between base triplets and amino-acids) was deciphered (Nirenberg et al., 1965; Holley et al., 1965). The many molecular tools developed from the beginning of the 1970s, as well as the discovery of the polymerase chain reaction (Mullis et al., 1986; Mullis and Faloona, 1987) set the basis for most modern and fast developments of biotechnologies based on DNA, RNA, and proteins. The first plant genomes were sequenced: *Arabidopsis* in 2000 (The *Arabidopsis* Genome initiative) and rice in 2002 (Jun Yu et al., 2002; Goff et al., 2002). These are exciting times for genetics.

PRODUCTION OF PLANTS AND COMPOUNDS

Virus Elimination

Since meristems are most often virus free, it is possible to regenerate healthy plants from their in vitro culture. The cleansing rate is generally inversely proportional to the explant size. This technique is especially useful for vegetatively propagated species that are often chronically infected by various viruses, although symptoms are not always visible. The plants obtained from meristem culture can be used directly, but most often they are used as mother plants for conventional vegetative propagation to produce healthy materials for field cultivation. Saving of potato cultivars from degeneration was achieved by G. Morel and C. Martin as soon as 1955. The production of chinese artichoke (*Stachys sieboldii*) was almost abandoned in France in the 1970s because of yield depression, but was saved by the production of healthy tubers obtained by meristem culture, which boosted yield up to 300% (Boccon-Gibod, 1980). Garlic (Chovelon et al., 1990) and other crops such as artichoke (Pécaut et al., 1983), cauliflower (Crisp, 1974), forsythia (Duron, 1977) and banana (Vuylsteke, 1989) benefited from this technique. In France, in vitro virus elimination is now completely integrated in the production of healthy material for crops such as strawberry, raspberry, *Prunus* species, garlic, and potato (Navatel, 1990; Anon., 2001).

Failure of direct meristem culture can be overcome by grafting the small meristematic tips onto micro-rootstocks obtained from seeds grown in vitro. This technique is largely used by several countries for cleansing *Citrus* (Navarro, 1981). In addition to regenerating virus-free material, this technique presents the great advantage of producing plants able to set fruits after a shortened juvenile period since the scion keeps the physiological age of its mother plant.

Micropropagation

In vitro culture of any explant (meristem, bud, shoot, node, internode, leaf, petal, root) makes possible vegetative cloning by axillary bud (preexistent bud, which lies at the junction of stem and petiole) or adventitious shoot multiplication from neo-formed (adventitious) buds. Within one year, the multiplication factor can be enormous (10^6 to 10^7). Various explants can undergo direct morphogenesis (adventitious buds or somatic embryos) or indirect morphogenesis (dedifferentiation stage leading to callogenesis, which is then followed by the initiation of adventitious buds). Indirect morphogenesis can induce genetic instability, and the control of genetic conformity during the in vitro

Industrial scale micropropagation: (A) growth room; (B) media preparation; and (C) transfer room. (Courtesy of Agromillora Catalana, S.A., Barcelona, Spain.)

phase is often necessary. Direct morphogenetic methods, when available, are preferred in practice. Solid, semi-solid, or liquid culture systems (Hvoslef-Eide and Preil, 2005) are used for micropropagation. A recently designed technology called "temporary immersion systems" (Etienne and Berthouly, 2002) improves the number and the quality of adventitious buds or somatic embryos produced via organogenesis, and makes easier their development into viable plantlets. There are many advantages to micropropagation: reduced weight and volume of plants, reduction of pathogens, decreasing the number of multiplication cycles in the field, increasing the multiplication rate and speed, easier propagation of plants difficult to reproduce (e.g. orchids) or of particularly valuable heterozygous genotypes. The main disadvantages are the higher cost of plants and technical difficulties such as unexpected somaclonal variation, hyperhydricity of tissues and plantlets, production of unwanted phenolics, interaction of in vitro propagation with growth features (juvenile vs. mature or orthotropic vs. plagiotropic), and accidental bacterial contamination. At present most horticultural species can be micropropagated by axillary bud or adventitious shoot multiplication, and this technique became a commercial practice for a wide range of species such as cauliflower, garlic, onion, potato, banana, pineapple, *Prunus* rootstocks (e.g. GF 677, MrS 2/5, Penta, Tetra, Myrobalan 29C), apple and citrus rootstocks, grapevine, foliage plants, and ornamentals (*Gerbera, Saintpaulia, Spathiphyllum*, orchids). *Phalaenopsis* production is organised internationally in one cooperative venture between USA, China, Japan, and The Netherlands (Griesbach, 2003). Micropropagation can also be helpful for multiplying parents of commercial hybrids of some crops, such as those of cauliflower and broccoli (Ruffio-Chable and Hervé, 1999). For asparagus, heterozygous parents of some clonal hybrid cultivars are micropropagated, and in some cases, one of the two homozygous parents of F_1 hybrids (Corriols et al., 1990; Doré, 1975; Doré, 1990).

In vitro somatic embryogenesis is another form of vegetative propagation. Somatic embryos reproduce the mother plant genotype from its somatic cells and behave exactly the same as zygotic embryos. Although there are natural cases of somatic embryogenesis such as polyembryony in *Citrus*, mango and *Pinus*, the induction of somatic embryogenesis requires the use of culture media specific to organ and species. Bioreactor technology is used for mass production of somatic embryos, with average yields of about $4x10^4$ to $4x10^5$ embryos/L. Somatic embryogenesis is used for the mass propagation of banana (Cote et al., 1996; Bakry et al., 2001) and of hybrid cultivars of coffee (Charrier and Eskes, 2001; Etienne et al., 2002). Nestlé Company produced and planted some $3x10^5$ somatic embryo derived coffee plants (Ducos et al., 2003) and produced some 2 million plants in 2006 (D. Courtois, Nestlé, pers. com.). This technique is also applied to oil palm (Jacquemard et al., 2001) where it is the only vegetative propagation method available, and *Liquidambar* (Vendrame et al., 2003). The exploitation of somatic embryogenesis is expanding and new types of bioreactors are being developed. This technique could lead to the creation of artificial seeds by wrapping somatic embryos in an artificial seed coat, such as alginate beads, but the technical difficulties have not been overcome.

In Vitro Production of Compounds

Plant cell and tissue have the potential of producing many compounds of interest. Cultures of callus, cell suspension, immobilized cell and transgenic hairy roots are processed into bioreactors for industrial or semi-industrial production of various secondary metabolites used as pharmaceuticals, flavour, and fragrance ingredients, or food additives, which are synthesized by natural or genetically engineered plant cells. The first patent for the production of a plant substance by plant tissue culture methods on a large scale was taken by J.B. Routien and L.G. Nickel in 1956. The first in vitro industrial production was developed by Mitsui Petrochemicals Industry (Japan) in 1983 for the medicinally valuable naphthoquinone pigment shikonin from *Lithospermum erythrorhizon*. In 1987, Fontanel and Tabata gave an overview of the production of secondary metabolites from cell and tissue culture. At present, metabolites produced include alkaloids (vincristine and vinblastine), terpenoids (taxol), steroids (diosgenin), saponins, phenolics, and flavonoids (Mulabagal Vanisree et al., 2004). Yet, in spite of technical progress and several major advantages of in vitro systems over conventional cultivation (such as emancipation from climatic or pathological constraints, reduction of labour costs, productivity enhancement thanks to genetic selection of high yielding cell strains, automated control of cell growth, rational regulation of metabolite processes, and easy extraction of organic substances), the marketing of such products is still limited. Several companies are currently investigating the feasibility of the commercial production by cell cultures of tobacco, rice, soybean, and tomato, of therapeutically valuable recombinant proteins, such as monoclonal antibodies, human serum albumin and human erythropoietin (Hellwig et al., 2004).

CROP IMPROVEMENT

Conservation of Genetic Resources

Micropropagation can be exploited for long term conservation of valuable genetic stock such as *Allium* spp. male sterile material, diverse heterozygous or haploid plants (Kästner et al., 2001), as well as interspecific hybrids (Keller et al., 1996). It is currently used for storing genetic resources of vegetatively propagated plants (Ashmore, 1997) such as coffee (Florin et al., 2000) and can interfere with biodiversity protection, by rescuing endangered species (e.g. Kew Gardens activities, http://www.kew.org). Micropropagation can be combined with cryo-conservation, which means the storage of plant material (meristems or embryogenic cell suspensions) in liquid nitrogen at very low temperatures (-196°C). It is a promising option for long term storage of vegetatively propagated crops and for rescuing endangered crops. This method requires only limited space, protects the material from contamination, and involves little maintenance. This technique is used for crops such as potato (Schäfer-Menuhr et al., 1997), garlic (Keller, 2002), *Pelargonium* (Dumet et al., 2002), *Dianthus* (Tannoury et al., 1995), *Azalea* (Verleysen, 2005), *Malus* sp. (Towill et al., 2004), and oil palm (Dumet et al., 1993).

Creation of Genetic Variability

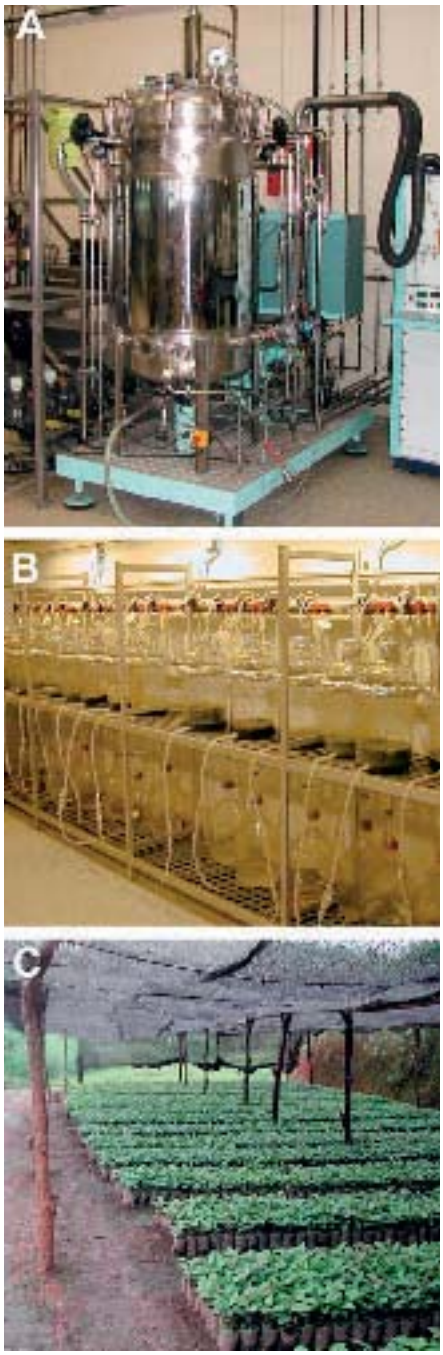
Artificial mutagenesis with physical or chemical methods can be applied to a great diversity of isolated cells such as microspores (haploid cells), protoplasts, or plant organs (buds, stem or

foliar explants). The results are variable depending on the species. The potential of mutagenesis has been explored with *Weigela* (Duron, 1992), and applied to lettuce protoplasts (Mazier et al., 1999). New fruit flesh colours and seedlessness have been produced this way in *Citrus* (Ollitrault and Luro, 2001), and improved organoleptic quality has been obtained in banana (Bakry et al., 2001).

Plant cells that pass through the callus stage can undergo somaclonal variations due to genetic modifications such as chromosome number changes, chromosomal deletions or translocations, activation of transposons, gene mutations, or epigenetic variations. When diverse pressures such as cold, toxins or salinity are applied during the regeneration process, it is possible to direct the selection towards plants with new interesting traits, which could not have been otherwise obtained. However, commercial use of somaclonal variants is possible only when the mutations are stable. Several ornamental new cultivars having original traits have been obtained with this technique, such as the *Pelargonium* 'Velvet Rose', a callus clone of *P. graveolens* 'Robert's Lemon Rose', with thick grey-green and densely pubescent leaves (Skirvin and Janick, 1976). 'Inovera' CHAMALLOW® (Duron et al., 2003) is a new cultivar of *Lavatera thuringiaca*, obtained from somaclonal variation of petiole fragments of the cultivar 'Bredon Springs'. 'Inovera' is tetraploid, and displays a compact growth habit, generous flower production, special leaf shape and larger flowers than those of the mother cultivar. Other valuable somaclonal changes include seed weight variants for pea (Masseret et al., 1987), and disease resistance, increased food quality and productivity for banana (Bakry et al., 2001). Somaclonal variation is extensively exploited for foliage plants improvement, as it is the case of *Syngonium* (22 somaclonal cultivars originated from 'White Butterfly'), *Anthurium*, *Aglaonema* and *Dieffenbachia* (Henny and Chen, 2003).

Embryo Rescue

In some cases zygotic embryos are unable to reach their full development in situ for various reasons. In vitro culture can save such embryos when isolated at an early developmental stage, and allows them to become whole plants. This technique is widely applied to embryos issuing from interspecific hybridizations, for vegetable species such as eggplant, lettuce and tomato (Dumas de Vaulx, 1982; Maisonneuve, 1987; Daunay et al., 1991), ornamentals such as *Pelargonium* (Scemama, 1991) and many other horticultural crops (Sharma et al., 1996). For *Citrus* species, polyploid embryos from various origins were rescued (Ollitrault and Luro, 2001). In banana, the fragile embryos that derive from manual pollinations have been rescued for breeding programmes since the 1960s (Smith et al., 2005).



Industrial scaleup for metabolite production and micropropagation: (A) 400 L bioreactor for production of secondary metabolites; (B) *Coffea* somatic embryos produced by a temporary immersion system; and (C) *Coffea* plants derived from somatic embryogenesis. (Courtesy of Nestlé Centre R & D, Tours, France.)

Somatic Hybridization

A plant cell, when rid of its pecto-cellulosic wall after an enzymatic treatment (cellulase and pectinase) becomes a protoplast and is able to fuse with another protoplast under appropriate conditions, such as electric pulse or presence of polyethylene glycol combined with high pH. When suitable conditions are then applied to the fusion product, cell divisions, callogenesis, and organogenesis can take place giving rise to a totally new plant, which has theoretically the nuclear genomes and the cell organelles of both parents. In practice, after nuclear fusion some chromosomes are often eliminated and the ploidy status of the somatic hybrid can be highly variable; generally only one of the parent chloroplast populations is retained (the other one being eliminated) and the mitochondria of both parents most often recombine. When nuclear fusion occurs, regenerated plants are called somatic hybrids, but when one of the parental nuclei is completely eliminated, the regenerated plants are called cybrids because only their cytoplasm is hybrid. The genetic interest of cybrids lies in the transfer into the cultivated species of traits that are coded by the cytoplasmic genome of a "donor" plant. There are various techniques used for obtaining cybrids, for instance by inactivating temporarily the nucleus of the protoplasts of the recipient parent with iodo-acetamide, and by killing by X or gamma rays the nucleus of the protoplasts of the donor parent. The distinction between the allo-fusion products and the autofusion products can be achieved by markers, such as a nuclear resistance to kanamycin of one parent, and defective chloroplasts of the same parent: in this case, the allo-fusion products are resistant to kanamycin and green.

Somatic hybridization has been used in research programmes on potato (Chauvin et al., 1992), eggplant (Sihachakr et al., 1994), lettuce (Chupeau et al., 1994; Maisonneuve et al., 1995) and *Pelargonium* (Nassour and Dorion, 2003) for introducing disease resistance available in distantly related species. Recently *Chrysanthemum* intergeneric somatic hybrids were obtained with rust resistance (Furuta et al., 2004). Somatic hybrids have also been obtained with *Allium, Asparagus, Hibiscus, Lilium, Mentha, Passiflora*, and *Primula* species. For *Citrus* species, this method is successfully used in breeding programmes for creating tetraploid rootstocks that combine desirable traits from both diploid parents (Grosser et al., 1998); it is also useful for creating tetraploid material that is either used directly as cultivars or in interploid crosses for generating seedless triploid cultivars (Guo et al., 2004).

Cybridization also has horticultural applications, for simplifying the production of hybrid seed by creating cytoplasmic-male-sterile (CMS) seed parents, which are then pollinated by male-fertile plants. Cytoplasmic male sterility discovered by Ogura (1968) in radish (*Raphanus sativus*), was first transferred into cabbage (*Brassica oleracea*) and rapeseed (*B. napus*) by sexual hybridization, but the "ogura" sterility was linked to other cytoplasmic traits, such as chlorophyll deficiency, atrophied nectaries, and ovary abnormalities (Bannerot et al., 1977). Cybridization proved to be an outstanding tool for correcting this dysfunctional nucleo-cytoplasmic interaction. The fusion of cabbage (or rapeseed) protoplasts carrying the "ogura"

cytoplasm with normal protoplasts of cabbage (or rapeseed), produced a normal chlorophyll efficiency (after exchange of the chloroplasts) and a normal flower morphology (nectaries and ovaries), thanks to mitochondrial genome recombinations (Pelletier et al., 1983; Pelletier, 1990). Cybridization was then used to engineer further male sterile cytoplasms of *Brassica napus* and *B. oleracea* (Pelletier et al., 1995). CMS has also been generated by cybridization for *Daucus carota* (Tanno-Suenaga et al., 1991), potato (Golmirzaie et al., 2003), and *Cichorium intybus* (Dubreucq et al., 1999).

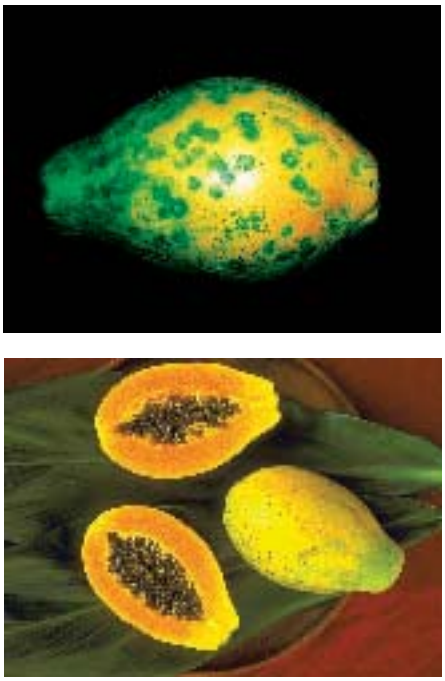
Haploid Production

Haploid plants can be obtained naturally or by numerous artificial in situ or ex situ in vitro methods applied to male gametophyte (immature pollen grains in or out of the anthers) or to the female gametophyte (embryo sac). In this latter case, direct in vitro culture of ovules is possible, as well as the in situ induction of embryo development by pollination with a distant species or with irradiated pollen having lost its fertility, followed later on by in vitro embryo rescue from the endosperm-free seeds. Haploids are very often sterile, and the doubling of their chromosome number (spontaneous or induced, if needed) is necessary for the restoration of their fertility. Haplo-methods present many advantages for geneticists and breeders, namely (1) the rapid obtaining of homozygous material; (2) the obtaining of direct products from meiosis (which increases the probability to obtain multirecessive genotypes); (3) the simplification of genetic analysis; and (4) the possibility of realizing interspecific hybridizations between species of different ploidy levels (very useful for tuberiferous *Solanum* species).

Androgenesis in the broad sense (anther or microspore culture) has been applied very successfully in breeding programmes of vegetable crops such as asparagus (Doré, 1990), diverse Brassicaceae such as cabbage, cauliflower, broccoli and pakchoi (Chauvin et al., 1993; Doré and Dumas de Vaulx, 1990; Cao et al., 1990; Cao et al., 1994), eggplant (Anon., 1978; Dumas de Vaulx and Chambonnet, 1982), pepper (Sibi et al., 1979; Dumas de Vaulx et al., 1981; Dumas de Vaulx, 1990), potato (Dunwell and Sunderland, 1973; Foroughi-Wehr et al., 1977); apple and pear (Lespinasse et al., 1999). Gynogenesis was successful for melon (Sauton and Dumas de Vaulx, 1987), *Allium* species (Keller, 1990; Schum et al., 1993; Geoffriau et al., 1996; Keller and Korzun, 1996), apple (Zhang et al., 1988), pear (Bouvier et al., 1990), and *Gerbera* (Miyoshi and Asakura, 1996; Tosca et al., 1990). Haploids have been used for genetic analysis of pepper (Lefebvre et al., 1995; Caranta and Palloix, 1996) and apple (Bouvier et al., 2000).

Transgene Technology

Genetic engineering has been largely used for



Fruit of papaya infected with ringspot virus (top) and 'Sun Up', a resistant cultivar from transgene technology (bottom). Source: D. Gonsalves.

20 years for research purposes, mainly for a better understanding of animal, microbial or plant gene functions. This technique is now used more and more for breeding purposes. The allogenes to be transferred to a plant genome are engineered constructions including the encoding sequence for the gene of interest, edged by promoting and ending sequences. A marker gene, encoding most of the time for antibiotic resistance, is often introduced with the gene of interest to facilitate the identification and selection of the transformed plants. The two methods frequently used to transfer foreign genes are either the plant transformation via *Agrobacterium tumefaciens* or biolistics. The traits used in genetic engineering focus on various important horticultural characters for which natural diversity is insufficient, using natural genes already cloned as well as fully synthetic genes. Although the use of transgenic plants (or genetically modified organisms - GMOs) is very restricted in European agriculture because of consumer reluctance, field release of GMO is widespread in other countries, in particular for food or feed (maize, soybean, rapeseed) or industrial crops (cotton). Transgenic maize has now been approved in Spain.

The tomato 'Flavr-Savr' engineered in the 1980s by Calgene, using an antisense strategy (inhibition of the polygalacturonase enzyme involved in fruit maturation process) to extend fruit shelf life, was released in 1994 with the approval of the US Food and Drug Administration. It was the first historic and media-event example of genetic engineering applied to a horticultural crop, but while successful with consumers was unsuccessful commercially due to production and other problems (Janick and Goldman, 2003). Later on, transgenic insect or virus resistant potato, sweet corn and squash proved their interest in practice, but market resistance led to their withdrawal (transgenic potatoes) or limited their marketing in the U.S. (Bradford and Alston, 2004).

For fruits, transgenic research is active on strawberry, apple, pear and other crops for traits such as resistance to viruses, fungi, bacteria and insects, fruit quality, and rooting ability. Among the typical examples are fruit crops that are damaged by dangerous virus diseases. Papaya (Gonsalves et al., 2006) and plum (Scorza et al., 2003) were genetically modified following the pathogen-derived resistance concept. Both GM fruit trees are regarded as outstanding examples of technical success and serve as models for the control of virus diseases by biotechnology. Resistance to papaya ringspot virus does not exist within the cultivated papaya germplasm. Resistant material was obtained (Fitch et al., 1990) using biolistics to integrate a construct including the coat protein gene of a Hawaiian PRSV strain, into embryogenic tissues of Hawaiian cultivars that regenerated whole plants. The mechanism of resistance has been shown to be RNA mediated through post-transcriptional gene silencing. Later conventional crosses using transgenic material led to obtaining cultivars suitable for marketing, with a resistance efficient against the Hawaiian PRSV isolates (but only partially efficient or not efficient towards foreign isolates, in particular when heterozygous). The early involvement of the US agencies in charge of the deregulation of transgenic products led to the release of transgenic material by the growers as soon as 1998 and to the rescue of Hawaiian papaya production, which nowadays includes transgenic as well as conventional cultivars. The commercialisation of transgenic papaya was directed first to mainland USA, and then to Canada where they were legally accepted in 2003, but the Japanese market is still not open to it. Since PRSV threatens papaya production worldwide, several countries have developed similar genetic engineering strategies, by using local cultivars and constructs involving the coat protein gene of local PRSV strains, but progress towards commercialisation is slower than the program that was followed in Hawaii, for reasons that include different states of governmental programs dealing with transgenic crops as well as unsettled attitudes throughout the world towards GMOs. For broadening the spectrum of resistance, new high tech transgenic strategies, based on the molecular understanding of PRSV virus genome, are being developed in the USA.

Resistance of plum tree to plum pox virus - PPV (Ravelonandro et al., 1997; Malinowski et al., 2006), the most serious virus affecting *Prunus* species, has been successfully engineered. Using *Agrobacterium tumefaciens* as a vector,

Transgenic 'Honeysweet' plum resistant to Plum Pox Virus (PPV): (A) PPV symptoms on fruits of a susceptible plum clone; (B) leaves of susceptible clone (left) and leaves of resistant 'Honeysweet' (right); and (C) fruit of transgenic 'Honeysweet'. (Courtesy of M. Ravelonandro, INRA, Villenave d'Ornon, France.)

hypocotyl slices from open pollinated seed of 'Bluebyrd' plum were transformed with a gene construct encoding for PPV coat protein and two marker genes. Resistance to PPV was mediated through post transcriptional gene silencing (Scorza et al., 2001; Hily et al., 2005). RNA silencing in resistant transgenic plums, a natural defense, leads to the degradation of either the transgene mRNA transcript or the homologous virus RNA, in particular PPV RNA. The transgene insert is transferred as a single genetic locus and resistance is dominantly inherited (Ravelonandro et al., 1998). The engineered resistance is efficient against the major known serotypes of PPV (Ravelonandro et al., 2001). The first plum material of commercial quality obtained by this strategy, 'Honeysweet' (Scorza et al., 2005), heterozygous for the resistance, has been patented by the United States Patent Trademark Office in 2004 and is awaiting the approval of Animal Plant Health Inspection Service for its development as a commercial cultivar in the US where PPV has been recently discovered and causes disastrous damages (Levy et al., 2000). The future use of this cultivar is unpredictable in European areas contaminated by PPV, because of social resistance to GMOs. The successful results of Gonsalves et al. (2006) and Ravelonandro et al. (2000) indicate that the use of GMOs for combating severe pathogenic problems needs to be seriously considered as part of a general strategy integrating conventional cultivars, and adapted cultural practices as well.

Transgene technology applications to ornamentals have been recently reviewed by Tanaka et al. (2005). The very first result was obtained on *Petunia* in 1987 (Meyer et al., 1987). For foliage plants, transgenic technology aims at modifying plant forms and colours (Henny and Chen, 2003). More generally, the traits that are focused on are mostly related to flower colour (e.g. *Saintpaulia, Dianthus, Dendranthema, Limonium, Petunia, Anthurium, Dendrobium*), flower and leaf morphology (e.g. *Osteospermum, Pelargonium*), resistance to mostly viruses and insects (e.g. *Dendranthema, Dianthus, Zoysia, Petunia*), as well as some other traits such as rooting ability, herbicide resistance (Poaceae), production of secondary metabolites, resistance to cold, and fragrance.

For species that are used mainly as cut flowers, research has been developed to increase shelf life by working on ethylene regulation (*Dianthus*). Transgenic cultivars have been released for *Dianthus caryophyllus*. In 1996, the first cultivar with a modified anthocyanin biosynthetic pathway, leading to various new violet nuances, was released in Australia and some others were engineered to produce the so called Moon Series® (http://www.florigene.com/products/index.php). Increased shelf life, *Fusarium* resistance, higher productivity, and improved rooting ability of carnation are expected to be released (Zuker et al., 2001), as well as various orange nuances instead of yellow flowers of *Forsythia* (Rosati et al., 2003). Methodologies are still in progress for several major species such as *Gladiolus*, tulips, *Lilium* and others. Recently a Japanese company (Suntory Ltd) jointly with Florigene Company claimed success in obtaining transgenic rose flowers, containing the anthocyanin pigment delphinidin (http://www.florigene.com.au/news/news.php). The flowers from the transgenic material have a violet colour (the non-transgenic control material has pink flowers).

Technically speaking, transgenic technology is able to solve elegantly many horticultural problems. However, after the exciting period of research and development in horticulture at the end of the 1990s, the lack of commercial success led to a slow down. The commercial successes (papaya and novel flower colour) should extend to major horticultural crops. The best opportunity in the near future is to incorporate resistant traits for crops threatened with total destruction. However the release of transgenic plants into culture faces various obstacles. These include patent complications that increase costs, markets that are too small to offer investment returns, and especially consumer resistance to GMOs, although public acceptability might differ between ornamentals and edible species. Clearly much better communication between scientists and the public is essential for getting this technology accepted but the opposition is organized and emotional. Bradford and Alston (2004) and Thompson (2005) give an overview of the challenges that this technology must win for succeeding in horticultural crops. Technical and biological problems that need to be addressed are the establishment of "clean transgenic techniques" that yield transgenic plants without the incorporation of antibiotic resistance as a marker, and risk control to avoid transgene transfer or escape to non GM cultivars and wild relatives.

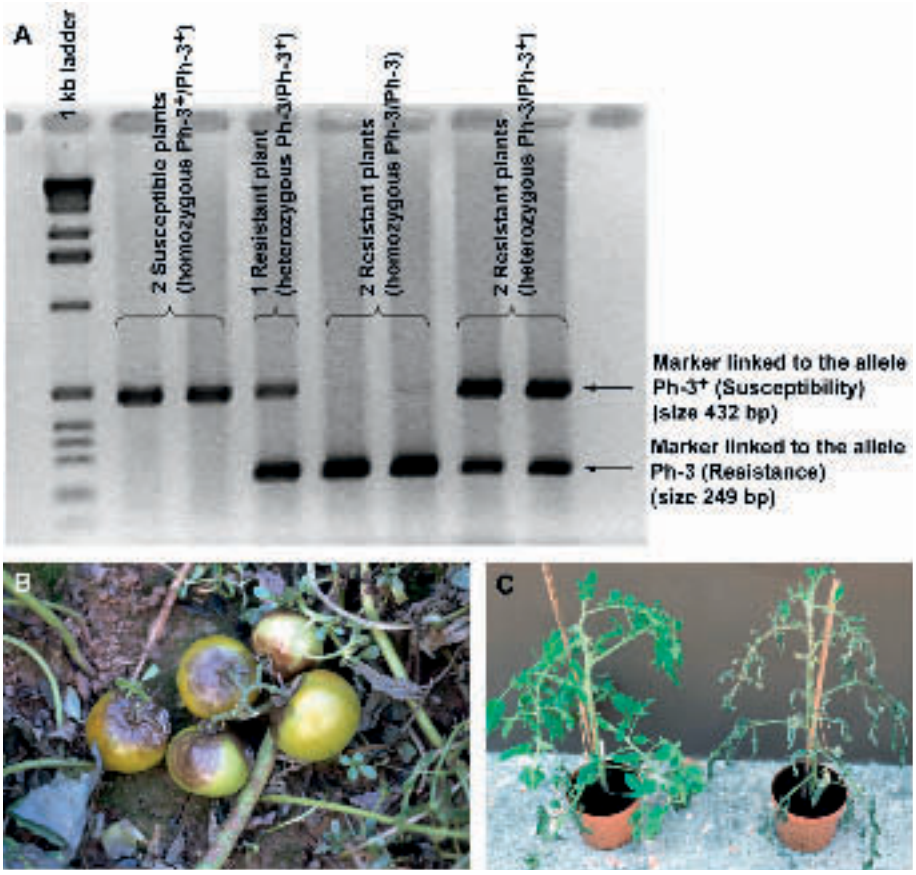
Genomics

Genomics basic goal is to unravel the organisation (structural genomics) and functioning (functional genomics) of entire genomes. Based on the study of DNA and RNA, it uses molecular tools (e.g. various types of markers, bacterial artificial chromosome (BAC) libraries, expressed sequence tag (EST) libraries, micro-arrays) and techniques (e.g. mapping, cloning, sequencing) that yield masses of data, analyzed thanks to the progresses of bio-informatics. Applied to various segregating progenies, mutants, plant organs at precise developmental stages, genomics is bringing a revolution to the understanding of crop genomes and development: (1) by yielding genetic and physical maps where genes and quantitative trait loci (QTL) controlling traits of interest are identified and located, (2) by characterizing gene functions and gene interactions, and (3) by giving access to the simultaneous analysis of the expression of thousands of genes.

Because of high cost, scientists attempt to use the knowledge obtained on model species for applications to other species. Comparative mapping in plant families such as Rosaceae and Solanaceae, which have been studied extensively, indicates that genome evolution within a family concerns mostly chromosome restructu-

Transgenic rose obtained by Florigene and containing the anthocyanin pigment delphinidin. Flowers have a violet color; the non-transgenic control has pink flowers. (Courtesy of Suntory Limited, Japan.)

ring (inversions or translocations) and that large chromosomal fragments are conserved between related species and genera. Molecular maps of *Prunus* species (almond, peach, apricot, cherry, wild material) constructed with different markers [restriction fragment length polymorphisms (RFLP), simple sequence repeats (SSR), amplified fragment length polymorphisms (AFLP) and isozymes] present a very strong colinearity without any major chromosomal rearrangement (Dirlewanger et al., 2004). Maps and gene positions obtained from populations of different *Prunus* species have been integrated into a single map, the so called general map for *Prunus*, developed from the original 'Texas' almond x 'Earlygold' peach map of Joobeur et al. (1998), which is being enriched with additional markers in the regions of interest. This map has been anchored to the peach physical map developed at Clemson University (http://www.genome.clemson.edu /gdr) and this complementary tool allows the development of markers focused on the specific genomic regions of interest. The study of genome evolution as well as the use of molecular tools in research and breeding is also advanced in the Solanaceae: by Gebhardt et al. (1991) for potato, Tanksley et al. (1992) for potato and tomato, Livingstone et al. (1999) for pepper, and Doganlar et al. (2002) for eggplant. For tomato, many genes have already been cloned, and molecular dissection and candidate gene strategy are commonly used for identifying and characterizing major QTL involved in fruit quality components (Causse et al., 2004). For pepper, QTL of resistance to several pests and diseases are currently mapped and their function investigated at the molecular level (Caranta et al., 1997, Pflieger et al., 1999). International collaborations on crop genomics are being set up for Rosaceae (http://www.genome.clemson.edu/gdr), Musaceae (http://www.musagenomics.org/), and Solanaceae (http://www.sgn.cornell.edu). They aim at sharing the work, at coordinating at the worldwide level the research initiatives, at facilitating the access to the information through its centralization into web searchable databases, and more generally at speeding up further progress such as the sequencing of entire genomes (e.g. for tomato http://www.sgn.cornell.edu/about/tomato_sequencing.pl).



Marker assisted selection in tomato, for resistance to *Phytophthora infestans*: (A) the allele Ph-3 confers resistance, the allele Ph-3$^+$ confers susceptibility, Ph-3 is dominant over Ph-3$^+$. The co-dominant markers used here allow the distinction between homozygous and heterozygous genotypes for Ph-3 (Courtesy of Vilmorin and Company, France); **(B) *P. infestans* on tomato fruits** (Courtesy of D. Blancard, INRA, Villenave d'Ornon, France); **and (C) *P. infestans* on a resistant genotype (left) and a susceptible one (right)** (Courtesy of A. Moretti, INRA, Montfavet, France).

Molecular Markers

Markers are protein based (such as isozymes, allozymes) or DNA based (such as RFLP, AFLP, SSR). Their use has been reviewed by several authors such as Lefebvre (2004) for pepper, Sanchez-Perez et al. (2004) for almond, and Rout and Mohapatra (2006) for ornamental plants. They are commonly used for many purposes in pre-breeding such as the identification and control of material obtained (e.g. somatic hybrids, haploids, vitro-variants) or maintained (e.g. genetic resources of vegetatively propagated crops) by in vitro methods (e.g. Potter and Jones, 1991). They are increasingly used for the management of genetic resources collections, because they are complementary tools to conventional descriptors (passport or morphological) for characterizing and structuring the genetic diversity, e.g. Baranger et al. (2004) for pea, Bakry et al. (2001) for banana, Zhebentyayeva et al. (2003) for apricot, and Mortreau et al. (2003) for *Hydrangea*.

Marker assisted selection (MAS), which involves preferably simple products of the polymerase chain reaction (PCR) as markers, is increasingly associated to breeding schemes, in particular for vegetables and fruit trees. A number of technical pre-requisites are necessary to use MAS. Most important is the availability of markers linked to the traits of interest for a given target species. Synteny features between phylogenetically related crop species (such as the similarity of the molecular structure of genetic maps, and of gene positions and functions) can contribute to enrich markers availability. For *Prunus* species, the synteny between the genomes and the set up of a consensus map, offer the potentiality to use markers linked to interesting traits in one species for screening for the same traits in another species (Dirlewanger et al., 2004). For instance, plum SSR are transferable to peach and almond (Mnejja et al., 2004). Second, the markers need to be closely linked (distance of 1cM or less) or even to be located within the major genes or major QTL controlling traits of interest, such as gametophytic self incompatibility, and fruit quality traits (flesh colour, flesh adherence to stone, fruit skin pubescence) in *Prunus* species. Co-dominant markers are preferred to dominant ones, since they indicate at once whether a given individual is homozygous or heterozygous. Some conditions are favourable to the use of the costly molecular techniques. This is the case for late expressing traits, such as self compatibility (e.g. Lopez et al., 2005), blooming time and fruit traits of crops having a long juvenile period (e.g. fruit trees), and of traits difficult or costly to identify or measure (e.g. pest and disease resistance). This is also the case when a large number of plants have to be screened, and/or when several traits are intended to be screened at once. Furthermore, it is usually not possible to evaluate simultaneously on the same plant reaction towards several fungi or viruses, or strains or pathotypes. If markers are used for screening, they can also be used to eliminate undesired genotypes. Markers can be used to

identify new alleles of known genes, and to speed up breeding programmes. However, their use, which requires efficient logistics in order to optimize the ratio between their cost and gains, cannot be exhaustive, because of genetic recombination and genetic background influence on gene expression. Thus, phenotypical checking for the presence of the desired trait(s) needs to be implemented regularly along the breeding process. Since 1995, MAS methods have been developed for many horticultural crops including potato (Barone, 2004), and have become routine procedures for many monogenic traits of tomato, pepper, melon, apple (Tartarini et al., 2002), and *Prunus* species (Srinivasan et al., 2005).

Markers are increasingly integrated in horticultural practices. Cultivars can be identified by fingerprint [see Doré et al. (2000) for a review, Aranzana et al. (2003) for peach, Struss et al. (2003) for cherry and Arnau et al. (2003) for strawberry]. These techniques are particularly useful in nurseries where numerous cultivars, difficult to differentiate on a morphological basis at the vegetatively propagated stage, are simultaneously multiplied at a large scale. Markers become increasingly part of the procedure for cultivar certification. They are routine tools for seed quality control (genetic identity and purity) operated by seed companies, in particular for the costly and high performing vegetable hybrids. The use of DNA markers for plant registration testing (Distinction, Uniformity, Stability), essential derivation determination, as well as for plant breeder's rights (Lefebvre et al., 2001) is still experimental, but it provides an additional tool over conventional morphological identification. The updated state of the art is available on the International Seed Federation web site (http://www.worldseed.org/).

CONCLUSION

At the very beginning of the 20th century, the rediscovery of Mendel's paper on inheritance in the garden pea led to a revolution in plant breeding methods that is still ongoing. In 1953, a half century later, Watson and Crick authored their famous paper on the structure of DNA. At the present time, a little more than a half century after Watson-Crick's paper, we are on the edge of what promises to be a complete transformation of biology, agriculture, and horticulture.

Since the 1950s, when Morel published the first paper on in vitro regeneration of virus-free dahlias and potatoes, tissue and cell culture, sometimes referred to as the soft side of biotechnology, has expanded to a myriad of techniques including micropropagation, embryo rescue, somatic hybridization, and haploidization, that have wide and expanding applications on horticultural plants. These include virus elimination, mass production of plants, production of various compounds, conservation and creation of genetic diversity, haploids production, and regeneration techniques to facilitate transgene technology. Although the original research was generally based on a few species, these techniques have been (and still are) successfully transferred to an enormous range of horticultural crops, demonstrating their practical and economic interest in addition to their ability to engender a deluge of academic publications. Micropropagation in the broad sense, from axillary or adventitious buds and somatic embryogenesis, to cell and tissue culture, has the widest applicability that has spread (1) to all sectors of horticulture (vegetables, fruits, ornamentals, medicinal, and aromatic plants), often on an industrial scale, and (2) to other economic sectors (food and pharmaceutical industry).

At the same time the rapid progress of DNA technologies in terms of diversity, efficiency, and precision, has demonstrated enormous potential, particularly in the field of transgene technology and marker assisted selection. Advances in plant genomics are yielding mind boggling insights into the genes, gene action, and processes responsible for horticultural traits of interest. Transgene technology has an extraordinary creative potential for horticulture, and the few applied examples released so far (papaya resistant to PRSV, violet carnations) give a foretaste of what could be expected.

Many of the in vitro methods presented in this paper are now routinely incorporated into the breeding and production of most horticultural plants. However, in DNA technologies there often is a disparity between their technical potentialities, as demonstrated by research, and the practical impact in the horticultural world. Genomics and molecular marker technologies are costly but with outstanding advances they are increasingly used for major horticultural crops where breeding engenders a high return. Transgene technology suffers a special status, since the gap between its potentialities and its applications in horticulture is enormous. The bottleneck is linked to social reluctance to GMOs in some countries, especially in Europe, for both rational and irrational fears involving perceived danger to health and threats to the environment through gene escape. The uncertainty signifies that we are at a crossroads, and clearly, there is a need of a longer and wider view, involving scientists, philosophers, and citizens. However, a careful analysis of the scientific and applied achievements of all facets of biotechnology indicates that advances in this area will be a key factor in the future development of science and horticulture.

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REFERENCES

Anon. (Research group on haploid breeding) 1978. Induction of haploid plants of *Solanum melongena* L. Proc. of Symp. on Plant Tissue Culture, May 25-30, 1978, Peking, Inst. Veg., CAAS, China.

Anon. 2001. Règlement Technique de Production, Contrôle et Certification des Plants, Règlement technique annexe "Plants de Pomme de Terre". Ed. SEDIS, Paris (FRA).

Aranzana, M.J., Carbo, J. and Arus, P. 2003. Using amplified fragment-length polymorphisms (AFLPs) to identify peach cultivars. J. Amer. Soc. Hort. Sci. 128(5):672-677.

Arnau, G., Lallemand, J. and Bourgoin, M. 2003. Fast and reliable strawberry cultivars identification using inter simple sequence repeat (ISSR) amplification. Euphytica 129:69-79.

Ashmore, S.E. 1997. Status report on the development and application of in vitro techniques for the conservation and use of plant genetic resources. Ed. IPGRI.

Avery, O.T., Mac Leod, M. and Mac Carthy, M.J. 1944. Studies on the Chemical Nature of Substance Inducing Transformation of Pneumococcal Types. Induction of Transformation by a Desoxyribonucleic Acid Fraction Isolated from *Pneumococcus* Type III. J. Experim. Medicine 79:137-158.

Bakry, F., Carreel, F., Caruana, M.L., Côte, F.X., Jenny, C. and Tézenas du Montcel, H. 2001. Banana. p.1-29. In: A. Charrier, M. Jacquot, S. Hamon and D. Nicolas (sci. eds.), Tropical Plant Breeding, (CIRAD), Science Publ. Inc. Enfield (NH) USA / Plymouth, UK.

Bannerot, H., Boulidard, L. and Chupeau, Y. 1977. Unexpected difficulties met with the radish cytoplasm in *Brassica oleracea*. Eucarpia Cruciferae Newsl. 2.

Baranger, A., Aubert, G., Arnau, G., Lainé, A.L., Deniot, G., Potier, J., Weinachter, C., Lejeune, I., Lallemand, J. and Burstin, J. 2004. Genetic diversity study of *Pisum sativum* using PCR-based and allozymes markers. Theor. Appl. Genet. 108:1309-1321.

Barone, A. 2004. Molecular marker-assisted selection for potato breeding. Amer. J. Potato Res. 81(2):111-117.
Barton, K.A., Binns, A.N., Matzke, A.J.M. and Chilton, M.D. 1983. Regeneration of intact tobacco plants containing full-length copies of genetically engineered T-DNA, and transmission of T-DNA to RI progeny. Cell 32:1033-1043.
Beadle, G.W. and Tatum, E.L. 1941. Genetic control of biochemical reactions in *Neurospora*. Proc. Natl. Acad. Sci. 27:499-506.
Bevan, M. 1984. Binary *Agrobacterium* vectors for plant transformation. Nucl. Acids Res. 12:8711.
Boccon-Gibod, J. 1980. Régénération du crosne du Japon par culture de méristèmes. C.R. Réunion Eucarpia Versailles (FRA) Application de la culture in vitro à l'amélioration des plantes potagères. p.31-37.
Bourgin, J.P. and Nitsch, J.P. 1967. Obtention de *Nicotiana* haploides à partir d'étamines cultivées in vitro. Ann. Physiol. Veg. 9(4):377-382.
Bouvier, L., Lespinasse, Y. and Schuster, M. 2000. Karyotype analysis of an haploid plant of apple (*Malus domestica*). Acta Hort. 538:321-324.
Bouvier, L., Zhang, Y.X. and Lespinasse, Y. 1990. Two methods of haploidization in pear, *Pyrus communis* L.: greenhouse seedling selection and in situ parthenogenesis induced by irradiated pollen. Theor. Appl. Genet. 87(1-2): 229-232.
Bradford, K.J. and Alston, J.M. 2004. Horticultural biotechnology: challenges for commercial development. Chronica Hort. 44(4):4-8.
Cao, M.Q., Charlot, F. and Doré, C. 1990. Embryogenèse et régénération de plantes de chou à choucroute (*Brassica oleracea* L. spp. *capitata*) par culture in vitro de microspores isolées. C.R. Acad. Sci. Paris, t.310, Série III:203-209.
Cao, M.Q., Li, Y., Liu, F. and Doré, C. 1994. Embryogenesis and plant regeneration of pakchoi (*Brassica rapa* L. ssp. *chinensis*) via in vitro isolated microspore culture. Plant Cell Rep. 13:447-450.
Caplan, A., Herrera-Estrella, L., Inze, D., Van Haute, E., Van Montagu, M., Schell, J. and Zambryski, P. 1983. Introduction of genetic material into plant cells. Science 222:815-821.
Caranta, C. and Palloix, A. 1996. Both common and specific genetic factors are involved in polygenic resistance of pepper to several potyviruses. Theor. Appl. Genet. 92:15-20.
Caranta, C., Palloix, A., Lefebvre, V. and Daubeze, A.M. 1997. QTLs for a component of partial resistance to cucumber mosaic virus in pepper: restriction of virus installation in host-cells. Theor. Appl. Genet. 94:431-438.
Carlson, P.S., Smith, H.H. and Dearing, R.D. 1972. Parasexual interspecific plant hybridization. Proc. Natl. Acad. Sci. 69:2292-2294.
Causse, M., Duffe, P., Gomez, M.C., Buret, M., Damidaux, R., Zamir, D., Gur, A., Chevalier, C., Lemaire-Chamley, M. and Rothan, C. 2004. A genetic map of candidate genes and QTLs involved in tomato fruit size and composition. J. Expt. Bot. 55(403):1671-1685.
Charrier, A. and Eskes, A.B. 2001. Coffee. p.128-152. In: A. Charrier, M. Jacquot, S. Hamon and D. Nicolas (sci. ed.), Tropical Plant Breeding, (CIRAD), Science Publ. Inc. Enfield (NH) USA / Plymouth, UK.
Chauvin, L., Rousselle, P., Borgat, C. and Rousselle-Bourgeois, F. 1992. Production and characterization of potato somatic hybrids. p.94-96. In: Proc. Joint Conf. EAPR-Breeding Section and Eucarpia Potato Section, Landerneau (France), 12-17 Jan. 1992.
Chauvin, J.E., Yang, Q., Le Jeune, B. and Hervé, Y. 1993. Obtention d'embryons par culture d'anthères chez le chou fleur et le brocoli et évaluation des potentialités du matériel obtenu pour la création variétale. Agronomie 13(7):579-590.
Chovelon, V., Leroux, J.P. and Blond, C. 1990. Sélection sanitaire de l'ail et de l'échalote: culture de méristèmes et régénération de variétés. p.141-150. In: C. Doré (ed.), Cinquantenaire de la culture in vitro chez les végétaux, Xè colloque de la section française de l'Int. Assoc. Plant Tissue Culture (Versailles, 24-25 Oct. 1989). Les Colloques de l'INRA (51).
Chupeau, M.C., Maisonneuve, B., Bellec, Y. and Chupeau, Y. 1994. A *Lactuca* universal hybridizer, and its use in creation of fertile interspecific somatic hybrids. Mol. Gen. Genet. 245:139-145.
Corriols, L., Doré, C. and Rameau, C. 1990. Commercial release in France of Andreas, the first asparagus all-male F1 hybrid ! (Cobreeding INRA-Darbonne-Vilmorin). Acta Hort. 271:249-252.
Cote, F.X., Domergue, R., Monmarson, S., Schwendiman, J., Teisson, C. and Escalant, J.V. 1996. Embryogenic cell suspensions from the male flower of *Musa* AAA cv. Grand Nain. Physiologia Plantarum 97(2):285-290.
Crisp, P. 1974. Meristem culture and the breeding of cauliflowers. Proc. Eucarpia meeting on *Brassica* breeding, Dundee, 1974.
Daunay, M.C., Lester, R.N. and Laterrot, H. 1991. The use of wild species for the genetic improvement of Brinjal Eggplant (*Solanum melongena*) and Tomato (*Lycopersicon esculentum*). p.389-412. In: J.G. Hawkes, R.N. Lester, M. Nee and N. Estrada-R (eds.), *Solanaceae* III, Taxonomy, Chemistry, Evolution. Pub. Royal Botanic Gardens, Kew, for the Linnean Society of London.
Dirlewanger, E., Graziano, E., Joobeur, T., Garriga-Calderé, F., Cosson, P., Howad, W. and Arus, P. 2004. Comparative mapping and marker assisted selection in *Rosaceae* fruit crops. Proc. Natl. Acad. Sci. (USA) 101(26):9891-9896.
Doganlar, S., Frary, A., Daunay, M.C., Lester, R.N. and Tanksley, S.D. 2002. A comparative linkage map of eggplant (*Solanum melongena*) and its implications for genome evolution in the *Solanaceae*. Genetics 161:1697-1711.
Doré, C. 1975. La multiplication clonale de l'asperge par culture in vitro: son utilisation en sélection. Ann. Amélior. Plantes 25(2):201-224.
Doré, C. 1990. Asparagus anther culture and field trials of di-haploids and F1 hybrids. p.322-345. In: Y. Bajaj (ed.), Biotechnology in Agriculture and Forestry, vol.12, Springer Verlag, Heidelberg.
Doré, C., Dosba, F. and Bari, C. (eds.) 2000. Molecular markers for characterizing genotypes and identifying cultivars in horticulture. Acta Hort. 546.
Doré, C. and Dumas de Vaulx, R. 1990. Utilisation de l'haploïdie dans l'amélioration de quelques espèces potagères (asperge, chou, piment, aubergine et melon). p.177-185. In: Cinquantenaire de la culture in vitro (Les colloques de l'INRA), Versailles, 24-25 Oct. 1989, ed. INRA.
Dubreucq, A., Berthe, B., Asset, J., Boulidard, L., Budar, F., Vasseur, J. and Rambaud, C. 1999. Analyses of mitochondrial DNA structures and expression in three cytoplasmic male-sterile chicories originating from somatic hybridisation between fertile chicory and CMS sunflower protoplasts. Theor. Appl. Genet. 99(7/8):1094-1105.
Ducos, J.P., Alenton, R., Reano, J.F., Kanchanomai, C., Deshayes, A. and Petiard, V. 2003. Agronomic performance of *Coffea canephora* P. trees derived from large-scale somatic embryo production in liquid medium. Euphytica 131:215-223.
Dumas de Vaulx, R. 1982. Applications de l'hybridation interspécifique à l'amélioration des plantes maraîchères. Le sélectionneur français 30:21-26.
Dumas de Vaulx, R. 1990. Haploidy and pepper breeding: A review. Capsicum Newlett. 8-9:13-17.
Dumas de Vaulx, R. and Chambonnet, D. 1982. In vitro anther culture in eggplant (*Solanum melongena* L.): stimulation of plant production by means of treatments at 35°C combined with low concentrations of growth substances. Agronomie 2:983-988.
Dumas de Vaulx, R., Chambonnet, D. and Pochard, E. 1981. Culture in vitro d'anthères de piment (*Capsicum annuum*). Agronomie 1(10):859-864.
Dumet, D., Engelmann, F., Chabrillange, N. and Duval, Y. 1993. Cryopreservation of oil palm (*Elaeis guineensis* Jacq.) somatic embryos involving a desiccation step. Plant Cell Rep. 12:352-355.
Dumet, D., Grapin, A., Bailly, C. and Dorion, N. 2002. Revisiting crucial steps of an encapsulation/desiccation based cryopreservation process: importance of thawing method in the case of *Pelargonium* meristems. Plant Sci. 163:1121-1127.
Dunwell, J.M. and Sunderland, N. 1973. Anther culture of *Solanum tuberosum* L. Euphytica 22:317-323.
Duron, M. 1977. Utilisation de la culture in vitro pour l'amélioration de l'état sanitaire de cultivars de *Forsythia* (Vahl). C.R. Acad. Sc. Paris, t.284, Série D, 3:83-185.
Duron, M. 1992. Induced mutations through EMS treatment after adventitious bud formation on shoot internodes of *Weigelia* cv. Bristol Ruby. Acta Hort. 320:113-118.
Duron, M., Belin, J. and Cadic, A. 2003. 'Inovera' CHAMALLOW®: new variety of *Lavatera* for the amateur market obtained by somaclonal variation. PHM Revue Horticole 448:34-36.
Etienne, H., Anthony, F., Dussert, S., Fernandez, D., Lashermes, P. and Bertrand, B. 2002. Biotechnological applications for the improvement of coffee (*Coffea arabica* L.). In vitro Cell. Dev. Biol. Plant 38:129-138.
Etienne, H. and Berthouly, M. 2002. Temporary immersion systems in plant micropropagation. Plant Cell, Tissue Organ Cult. 69:215-231.
Fitch, M., Manshardt, R.M., Gonsalves, D., Sligh, J.L. and Sanford, J.C. 1990. Stable transformation of papaya via microprojectile bombardment. Plant Cell Rep. 9:189-194.
Florin, B., Brulard, E., Ducos, J.P., Tessereau, H. and Petiard, V. 2000. Development of a simplified method for the routine cryopreservation of coffee germplasm collection. p.349-351. In: F. Engelman and H. Tagakie (eds.), Cryopreservation of tropical plant germplasm, current research and application, IPGRI, Rome.
Fontanel, A. and Tabata, M. 1987. Production of secondary metabolites by plant tissue and cell culture: present aspects and prospects. Nestlé Research News, 1986/87:93-105.
Foroughi-Wehr, B., Wilson, H.M., Mix, G. and Gaul, H. 1977. Monohaploid plants from anther

culture of a diploid genotype of *Solanum tuberosum* L. Euphytica 26:361-367.
Franklin, R.E. and Gosling, R.G. 1953. Molecular configuration in sodium thymonucleate. Nature 171:740-741.
Furuta, H., Shinoyama, Y., Nomura, Y., Maeda, M. and Makara, K. 2004. Production of intergeneric somatic hybrids of *Chrysanthemum* [*Dendranthema* x *grandiflorum* (Ramat.) Kitamura] and wormwood (*Artemisia sieversiana* J.F. Ehrh. ex. Willd) with rust (*Puccinia horiana* Henning) resistance by electrofusion of protoplasts. Plant Sci. 166:695-702.
Gautheret, R.J. 1939. Sur la possibilité de réaliser la culture indéfinie des tissus de tubercules de carotte. C.R. Acad. Sci. 208:118-120.
Gebhardt, C., et al. 1991. RFLP maps of potato and their alignment with the homologous tomato genome. Theor. Appl. Genet. 83(1):49-57.
Geoffriau, E., Kahane, R. and Rancillac, M. 1996. Variability of gynogenesis ability in onion (*Allium cepa* L.). Euphytica 94:37-44.
Goff, S.A., et al. 2002. A draft sequence of the rice genome (*Oryza sativa* L. ssp. *japonica*). Science 296(5565):92-100.
Golmirzaie, A.M., Tenorio, J., Serguen, F. and Ortiz, R. 2003. Cybrids and tetrad sterility for developing true potato seed hybrids. Ann. Appl. Biol. 143(2):231-234.
Gonsalves, D., Vegas, A., Prasartsee, V. and Drew, R. 2006. Developing papaya to control Papaya ringspot virus by transgenic resistance, intergeneric hybridization, and tolerance breeding. Plant Breed. Rev. 26:35-78.
Griesbach, R.J. 2003. Orchids emerge as major world floral crop. Chronica Hort. 43(3):6-9.
Grosser, J.W., Jiang, J., Louzada, E.S., Chandler, J.L. and Gmitter, F.G., Jr. 1998. Somatic hybridization, an integral component of citrus cultivar improvement. II. Rootstock improvement. HortScience 33(6):1060-1061.
Grumberg-Manago, M. and Ochoa, S. 1955. Enzymatic synthesis and breakdown of polynucleotides: polynucleotides phosphorylase. J. Amer. Chem. Soc. 77:3165-3166.
Guha, S. and Maheshwari, S.C. 1964. In vitro production of embryos from anthers of *Datura*. Nature 204:497.
Guo, W.W., Prasad, D., Serrano, P., Gmitter, F.G. Jr. and Grosser, J.W. 2004. Citrus somatic hybridization with potential for direct tetraploid scion cultivar development. J. Hort. Sci. Biotech. 79(3):400-405.
Haberlandt, G. 1902. Culturversuche mit isolierten. Pflanzenzellen. Sitzungsber Akad. Wiss. Wien, Math. Natur. Klasse 111, Abt 1:69-72.
Hellwig, S., Drossard, J., Twyman, R.M. and Fischer, R. 2004. Plant cell cultures for the production of recombinant proteins. Nat. Biotechnol. 22(11):1415-1422.
Henny, R.J. and Chen, Jianjun 2003. Cultivar development of ornamental foliage plants. Plant Breed. Rev. 23:245-290.
Hernalsteens, J.P., Van Vliet, F., De Beukeleer, M., Depicker, A., Engler, G., Lemmers, M., Holsters, M., Van Montagu, M. and Schell, J. 1983. The *Agrobacterium tumefaciens* Ti plasmid as a host vector system for introducing foreign DNA in plant cells. Nature 287:654-656.
Herrera-Estrella, L., Depicker, A., van Montagu, M. and Schell, J. 1983. Expression of chimaeric genes transferred into plant cells using a Ti plasmid-derived vector. Nature 303(5914):209-213.
Hily, J.M., Scorza, R., Webb, K. and Ravelonandro, M. 2005. Accumulation of the long class of siRNA is associated with resistance to Plum pox virus in a transgenic woody perennial plum tree. Mol. Plant-Microbe Interact. 18(8):794-798.
Holley, R.W., Apgar, J., Everett, G.A., Madison, J.T., Marquisee, M., Merrill, S.M., Penswick, J.R. and Zamir, A. 1965. Structure of a ribonucleic acid. Science 147:1462-1465.
Hvoslef-Eide, A.K. and Preil, W. 2005. Liquid culture systems for in vitro plant propagation. Springer, Dordrecht.
Jacquemard, J.C., Baudouin, L. and Noiret, J.M. 2001. Oil palm. p.338-360. In: A. Charrier, M. Jacquot, S. Hamon and D. Nicolas (sci. eds.), Tropical Plant Breeding, CIRAD, Science Publ. Inc. Enfield (NH) USA / Plymouth, UK.
Janick, J. and Goldman, I.L. 2003. Horticulture, horticulture science and 100 years of ASHS. Hortscience 38(5):883-900.
Joobeur, T., Viruel, M.A., de Vicente, M.C., Jaúregui, B., Ballester, J., Dettori, M.T., Verde, I., Truco, M.J., Messeguer, R., Battle, I., Quarta, R., Dirlewanger, E. and Arús, P. 1998. Construction of a saturated linkage map for *Prunus* using an almond x peach F2 progeny. Theor. Appl. Genet. 97(7):1034-1041.
Jun Yu, et al. 2002. Draft sequence of the rice genome (*Oryza sativa* L. ssp. *indica*). Science 296(5565):79-92.
Kästner, U., Klahr, A., Keller, E.R.J. and Kahane, R. 2001. Formation of onion bulblets in vitro and viability during medium-term storage. Plant Cell Rep. 20:137-142.
Keller, J. 1990. Culture of unpollinated ovules, ovaries, and flower buds in some species of the genus *Allium* and haploid induction via gynogenesis in onion (*Allium cepa* L.). Euphytica 47:241-247.
Keller, E.R.J. 2002. Cryopreservation of *Allium sativum* L. (garlic). p.37-47. In: L.E. Towill and Y.P.S. Bajaj (eds.), Biotechnology in Agriculture and Forestry v.50, Cryopreservation Plant Germplasm II, Springer-Verl., Heidelberg.
Keller, E.R.J. and Korzun, L. 1996. Haploidy in onion (*Allium cepa* L.) and other *Allium* species. p.51-75. In: S.M. Jain, S.K. Sopory and R.E. Veilleux (eds.), In vitro haploid production in higher plants, Vol. 3: Important selected plants (Ser. Current plant science and biotechnology in agriculture 25), Kluwer Acad. Publ., Dordrecht.
Keller, E.R.J., Schubert, I., Fuchs, J. and Meister, A. 1996. Interspecific crosses of onion with distant *Allium* species and characterization of the presumed hybrids by means of flow cytometry, karyotype analysis and genomic in situ hybridization. Theor. Appl. Genet. 92:417-424.
Kögl, F., Haagen-Smit, A.J. and Erxleben, H. 1934. Über ein neue Auxin ("Heteroauxin") aus Harn. Zeitschrift für physiologische Chemie 228:90.
Kornberg, A., Lehman, I.R., Besman, M.J. and Simms, E.S. 1956. Enzymic synthesis of deoxyribonucleic acid. Biochim. Biophys. Acta 21:197-198.
Lefebvre, V. 2004. Molecular markers for genetics and breeding: development and use in pepper (*Capsicum* spp.). p.189-214. In: H. Lörz and G. Wenzel (eds.), Biotechnology in Agriculture and Forestry. Molecular markers systems. Springer-Verlag, Berlin, Heidelberg.
Lefebvre, V., Goffinet, B., Chauvet, J.C., Caromel, B., Signoret, P., Brand, R. and Palloix, A. 2001. Evaluation of genetic distances between pepper inbred lines for cultivar protection purposes: comparison of AFLP, RAPD and phenotypic data. Theor. Appl. Genet. 102:741-750.
Lefebvre, V., Palloix, A., Caranta, C. and Pochard, E. 1995. Construction of an intraspecific integrated linkage map of pepper using molecular markers and doubled haploid progenies. Genome 38:112-121.
Lespinasse, Y., Bouvier, L., Djulbic, M. and Chevreau, E. 1999. Haploidy in apple and pear. Acta Hort. 484:49-54.
Letham, D.S. 1967. Chemistry and physiology of kinetin-like compounds. Ann. Rev. Plant Physiol. 18:349-364.
Levy, L., Damsteegt, V. and Welliver, R. 2000. First report of plum pox virus (Sharka disease) in *Prunus persica* in the United States. Plant Dis. 84(2):202.
Livingstone, K.D., Lackney, V.K., Blauth, J.R., van Wijk, R. and Jahn, M.K. 1999. Genome mapping in *Capsicum* and the evolution of genome structure in the *Solanaceae*. Genetics 152:1183-1202.
Lopez, M., Mnejja, M., Romero, M.A., Vargas, F.J., Arus, P. and Batlle, I. 2005. Use of Sf-specific PCR for early selection of self-compatible seedlings in almond breeding. In: M.M. Oliveira and V. Cordeiro (eds.), Options Mediterranéèennes, Serie A, Seminaires Mediterranéèns 63:269-274.
Maisonneuve, B. 1987. Utilisation de la culture in vitro d'embryons immatures pour les croisements interspécifiques entre *Lactuca sativa* L. et *L. saligna* L. ou *L. virosa* L., étude des hybrides obtenus. Agronomie 7(5):313-319.
Maisonneuve, B., Chupeau, M.C., Bellec, Y. and Chupeau, Y. 1995. Sexual and somatic hybridization in the genus *Lactuca*. Euphytica 85:281-285.
Malinowski, T., Cambra, M., Capote, N., Zawadzka, B., Gorris, M.T., Scorza, R. and Ravelonandro, M. 2006. Plant Dis. 90(8):1012-1018.
Masseret, B., Stegmark, R. and Petiard, V. 1987. Use of somaclonal variation as a source of variability for pea (*Pisum sativum* L.). Cell Culture Techniques Applied to Plant Production and Plant Breeding, IAPTC, Colloque Franco-Britannique, Angers, 8-9 Oct. 1987 (France).
Mazier, M., Maisonneuve, B., Bellec, Y., Chupeau, M.C., Souche, S. and Chupeau, Y. 1999. Interest of protoplasts for lettuce breeding. In: A. Lebeda and E. Kristkova (eds.), Eucarpia Leafy Vegetables 99, Palacky University, Olomouc, Czech Republic.
Melchers, G., Sacristan, M.D. and Holder, A.A. 1978. Somatic plants of potato and tomato regenerated from fused protoplasts. Carlsberg Res. Comm. 43:203-218.
Meyer, P., Heidmann, I., Forkmann, G. and Saedler, H. 1987. A new *Petunia* flower colour generated by transformation of a mutant with a maize gene. Nature 330(6149):677-678.
Miller, C.O., Skoog, F., Saltza von, M.H. and Strong, F.M. 1955. Kinetin, a cell division factor from desoxyribonucleic acid. J. Amer. Chem. Soc. 77:1392.
Miyoshi, K. and Asakura, N. 1996. Callus induction, regeneration of haploid plants and chromosome doubling in ovule cultures of pot gerbera (*Gerbera jamesonii*). Plant Cell Rep. 16(1-2):1-5.
Mnejja, M., Garcia-Mas, J., Howad, W., Badenes, M.L. and Arus, P. 2004. Simple sequence repeat (SSR) markers of Japanese plum transferable to peach and almond. Mol. Ecol. Notes 4:163-166.
Monod, J., Jacob, F. and Lwolf, A. 1961. Genetic regulatory mechanisms in the synthesis of proteins. J. Mol. Biol. 3:318-356.
Morel, G. 1960. Producing virus-free *Cymbidium*. Am. Orchid. Soc. Bull 29:495-497.

Morel, G. and Martin, C. 1952. Guérison de *Dahlia* atteints d'une maladie à virus. C.R. Acad. Sc. 235:1324-1325.
Morel, G. and Martin, C. 1955. Guérison de pommes de terre atteintes de maladies à virus. C.R. Acad. Agr. Fr. 41:472-475.
Mortreau, E., Bertrand, H., Lallemand, J. and Lambert, C. 2003. Collection of *Hydrangea*: genetic resources characterization. Acta Hort. 623:231-235.
Muir, W.H., Hildebrandt, A.C. and Riker, A.J. 1954. Plant tissues cultures produced from single isolated plant cells. Science 1119:877-878.
Mulabagal Vanisree, Chen-Yue Lee, Shu-Fung Lo, Satish Manohar Nalawade, Chien Yih Lin and Hsin-Sheng Tsay 2004. Studies on the production of some important secondary metabolites from medicinal plants by plant tissue cultures. Bot. Bull. Acad. Sin. 45:1-22.
Mullis, K., Faloona, F., Scharf, S., Saiki, R., Horn, G. and Erlich, H. 1986. Specific enzymatic amplification of DNA in vitro: the polymerase chain reaction. Cold Spring Harbor Symp. Quant. Biol. 51:263-273.
Mullis, K.B. and Faloona, F.A. 1987. Specific synthesis of DNA in vitro via polymerase catalyzed chain reaction. Meth. Enzymol. 155:335-350.
Murashige, T. and Skoog, F. 1962. A revised medium for rapid growth and bio-assays with tobacco tissue culture. Physiol. Plant 15:473-497.
Nassour, M. and Dorion, N. 2003. Somatic hybridization between *Pelargonium* x *hortorum* and *P.* x *domesticum* towards resistance to *Xanthomonas pelargonii*. Acta Hort. 612:75-81.
Navarro, L. 1981. *Citrus* shoot-tip grafting in vitro (STG) and its applications: A review. Proc. Int. Soc. Citricult. p.452-456.
Navatel, J.C. 1990. Intégration des techniques de culture in vitro dans les schémas de certification. Infos CTIFL 58:21-27.
Nirenberg, M.W., Leder, P., Bernfield, M., Brimacombe, R., Trupin, J., Rottman, F. and O'Neal, C. 1965. RNA codewords and protein synthesis, VII. On the general nature of the genetic code. Proc. Natl. Acad. Sci. 53:1161-1168.
Ogura, H. 1968. Studies on the new male-sterility in Japanese radish with special reference to the utilization of this sterility towards the practical raising of hybrid seeds. Mem. Fac. Agr. Kagoshima Univ. 6:39-78.
Okhuma, K., Lyon, J.L., Addicott, F.T. and Smith, O.E. 1963. Abscisin II, an abscission-accelerating substance from young cotton fruit. Science 142:1592-1593.
Ollitrault, P. and Luro, F. 2001. *Citrus*. p.55-77. In: A. Charrier, M. Jacquot, S. Hamon and D. Nicolas (sci. eds), Tropical Plant Breeding, CIRAD, Science Publ. Inc. Enfield (NH) USA / Plymouth, UK.
Pécaut, P., Dumas de Vaulx, R. and Lot, H. 1983. Virus free clones of globe artichoke obtained after in vitro propagation. Acta Hort. 131:303-309.
Pelletier, G. 1990. Protoplastes et échanges d'information cytoplasmique. p.205-210. In: C. Doré (ed.), Cinquantenaire de la culture in vitro chez les végétaux, Xè colloque de la section française de l'Int. Assoc. for Plant Tissue Culture (Versailles, 24-25 Oct. 1989), Les Colloques de l'INRA (51).
Pelletier, G., Primard, C., Vedel, F., Chetrit, P., Remy, R., Rousselle, P. and Renard, M. 1983. Intergeneric cytoplasmic hybridization in *Cruciferae* by protoplast fusion. Mol. Gen. Genet. 191:244-250.
Pelletier, G., Ferault, M., Lancemlin, D., Boulidard, L., Doré, C., Bonhomme, S., Grelon, M. and Budar, F. 1995. Engineering of cytoplasmic male sterility in vegetable by protoplast fusion. Acta Hort. 392:11-17.
Pflieger, S., Lefebvre, V., Caranta, C., Blattes, A., Goffinet, B. and Palloix, A. 1999. Disease resistance gene analogues as candidates for QTLs involved in pepper-pathogen interactions. Genome 42:1100-1110.
Potter, R.H. and Jones, M.G.K. 1991. Molecular analysis of genetic stability. p.71-91. In: J.H. Dodds (ed.), In vitro methods for conservation of plant genetic resources, Chapman and Hall, London, New York.
Ravelonandro, M., Briard, P. and Scorza, R. 2001. Significant resistance of transgenic plums against the four serotypes of plum pox potyvirus. Acta Hort. 550:431-435.
Ravelonandro, M., Scorza, R., Callahan, A., Levy, L., Jacquet, C., Monsion, M. and Damsteegt, V. 2000. The use of transgenic fruit trees as a resistance strategy for virus epidemics: the plum pox (sharka) model. Virus Res. 71:63-69.
Ravelonandro, M., Scorza, R., Renaud, R. and Salesses, G. 1998. Transgenic plums resistant to plum pox virus infection and preliminary results of cross hybridization. Acta Hort. 478:67-71.
Ravelonandro, M., Scorza, R., Bachelier, J.C., Labonne, G., Levy, L., Damsteegt, V., Callahan, A.M. and Dunez, J. 1997. Plant Dis. 81(11):1231-1235.
Reinert, J. 1958. Morphogenese und ihre Kontroll and Gewebekulturen aus Karotten. Naturwissenschaften 45:344-345.
Rosati, C., Simoneau, P., Treutter, D., Poupard, P., Cadot, Y., Cadic, A. and Duron, M. 2003. Engineering of flower color in *Forsythia* by expression of two independently-transformed dihydroflavonol 4-reductase and anthocyanidin synthase genes of flavonoid pathway. Mol. Breed. 12:197-208.
Rout, G.R. and Mohapatra, A. 2006. Use of molecular markers in ornamental plants: A critical reappraisal. Europ. J. Hort. Sci. 71(2):53-58.
Routien, J.B. and Nickel, L.G. 1956. Cultivation of plant tissues. US Patent, 2.747.334.
Ruffio-Chable, V. and Hervé, Y. 1999. Chou-fleur et brocoli. p.187-206. In: Technologies légumières, Bourgeois Tirilly (sci. eds), Coll. Agro-Alimentaire, Libr. Tech. et Doc. Lavoisier (ed).
Sanchez-Perez, R., Dicenta, F., Gradziel, T.M., Arus, P. and Martinez-Gomez, P. 2004. Application of molecular markers in almond breeding programmes. NUCIS Newslett. (12):9-12.
Sauton, A. and Dumas de Vaulx, R. 1987. Obtention de plantes haploïdes chez le melon (*Cucumis melo* L.) par gynogenèse induite par du pollen irradié. Agronomie 7(2):141-147.
Scemama, C. 1991. Etude des conditions de sauvetage d'embryons immatures de *Pelargonium*: application à des hybridations intra et interspécifiques entre *Pelargonium* x *hortorum* Bailey et *Pelargonium* x *hederaefolium* Bailey. Thèse Univ. Paris Sud Orsay.
Schäfer-Menuhr, A., Mix-Wagner, G. and Schumacher, H.M. 1997. Cryopreservation of potato to cultivars - design of a method for routine application in genebanks. Acta Hort. 447:477-483.
Schum, A., Mattiesch, L., Timmann, E.M. and Hofmann, K. 1993. Regeneration of dihaploids via gynogenesis in *Allium porrum* L. Gartenbauwissenschaft 58(5):227-232.
Scorza, R., Callahan, A.M., Levy, L., Damsteegt, V., Webb, K. and Ravelonandro, M. 2001. Post transcriptional gene silencing in Plum pox virus resistant transgenic European plum containing the Plum pox potyvirus coat protein gene. Transgenic Res. 10:201-209.
Scorza, R., Malinowski, T., Cambra, M., Zagrai, I., Hily, J.M., Callahan, A., Damsteegt, V., Briard, P. and Ravelonandro, M. 2005. 'Honeysweet' - a transgenic Plum pox virus resistant plum - development, field testing, and regulatory issues. Acta Hort. (in press).
Scorza, R., Ravelonandro, M., Malinowski, T., Cambra, M. and Minoiu, N. 2003. Potential use of transgenic plums resistant to Plum pox virus field infection. Acta Hort. 622:119-122.
Sharma, D.R., Kaur, R. and Kumar, K. 1996. Embryo rescue in plants - a review. Euphytica 89:325-337.
Sibi, M., Dumas de Vaulx, R. and Chambonnet, D. 1979. Obtention de plantes haploïdes par androgenèse in vitro chez le piment (*Capsicum annuum* L.). Ann. Amélior. Plant. 29(5):583-606.
Sihachakr, D., Daunay, M.C., Serraf, I., Chaput, M.H., Mussio, I., Haicour, R., Rossignol, L. and Ducreux, G. 1994. Somatic hybridization of eggplant (*Solanum melongena* L.) with its close and wild relatives. p.255-278. In: Y.P.S. Bajaj (ed.), Biotechnology in agriculture and forestry, vol.27, Somatic hybridization in crop improvement, Springer Verlag, Berlin, Heidelberg.
Skirvin, R.M. and Janick, J. 1976. 'Velvet Rose' *Pelargonium*, a scented *Geranium*. HortScience 11(1):61-62.
Skoog, F. and Miller, C.O. 1957. Chemical regulation of growth and organ formation in plant tissues cultured in vitro. Symp. Soc. Exp. Biol. Med. 11:118-131.
Smith, M.K., Hamill, S.D., Becker, D.K. and Dale, J.L. 2005. *Musa* spp. banana and plantain. p.366-391. In: R.E. Litz (ed.), Biotechnology of fruit and nut crops, Biotechnology in Agriculture Series n°29, CABI publ.
Srinivasan, C., Padilla, I.M.G. and Scorza, R. 2005. *Prunus* spp. almond, apricot, cherry, nectarine, peach and plum. p.512-542. In: R.E. Litz (ed.), Biotechnology of fruit and nut crops, Biotechnology in Agriculture Series, n° 29, CABI publ.
Steward, F.C. 1958. Growth and organised development of cultures cells. III. Interpretations of the growth from free cell to carrot plant. Amer. J. Bot. 45:709-713.
Struss, D., Ahmad, R. and Southwick, S.M. 2003. Analysis of sweet cherry (*Prunus avium* L.) cultivars using SSR and AFLP markers. J. Amer. Soc. Hort. Sci. 128:904-909.
Takebe, I., Labib, G. and Melchers, G. 1971. Regeneration of whole plants from isolated mesophyll protoplast of tobacco. Naturwiss. 5:318-320.
Tanaka, Y., Katsumoto, Y., Brugliera, F. and Mason, J. 2005. Genetic engineering in floriculture. Plant Cell, Tissue and Organ Culture 80:1-24.
Tanksley, S.D., et al. 1992. High density molecular linkage maps of the tomato and potato genomes. Genetics 132(4):1141-1160.
Tanno-Suenaga, L., Nagao, E. and Imamura, J. 1991. Transfer of the petaloid type CMS in carrot by donor recipient protoplast fusion. Japanese Journal of Breeding 41(1):25-33.
Tannoury, M., Vintejoux, C. and Dereuddre, J. 1995. Cryopreservation of carnation shoot-tips (*Dianthus caryophyllus* L.) by encapsulation-dehy-

dration. Acta Botanica Gallica 142(5):415-424.
Tartarini, S., Sansavini, S., Vinatzer, B.A., Barbieri, M., Patocchi, A., Gessler, C. and Gianfranceschi, L. 2002. Advances in marker-assisted selection for scab resistance in apple and cloning of the Vf gene. Acta Hort. 595:99-102.
The *Arabidopsis* Genome initiative. 2000. Analysis of the genome sequence of the flowering plant *Arabidopsis thaliana*. Nature 408(6814):796-815.
Thompson, K. 2005. Fruits, nuts, flowers and ornamentals, what's new in biotechnology for high value crops. New Ag Int. Mag. Dec. 2005:62-69.
Tosca, A., Lombardi, M., Marinoni, L., Conti, L. and Frangi, P. 1990. Genotype response to in vitro gynogenesis technique in *Gerbera jamesonii*. Acta Hort. 280:337-340.
Towill, L.E., Forsline, P.L., Walters, C., Waddell, J.W. and Laufmann, J. 2004. Cryopreservation of *Malus* germplasm using a winter vegetative bud method: results from 1915 accessions. CryoLetters 25(5):323-334.
Vendrame, W., Holliday, C.P. and Merkle, S.A. 2003. Clonal propagation of hybrid sweetgum (*Liquidambar styraciflua* x *L. formosana*) via somatic embryogenesis for ornamental application. Acta Hort. 625:241-247.
Verleysen, H. 2005. Development of cryopreservation strategies for woody ornamental plants. PhD thesis, Univ. Gent.
Vuylsteke, D.R. 1989. Shoot-tip culture for the propagation, conservation and exchange of *Musa* germplasm. Practical manuals for handling crop germplasm in vitro 2. Ed. IPGRI.
Watson, J.D. and Crick, F.H.C. 1953a. Molecular structure of nucleic acid: a structure for desoxyribose nucleic acid. Nature 171:737-738.
Watson, J.D. and Crick, F.H.C. 1953b. General implication of the structure of desoxyribonucleic acid. Nature 171:964-967.
White, P.R. 1934. Potentially unlimited growth of excised tomato root tip in a liquid medium. Plant Physiol. 9:385-600.
Wilkins, M.H.F., Stokes, A.R. and Wilson, H.R. 1953. Molecular structure of desoxypentose nucleic acids. Nature 171:738-740.
Yabuta, T., Sumiki, Y., Aso, K., Tamura, T., Igarashi, H. and Tamari, K. 1941. Agr. Chem. Soc. Japan 17:721-730.
Zambryski, P., Joos, H., Genetello, C., Leemans, J., van Montagu, M. and Schell, J. 1983. Ti plasmid vector for the introduction of DNA into plant cells without alteration of their normal regenerative capacity. EMBO J. 2:2143-2150.
Zhang, Y.X., Lespinasse, Y. and Chevreau, E. 1988. Obtention de plantes haploïdes de pommier (*Malus* x *domestica* Borkh.) issues de parthénogénèse induite in situ par un pollen irradié et culture in vitro des pépins. C.R. Acad. Sc., Paris, tome 307, série III:451-457.
Zhebentyayeva, T.N., Reighard, G.L., Gorina, V.M. and Abbott, A.G. 2003. Simple sequence repeat (SSR) analysis for assessment of genetic variability in apricot germplasm. Theor. Appl. Genet. 106:435-444.
Zuker, A., Shklarman, E., Scovel, G., Ben-Meir, H., Ovadis, M., Neta-Sharir, I., Ben-Yephet, Y., Weiss, D., Watad, A. and Vainstein, A. 2001. Genetic engineering of agronomic and ornamental traits in carnation. Acta Hort. 560:90-94.

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The Turfgrass Industry: Australia, New Zealand, and the Asia-Pacific Region

D.E. Aldous, K.W. McAuliffe and N.M. Power

Countries represented in the Asia-Pacific region include Singapore, Australia, New Zealand, Fiji, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, the Philippines, Taiwan, Thailand, and Vietnam. Across this region countries that exhibit a more maritime climate, such as Japan, China and Korea, manage the more sustainable warmer-season growing species such as Japanese lawngrass (*Zoysia japonica*), Korean lawngrass (*Z. matrella*), Korean velvet grass (*Z. tenuifolia*) or the more localized *Z. sinica* and *Z. macrostrachya* (Liu et al., 1998; Choi, 2006). The dominant cool-season grasses used in these areas include Kentucky bluegrass (*Poa pratensis*), redtop bentgrass (*Agrotis alba*), Penncross creeping bentgrass (*Agrostis palustris*), and red fescue (*Festuca rubra*). The cooler regions of Australia and the bulk of New Zealand use cool-season grasses, including the bentgrasses (*Agrostis stolonifera*, *A. canina*), ryegrasses (*Lolium perenne* and *L. multiflorum*), bluegrasses (*Poa pratensis*, *P. trivialis*) and the fescues (*Festuca arundinacea*, *F. rubra*, and *F. rubra* var. *commutata*). In the transition and warm-season growing areas, such as the remainder of Australia, the upper, warmer areas of the North Island of New Zealand, as well as much of the Asia-Pacific Region, such as Singapore, Fiji, Hong Kong, India, Indonesia, Malaysia, and the Philippines, grasses include the bermudagrasses (*Cynodon dactylon*, *C. tranvaalensis*), the paspalums (*Paspalum notatum*, *P. vaginatum*, and *P. distichum*), the buffalograsses (*Stenotaphrum secundatum*), kikuyugrass (*Pennesetium clandestinum*), Queensland bluecouch (*Digitaria didactyla*), and the carpetgrasses (*Axonopus affinis* and *A. compressus*). Some countries, such as New Zealand, also manage non-gramineous species, such as Cotula (*Leptinella dioica* and *L. maniototo*) and Starweed (*Plantago triandra*) for sport and recreation purposes. In recent years, there has been increasing interest in investigating the native grasses that show tolerance to localized conditions such as environmental stress (e.g. drought, temperature, salinity). Marine couch (*Sporobolus virginicus*), the weeping grasses (*Microlaena stipoides*, *M. tasmanica*), the wallaby grasses (*Austrodanthonia caespitosa*, *A. richardsonii*) and the red leg grasses (*Bothriochlora macra*, *B. decipiens*, *B. pertusa*) have shown potential as turfgrass surfaces in Australia (Aldous, 1999; Aldous and Chivers, 2002).

THE ASIA-PACIFIC TURFGRASS INDUSTRY

The Asia-Pacific region can be traditionally categorized into four categories, namely: turfgrass facilities (golf courses, bowling greens, horse racing tracks, sporting fields, sod farms, municipal parks, botanic gardens and reserves, residential and commercial lawns, roadsides, lawn cemeteries, public and private schools, airfields, and church, college and university grounds); manufacturing (equipment, seed, fertilizer, plant growth regulators, pesticides, irrigation systems); servicing (distributors and retailers, contracting services, soil and water testing laboratories) and education and training institutions (community colleges and/or universities, public and private research organizations, extension and outreach). However, there are considerable differences in the range and composition of these facilities throughout the Asia-Pacific region. For example sporting activities such as golf, soccer and racing are becoming very popular in many Asia-Pacific countries, often in an effort to promote tourism, yet the manufacturing and servicing components of these facilities are still provided by countries such as the United Kingdom, United States, Australia and New Zealand.

Figure 1. In Korea, the earthern tombs of the deceased have been estimated to cover as much as 1% of the national land space.

Figure 2. Approximately 200 new football stadiums, similar to this one in New Zealand, are under construction each year in mainland China.

In South Korea there were 281 golf courses in 2005, supporting some 12 million patrons, and some 10 new stadiums of 50,000 people capacity now servicing soccer. In China there are currently around 300 golf courses, 2000+ football (soccer) stadiums, 25 turf race courses, 30 turf bowling greens and 5,000 turf-related companies (Fig. 1). The number of turf facilities in mainland China is growing rapidly with approximately 200 new football stadiums, 6 new golf courses and 20 other synthetic sports grounds under construction each year (Fig. 2). Most golf courses within the Shanghai area use warm-season grasses, predominately bermudagrass and zoysiagrass. Greens are sprigged with Tifdwarf bermudagrass while the majority of courses use 419 bermudagrass on fairways, tees and roughs. In these areas the warm-season grasses are overseeded with rough bluegrass (*Poa trivialis*) or perennial ryegrass (*Lolium perenne*) over winter (Casey, 1999). In Japan the number of golf courses has been estimated at 2,460 comprising a total of 166,410 ha and averaging 67.6 ha per course. About 60% of these courses use *Zoysia japonica* or creeping bentgrass on the greens and 90% of the clubs use *Zoysia japonica* on the roughs and fairways. In addition there are some 120 public parks totaling 4,000 ha and some 2000 sports arenas (Fig. 3).

In countries such as Hong Kong and Taiwan, which are located between 25° to 22°N, *Zoysia japonica* is being introduced to replace the common bermudagrass on a number of golf courses and country clubs, as well as many football fields and public parks, as the latter has had difficulty adapting to the high heat and

Figure 3. Japanese lawn grass dominates some 120 public parks totaling 4,000 ha in Japan.

humidity in summer and to the dry, cold conditions in winter. Thailand's contribution to the turf industry has largely been through the development of some 200 golf courses, 100 of which are considered to be of a high standard (Suntisawasdi, pers. comm., 2005). In Vietnam the majority of the 10 golf clubs are located in the south of the country, mainly around Ho Chi Minh City. Principally foreigners have made up the bulk of the membership, but the number of local golfers is growing. In this part of the world, the wet tropics, broad-leafed carpet grass or cow grass (*Axonopus compressus*) thrives and is the dominant grass in most turf areas. Golf clubs and higher grade sports fields tend to prefer the introduced species, such as the Zoysiagrass strains and bermudagrass. Bermudagrass hybrids, such as Tifdwarf 328, Wintergreen and Tiffeagle are used in the greens. Low light quality and high humidity can make it difficult to get tight, high quality greens in this part of the world. The greens and tee boxes on many golf courses in Malaysia, Indonesia, Sri Lanka and Vanuatu, which lie between 5°-10°N and S of the equator, are dominated by bermudagrass and its hybrids, with Korean lawn grass and Korean velvet grass on the fairways.

In Australia some 180,000 ha of land has been dedicated to high-use sports and amenity turf. There are 1,500 golf courses (Anon., 2005), occupying some 48,000 ha, 2000 lawn bowling clubs, 722 city and shire councils maintaining parkland (Anon., 2006). According to the Australian Bureau of Statistics (Anon., 1998) there are 52,164 recreational parks and gardens in Australia as of June 1997 covering an area of 3.4 million ha. Power (2004, 2005) has also estimated that there are some 15,000 playing fields across Australia. This provides a ratio of 1 field per 1300 people, which compares favorably with Hall's (2005) estimate of 1 field per 1,000 people in the USA. In addition there are a large number of racetracks and sporting stadia. Principal grasses used in golf course management include bermudagrass fairways and bermudagrass hybrids tees and greens in the northern warmer-season areas and creeping bentgrass for the cool-season managed greens. Way (2000) revealed that New Zealand has some 60,000 ha of sport and amenity turf, of which 50% was council-owned land, 25% golf courses and 20% school grounds. Of the total turf area, approximately 50% (30,000 ha) has been classed as sports-related, with the remainder classed as passive turf area. The survey did not account for home lawns and roadside grassed areas, which would add considerably to the total passive turf area. However there has been a noticeable increase in the size and activity of the lifestyle/home lawn industry in both Australia and New Zealand over the past decade, which is reflected in the numerous home lawn maintenance franchises and new sod supply businesses around the country.

VALUE OF THE ASIA-PACIFIC TURFGRASS INDUSTRY

Although the full economic value of the turfgrass industry is yet to be determined, some early figures do exist in many Asia-Pacific countries. In South Korea, total sod production in 2005 was 3,000 ha and worth US$900,000 per annum (Joo, 2006). China has some 10,000 hectares of turf worth an estimated US$10,000 billion. Godfrey (2004) estimated that more than 4.5 billion euros have been spent on China's courses since 1984. The Hong Kong turf industry largely comprises five golf clubs, two horse racing tracks (Sha Tin and Happy Valley) and a number of sports fields and stadiums. The turf industry there employs in excess of 360 turf maintenance staff (Cribbes, pers. comm., 2005). Each of Thailand's 200 golf courses is reported to incur an annual maintenance cost of AUS$200-300,000, of which 50% accounts for salaries.

Research into accurately determining the value of the Australian and New Zealand turfgrass industries commenced in 2006, with work carried out at the New Zealand Sports Turf Institute and through The University of Melbourne in Australia. Early comparisons made with the US turfgrass industry, on a population basis, estimated that the Australian turfgrass industry may well encompass some 1.1 million ha, contribute some $AUS5.0 billion in maintenance costs, and employ some 80,000 people. In addition an estimated $AUS3.5 billion could be being spent on turf-related businesses and services, $AUS450 million on turfgrass sod, $AUS100 million on turfgrass seed, as well as an estimated payroll of more than $AUS300 million annually going back into the national economy (Aldous, 2003) (Fig. 4). A recent estimate of the direct annual expenditure costs of the Queensland turfgrass industry gave a figure of AUS$611 million (Aldous and Power, 2004) and in Western Australia, the total economic benefit attributed to community sports fields has been estimated at AUS$65 million in direct expenditure (maintenance, management, local and state government infrastructure development). With 7.4 million households in Australia averaging about 1/3 of

Figure 4. The nation-wide worth of the Australian sod industry has been estimated at $AUS450 million annually.

an acre (0.13 ha) there is approximately 2 million acres (808,000 ha) of lawn in Australia and this is considered one of the more expanding markets (Fig. 5). Australians spend proportionally $AUS3.0 billion on their lawns and gardens per year, or about $AUS150 per household. In New Zealand, sports and amenity turf cover 61,790 hectares, employ some 3,710 full-time employees and contribute an estimated $NZ329 million per year to the NZ economy. An estimated 4,000 volunteers are used on many New Zealand clubs to keep costs down.

Figure 5. Approximately 808,000 ha of lawn are maintained in Australia.

TURF RESEARCH IN THE ASIA-PACIFIC REGION

In Australia and New Zealand much of the turf research is conducted through the Universities, Technical and Further Education (TAFE) Institutes and State Departments of Agriculture/Natural Resources, with smaller programs being conducted by private industry, associations, and private consultants. In Australia turf research commenced in the three eastern States of Queensland, New South Wales and Victoria in the 1930's. Queensland's venture into turf was undertaken as early as 1934 by a small group of golf course enthusiasts. In the mid 1990's turf research in Queensland was rekindled by the public open space sector using private consultants, sponsored by local governments and the Department of Main Roads (Power, 2000). This provided the stimulus for today's turf research, which is largely conducted through the turf research group of the Department of Primary

Industries and Forestry, located at the Redlands Research Station, and private consultants working with local governments. In New South Wales the State Golf Association formed the Grass Research Bureau Ltd, in 1954, renamed the operation the Australian Turfgrass Research Institute, in 1970, until it closed its operation in the mid 1990's. Currently turf research is conducted through the amenity horticulture group at the University of Sydney at the Plant Breeding Institute at Castle Hill in Western Sydney, NSW. The University of Sydney also undertakes turf research through its postgraduate program, as well as working co-operatively with private contractors. In Victoria, The Victoria Golf Association has been investigating field trials on several Melbourne golf courses since 1938. In 1973 the Turf Research and Advisory Institute was established and provided excellent research until it closed its operation in 1992. Current research in the Victorian context is now largely conducted through the turf research program operating within the Faculty of Land and Food Resources at The University of Melbourne, as well as through individual private contractors and industry associations. In recent years turf research has also been conducted within the Faculty of Agriculture at The University of Western Australia.

Turf research in New Zealand was established as early as 1935 with the establishment of a Greenkeeping Research Committee within the NZ Golf Association. In 1949 this was re-organized into the NZ Sports Turf Institute, situated in the City of Palmerston North. The majority of turf research in New Zealand is carried out through this organization, often in partnership with other research organizations, such as Massey University or crown research institutes. The Institute is also the major provider of extension and training services to the NZ turf industry and, over the past decade, has offered its services to other Asia-Pacific countries (Fig. 6).

In South Korea turf research into breeding, management and production is conducted at a number of universities such as the Yonsei University, Wonju; Seoul National University, Seoul; Dankook University, Cheonan, the Turfgrass and Environment Research Institute, and Samsung Everland INC., Gunpo. In China, universities such as the South China Agricultural University, Guangzhou; Central South Forestry Science and Technology University, Changsha, Huan; as well as the Institute of Turfgrass, which is located within the Faculty of Agriculture, China Forestry, Beijing, are some higher education institutions that conduct research into turf. Turf research is also conducted at a number of universities in Japan, through the Japanese Society of Turfgrass Science, as well as organizations such as the Turfgrass R&D Organization of Japan in Toyoda, Shizuoka. Some turf research is also emerging from the Forest Research Institute Malaysia, in Kuala Lumpur, Malaysia.

Figure 6. The New Zealand horse racing industry has an export income of approximately $NZ69 million.

References

Aldous, D.E. 1999. International turfgrass management handbook. Butterworth Heinemann Press, Melbourne. 348p.

Aldous, D.E. 2003. Research and education imperatives for turf management in Australia. Acta Hort. 661:537-542.

Aldous, D.E. and Chivers, I.H. 2002. Sports turf and amenity grasses: a manual for use and identification. Landlinks Press. 120p.

Aldous, D.E. and Power, N.H. 2004. Environmental, social and economic trends in the Queensland turfgrass industry. 8th World Leisure Congress and National Conference of Parks and Leisure Australia, Brisbane, September 12-17. 12p.

Anon. 1998. Zoos, parks and gardens industry 1996-97. Australian Bureau of Statistics, Cat No 8699.0 ABS: Canberra.

Anon. 2005. Lifestyle horticulture sector. Report to the Lifestyle Horticulture Council by Agtrans Research in conjunction with CapeAbility Consultants, Brisbane, October.

Anon. 2006. About ALGA - about local government. Australian Local Government Association. http://www.alga.asn.au/about/

Casey, A. 1999. The golf course industry in China. Golf & Sports Turf Australia, December. p.47-54.

Choi, J.S. 2006. Distribution, classification and breeding of Zoysiagrass in Korea. Abstract, 27th International Horticultural Congress & Exhibition (IHC 2006), 13-19th August. p.24.

Cribbes, D. 2005. pers. comm. Turfgrass Systems. www.turfgrasssystems.com

Godfrey, M. 2004. Golf's Greener Pastures. http://www.chinatoday.com.cn/English/e2004/e200406/p22.htm

Hall, R. 2005. How big are we really? Athletic News, April 18, 2005.

Joo, Y.K. 2006. Turfgrass in Korean culture and industries. Abstract, 27th International Horticultural Congress & Exhibition (IHC 2006), 13-19th August. p.422.

Liu, J., Liu, Y. and He, S. 1998. Diversity of Chinese warm season turfgrass and the characteristic of geography distribution. Acta Agrestia Sinica 6(1):45-52.

Power, N.M. 2000. Grass research in Queensland. Australian Parks and Gardens. Volume 3, No. 1.

Power, N.M. 2004. The current state of water use efficiency in public open space. Research paper presented to the Queensland Department of Natural Resources and Mines (2003) and updated presentation to CRC Irrigation futures urban irrigation workshop, Sydney (2004).

Power, N.M. 2005. The impact of water restrictions on community based sports fields. Proceedings of Parks and Leisure Australia National conference, Hobart. http://www.dpi.qld.gov.au/canegrowers/15214.html

Suntisawasdi, M. 2005. pers. comm. Procrop T & O, 57/17 Moo 3, Soi 118, Phaholyothin Road, Lad Prao, Bangkok 10230.

Way, B. 2000. New Zealand Turf-2000. NZ Turf Management Journal, August. p.14-17.

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Malatya: World's Capital of Apricot Culture

Bayram Murat Asma

The world apricot production and consumption is lower than many other *Prunus* fruit crops despite the fact that the apricot fruit is attractive, with delicious flavor, aroma, high vitamin content, plus known health benefits. Due to its unique climate, the Turkish province of Malatya has become the center of the world's dried apricot industry, and each year 80-110 thousand tonnes of dry apricots are exported to approximately 100 countries. Because of the superior quality of the apricots of Malatya as well as its reputation in the industry, the expansion of the industry is promising, provided research continues to improve production and processing.

The map of Turkey.

Although apricot is a temperate fruit crop, it is adapted to many growing regions including Siberia, the North African subtropics, Central Asian deserts, and the humid areas of China and Japan. There are several apricot species and varieties grown under various conditions but total world apricot production is lower when compared to many other important temperate crops, probably because the apricot flowers very early and is susceptible to frosts while the fruits tend to be soft with a short fresh storage life. World production in 1950 was 650 thousand tonnes (t), which increased to 1.6 million t in 1970, 2.2 million t in 1990, and 2.8 million t in 2000. Currently, there are 400 thousand hectares of apricots producing 2.5 to 2.8 million t with yield per hectare averaging 6,400 kg. This production is lower than other *Prunus* fruit crops such as peach and plum. Apricot consumption per capita in the world is about 500 g (Mehlenbacher et al., 1991; FAO, 2006).

Apricot culture is centered on countries surrounding the Mediterranean Basin, although important producers include the former Soviet Union countries, Iran, Pakistan, USA, China, and South Africa. In 2004, Turkey had 16.7 million apricot trees on 64,000 hectares; producing 4,843 kg/ha (Table 1). There remains great potential for enlarging apricot culture in Turkey in light of its leading position in world production and the important genetic resources that it contains.

Apricot can be produced in almost all areas of Turkey except the Black Sea region, which has a high precipitation and a cold, continental climate. Important areas for apricot culture are the Aegean Region (İzmir and Manisa), Central Anatolia Region (Ankara, Kayseri, Konya, Nevşehir and Niğde) and Eastern Anatolia Region (Erzincan, Elaziğ, Sivas, Iğdır and Elbistan) (Asma, 2000). The earliest apricot harvests begin in the second week of May in the coastal Mediterranean Region where there is an increasing trend for local and foreign cultivars.

Malatya, located in the southwest Eastern Anatolia Region, the crossroads of Central, Mediterranean, Eastern and Southeast Anatolia, is the most important apricot production region in Turkey and in the world producing 7-10% of the world's table apricots and 80-85% of dried apricots. Although apple, pear, peach, walnut and mulberry can also be grown in this area, the fruit growers of Malatya specialize in apricot culture and still call apricot the ancient name of *mish mish* despite the fact that the Turkish name of apricot is *kayısı*.

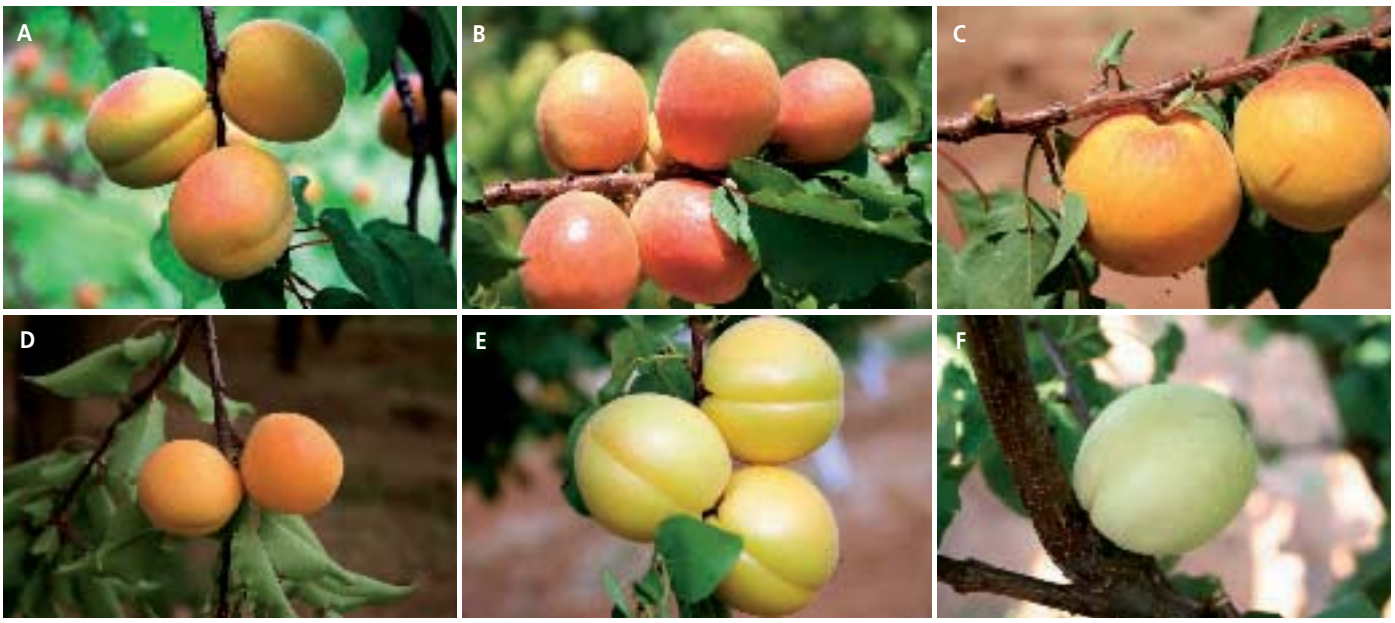
Apricot has been an important fruit for both production and trade in Anatolia since ancient times. Valuable information on the history of Anatolia is based on Hittite writings (1650-1200 BCE) found in excavations at Boğazköy (Hattusas). Dr. Hayri Ertem, author of *Flora of Hittite-Era's Anatolia based on Boğazköy*

Table 1. Apricot production and importance of Malatya. Source: Malatya Province Agriculture Department; Malatya Commerce Office.

Year	Dry apricot production[1] (thousand t)	Exported dry apricot[3] (thousand t)	Export income (million US$)
1980	6	8	24
1990	21	32	72
2000	120	72	119
2001	80	99	89
2002	27[2]	70	123
2003	50	73	153
2004	19[2]	80	199
2005	116	73	147

[1] About 4 kg of fresh apricots are need to produce 1 kg of the dried product.
[2] Indicates years with late spring frost damage.
[3] Exports include stored apricots.

Apricot flowering and fruiting: orchard in bloom (left), closeup of flowers (middle), and immature fruit, about 30-35 days old (right).



Apricot cultivars: (A) 'Hacıhaliloğlu', (B) 'Kabaaşi', (C) 'Alyanak', (D) 'Çöloğlu', (E) 'Soğancı' and (F) 'Ağerik'.

Manuscripts (1974), suggests that tree fruit production played an important role in the economy of the Hittite Era, 18th to 8th century BCE, along with viticulture, field crops, and animal culture. A tablet from that era, Kbo V 7 Rs.28, contains the information that a person named Tiuatapara had 42 apricot trees. Tablet VI 12 Vs. I 17-21 refers to a law that prohibits damaging vines, figs, apples, and apricots. Hittites called apricot *hashur.kur.ra*, which derives from Sumerian where *hashur* means "mountain" and *kur.ra* means "apple" (Ertem, 1974). Hittites used apricot for both fresh and dry consumption and apricot found a place in religious ceremonies. These findings indicate that there has been apricot culture in Anatolia before the Asian journey of Alexander the Great who crossed Anatolia in the 4th century BCE.

Sulphur rooms at Malatya.

APRICOT CULTURE IN MALATYA

Apricot is grown in almost all orchards in Malatya. The region has 8 million apricot trees, 73% of which consists of 'Hacıhaliloğlu', a cultivar perfectly suitable for drying, followed by 'Kabaaslı' (17%); other cultivars include 'Hasanbey', 'Çataloğlu', 'Soğanci', 'Çöloğlu', 'Alyanak', 'Şekerpare', 'Kurukabuk' and 'Ismailaga'. Breeding efforts in the Apricot Research Center of Inonu University in Malatya have produced selections now under test such as 'Levent', an extremely late apricot (Asma and Birhanli, 2004).

'Hacıhaliloğlu', the most important drying apricot cultivar of Malatya, was selected in 1850. The trees are vigorous, and produce fruits every year in irrigated and well-managed orchards. It is medium-yielding but susceptible to frosts, drought, and some diseases such as brown rot (*Sclerotinia laxa*) and shothole (*Coryneum beyerinckii*). The fruits are medium-sized, 25-35 g, oval-shaped, symmetrical; skin and flesh colors are yellow. Fruit has a tendency to be red blushed. Flesh is firm-textured, low in water content, very sweet, and aromatic. On average the fruit has 24-28% soluble solids, 0.20-0.40% acidity and pH is 4.5-4.8. The pit (1.7-2.2 g) is oval and does not cling to the flesh; kernel is sweet. Fruits are mature in the second week of July in Malatya. The chilling requirement is 850-100 hours (Anon., 1996; Gülcan et al., 2001; Asma, 2000).

'Hasanbey' is a table cultivar developed in 1930 by Hasan Derinkˆk, first mayor of Malatya City. The tree shape is spreading and vigorous. It is medium yielding and has heart-shaped fruit (40-55 g). Fruit skin and flesh colors are yellow; texture is medium. On average it has 18-22% soluble solids, 0.10-0.20% acidity and 4.9-5.1 pH. The pits are long-oval, 2.0-2.8 g, non-cling; kernels are sweet. In Malatya, harvest occurs at

Apricot fruits drying in the sun.

the end of June and beginning of July (Asma and Birhanli, 2004).

'Kabaaşi' is a drying apricot selected in 1960. The trees are medium-sized and grow straight and vigorously; yield is medium. Yellow fruit is medium-sized (30-35 g) and oval-shaped. The fruits are sweet, and on average have 24-26% soluble solids, 0.30-0.45% acidity, and 3.8-4.6 pH. The pit shape is oval, 1.9-2.4 g, non-cling to flesh; kernels are sweet. In Malatya, harvest occurs in the second week of July (Özçağiran et al., 2004).

'Soğanci' is a table and drying apricot cultivar obtained from studies by Ruhi Kadıoglu's in 1973. The trees are large, upright to globe-shaped, and vigorous. The fruits are 30-40 g, oval-shaped and both fruit and skin colors are yellow. The fruit is sweet and firm-textured. The soluble solids of fruits are 23-26%, acidity is 0.28-0.35%, and pH is 4.5-4.7. The pits are round in shape, 1.8-2.2 g, non-cling; kernels are sweet. The maturation period is the second week of July in Malatya (Asma, 2000).

'Çataloğlu' is a drying, high yielding cultivar, morphologically similar to 'Hacıhaliloğlu' but with better color (Özçağiran et al., 2004; Asma, 2000). Tree shape is spreading and vigorous. The fruits are medium, 25-35 g, oval-shaped with yellow skin and symmetrical. Yellow flesh is firm-textured, sweet, and aromatic with low water content. On average, the soluble solids are 24-28%, acidity is 0.10-0.25% and pH is 4.5-4.9. The pits are oval-shaped, 1.7-2.1 g, sweet and non-cling.

'Çöloğlu' can be both a table and drying cultivar with exceptional taste and aroma. Trees are medium-sized and vigorous, tolerant to drought but susceptible to brown rot (*Sclerotinia laxa*) and shothole (*Coryneum beyerinckii*). The fruit is round, 25-35 g, with an apparent carpel line, with two asymmetric halves. Skin and flesh color is yellow. The fruits are very sweet and soft-textured. On average, the pH is 4.7-5.1; soluble solids are 22-25%. The pit shape is round (1.9-2.3 g) and non-cling; kernels are sweet. Harvest begins on the second week of July in Malatya (Gülcan et al., 2001; Özçağiran et al., 2004; Asma, 2000).

'Alyanak' is an early, high-yielding, table cultivar selected in Malatya in 1961. The tree shape is round and growth is vigorous. Fruits are 30-45 g, oval-shaped. Fruit skin is orange with red blush, and flesh is orange. Fruits are only moderately sweet, soft-textured and on average have 12-14% soluble solids, 0.9-1.1% acidity, and 3.5-3.9 pH. In Malatya, the harvest date is the end of June (Gülcan et al., 2001; Asma and Birhanlı, 2004).

'Şekerpare' was selected in Malatya in 1941 and can be used as a table and drying cultivar. The tree shape is globular with vigorous growth; it is high-yielding. Fruit size is 25-30 g, oval-shaped, with yellow fruit. Yellow skin is russeted and spotted. The oval-shaped pits (1.8-2.3 g) are non-cling; kernels are sweet. Soluble solids are 20-25%, acidity is 0.20-0.30%, and pH is 4.1-5.2. Generally, harvest occurs in the first week of July in Malatya (Asma and Birhanli, 2004).

'Ağerik' is a table cultivar selected in Kars in 1977. Tree shape is globular and growth is vigorous but yield is medium. Fuits are 60-75 g, oval-shaped; fruit skin and flesh are white. The fruits are only moderately sweet, firm-textured, and have 15-17% soluble solids, 0.8-0.95 acidity and pH is 3.7-3.9. Harvest date in Malatya is the middle of July.

'Levent' was found in 1993 in Malatya and is extremely late and high yielding. The fruit development period is 180-193 days. Tree shape is spreading and growth is vigorous. Fruits are small, 22-25 g and round, with yellow skin and flesh. The fruit is sweet and the texture is medium. The pits are sweet and 1.8-2.1 g and not clinging to the flesh. Fruit has 17-18.5% soluble solids, 0.95-1.15% acidity, and 3.6-3.8 pH. Fruits are harvested at the end of September in Malatya (Asma and Öztürk, 2005).

Apricot Harvest and Drying

In Malatya, apricot is harvested in July. The soil is covered with plastic covers and the trees are vibrated so the fruits drop onto the covers. Fruits are gathered into containers and carried to the drying area.

Dried apricots ready for shipment to processing factory.

Sulfured and non-sulfured dried apricot: high, medium, low and no sulphur (left to right).

Apricot processing.

Apricot fruit profoundly changes its color during the drying process. Fruits are dried either without any treatments or after sulfur dioxide treatments. The sulfuring process not only keeps the color of apricot during drying but also avoids pest damage during storage. The fresh fruits are placed in wooden containers (90 x 180 cm); and the containers are kept in the sulfuring room for 8 to 12 hours. The ideal sulfuring rooms (2.5 x 2.5 x 2.2 m height) have walls of 30 cm thick, which are either brick or reinforced concrete. The airproof door of the sulfuring room is 110 cm in width and 200 cm in height. It is possible to treat 1,200-1,500 kg fresh apricots at once in each room. In the elemental sulfur method, sulfur is heated to form sulfur dioxide. For each 1,000 kg of fresh fruit 2-3 kg of sulfur is applied. Alternatives include liquid forms of sulfur such as sodium metabisulfite, sodium sulfite, or pure sulfur gas. There is no need for heating when sodium metabisulfite or sodium sulfite is used, since they are well dissolved in aqueous solutions. When sulfur gas is used, pre-heating of sulfuring room helps fruits to take up sulfur dioxide better. In Malatya apricot growers, however, prefer the elemental sulfur method. After the sulfuring, the fruits are placed in containers under direct sunlight and pits are removed by hand by squeezing each fruit. During the sun-drying process, water content drops to 20-25% (Asma, 2000).

Sulfuring is an integral part of the dried apricot industry. There are no known harmful effects of the sulfuring process on human health except for asthmatics. However, European Union Regulation restricts the amount of sulfur in dry apricot to 2000 ppm; the limit is 2500 ppm in Canada and 3000 ppm in the US. Sulfur treatment keeps apricots yellow and is necessary to preserve the dried product for an extended period of time.

A tray with sulfured and non-sulfured dried apricots.

Natural Drying (*Gün Kurusu*)

Fruits can be dried without sulfur treatment but the resulting product is brown, not yellow or orange, and the taste is different. The harvested fruits are carried to the drying areas, places on reinforced concrete or cover in a single layer. After the initial drying for a few days, the fruits are pitted, shaped and returned to the drying area until their water content drops to 10-13%. Since there are no sulfur treatments in natural drying, fruits brown because of enzyme activity. The naturally dried fruits must be kept refrigerated because they can deteriorate quickly under room temperature.

The Processing Industry

The market for the dry apricot in Malatya is called "Şire Pazarı" (meaning sweet bazaar). Buyers purchase apricots from producers and bring them to apricot processing facilities. In Malatya, there are 25 processing facilities. Here, the dry apricots are first washed several times and then dried in special ovens until their water content drops to 25%. The apricots are sized, sorted, and defects excised by paring. The product is packed into 0.5, 1, 5 and 12.5 kg trays by workers, usually young Turkish women. The dried fruit is then distributed to local and global markets!

There are other facilities in Malatya that prepare different apricot products such as jam and marmalades from either dry or fresh apricots, juice,

Apricot products displayed by Ipek, daughter of the author.

sweets, and *pekmez*, a local, thick, leathery apricot product made by boiling down the juice. Apricot marmalade is important for preparation of jams and cakes. For example, "Sachertorte," prepared for several centuries, requires apricot marmalade. The seeds of apricots are also widely used. *Amaretti Di Saronno* is prepared from apricot seeds in Italy. Each year, Malatya exports about 10 thousand tonnes of apricot seeds valued at $10-12 million.

Apricot Breeding

The Apricot Research Center of Inonu University has several apricot breeding programs. More than 5,000 hybrids from more than 50 combinations are being evaluated in the field for several objectives including early and late ripening, high drying efficiency, and resistance to Sharka (Plum pox virus).

MAJOR PROBLEMS OF MALATYA'S APRICOT CULTURE

There are a number of serious problems that need to be resolved for the apricot industry of Malatya to expand. Price fluctuations of dry apricot in the markets cause hardship to the industry. For example, late spring frosts occur every 2 to 3 years and cause significant yield losses. In the nonfrost years, overproduction often depresses market prices. New cultivars that can tolerate the spring frosts better than the current ones should be utilized in new orchards.

The consumption preferences and market conditions are dynamic. With the exception of studies at the Apricot Research Center of Inonu University, there have been few attempts to breed for cultivars to increase the production area for dried apricots.

At present, certified nursery trees are insufficient. Attempts need to be made to increase certified nursery tree production.

Management practices such as irrigation, fertilization, pest management, need to be upgraded. Extension efforts need to be expanded in the industry.

Attempts need to be made to increase apricot consumption. There have been few researches emphasizing the health benefits of dried apricot consumption. Scientific research and a marketing program to emphasize health benefits are needed to increase apricot consumption. Attempts should be made to develop value-added products from apricots in Turkey. These include frozen or canned apricot products and apricot marmalade. Finally research needs to be done on increasing organic production.

Market displaying the various dried fruits of Turkey.

ACKNOWLEDGEMENTS

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REFERENCES

Anon. 1996. Catalog of apricot varieties. Turkish Agriculture Ministry Press, Ankara.

Asma, B.M. 2000. Apricot production (in Turkish). Evin Press, Malatya.

Asma, B.M. and Birhanlı, O. 2004. Mişmiş (in Turkish). Evin Press, Malatya.

Asma, B.M. and Öztürk, K. 2005. Analysis of morphological, pomological and yield characteristics of some apricot germplasm in Turkey. Genet. Resour. Crop Evol. 52:305-313.

Ertem, H. 1974. Flora of Hittite-Era's Anatolia based on Boğazköy Manuscripts (in Turkish). TTK Press, Ankara.

FAO. 2006. FAO statistical database. http://apps.fao.org/page/collections?subset=agriculturegg

Gülcan, R., Mısırlı, A., Eryüce, N., Sağlam, H. and Demir, T. 2001. Apricot production (in Turkish). TARP Press, Ankara.

Mehlenbacher, S.A., Cociu, V. and Hough, L.F. 1991. Apricots (*Prunus*). Acta Hort. 290:65-107.

Özçağiran, R., Ünal, A., Özeker, E. and İsfendiyaroğlu, M. 2004. Temperature fruits. (Stone fruits). Vol.II, Egean Univ. Agr. Faculty Press, 553, İzmir.

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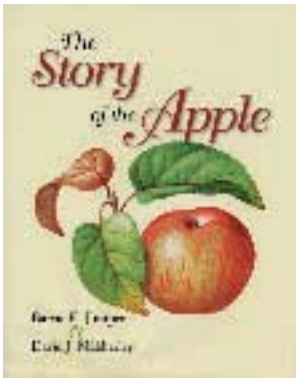
New Books, Websites

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 Story of the Apple. Barrie E. Juniper and David J. Mabberley. 2006. Timber Press, Portland Oregon, USA. 219p. Illustrated. ISBN-113: 978-0-88192-784-9. $29.95.



This long awaited volume by Barrie E. Juniper and his former student, David J. Mabberley, will be a bedside companion for all apple workers. The book is in a sense a history of the world, historical and prehistorical, taking for its focal point this wonderful pome fruit - source of legend and food, both solid and liquid. The evolution of the domesticated apple is traced from its origins in the Tian Shan, the celestial mountain range of Central Asia, its progression through the gut of bear and horse, and its transfer through the sweep of human migration east and west along the silk road and beyond the oceans to the Americas. The eclectic cast of characters include Alexander the Great, Ghenghis Khan, Cyrus the Great, Michael Drayton, Johann Sievers, Thomas Andrew Knight, John Chapman, Sir Ronald Hatton, and Nicolas Ivanovitch Vavilov. There is a large section devoted to grafting, so critical to the culture of apple, but whose origins are still unclear. The authors present circumstantial evidence of grafting 3800 years ago from a cuneiform tablet that involves shipment of grape scions, and suggests that grafting was practiced in Persia 2500 years ago. They seem unaware that the first documentary evidence of the grafting is the discussion of the graft union by unknown author of the school of Hippocrates, about 424 BCE. There are a few bloopers: the most important cultivar of apple is now 'Fuji', not 'Golden Delicious' or 'Delicious'.

There are lots of interesting factoids. I did not realize that the name *Malus* x *domestica* is illegitimate according to the Rules of Nomenclature and that we need to go back to *M. pumila*; that the apple seed has practically no endosperm; or that it is tannins that prevent the lack of rooting from shoots. Music lovers will be quick to point out that the Polovtsian melody of Alexander Borodin (printed on p.42) was used in the 1953 musical *Kismet* and became a popular song called *Stranger in Paradise*. What goes around comes around: for more about Paradise rootstocks and paradise gardens read the book. The price of *The Story of the Apple* is very reasonable and I recommend it enthusiastically.

Reviewed by Jules Janick, Purdue University, USA

NEW TITLES

Avanzato, D. and Vassallo, I. (eds.). 2006. Following Almond Footprints (*Amygdalus communis* L.): Cultivation and Culture, Folk and History, Traditions and Uses. Sulle Orme del Mandorlo (*Amygdalus communis* L.): Coltura e Cultura, Folclore e Storia, Tradizioni e Usi. Published by ISHS, Leuven, Belgium. 165p. ISBN 90 6605 679 7. € 30.00. www.ishs.org

Bernard, Didier. 2006. La Fleur d'Or - Le Chrysanthème. Editions Gunten, Dole Cedex, France. 240p. ISBN 2-914211-38-4. € 25.00. www.editionsgunten.com

Francis, C.A., Poincelot, R.P. and Bird, G.W. 2006. Developing and Extending Sustainable Agriculture: A New Social Contract. Food Products Press, The Haworth Press, Inc., New York. xxii + 368p. ISBN 1-56022-331-6 (hardback). $69.95. ISBN 1-56022-332-4 (paperback). $49.95. www.haworthpress.co

Gopal, Jai and Khurana, S.M. Paul (eds.). 2006. Handbook of Potato Production, Improvement, and Postharvest Management. Food Products Press, The Haworth Press, Inc., New York. xviii + 605p. ISBN 1-56022-271-9 (hardback). $149.95. ISBN 1-56022-272-7 (paperback). $79.95. www.haworthpress.com

Indira, V., Peter, K.V. (ed.) and Sudheer, K.P. 2007. Post Harvest Technology of Horticultural Crops. Akhil Books Pvt. Ltd., New Delhi, India. xxiv+291p. ISBN 818942243X (hardback). US$85.50. www.akhilbooks.com

Koike, S.T., Gladders, P. and Paulus, A.O. 2006. Vegetable Diseases: A Colour Handbook. Manson Publishing, London, UK. 320p. ISBN 1-84076-075-3 (hardback). £95.00. www.mansonpublishing. com

Levin, Gregory M. 2006. Pomegranate Roads. A Soviet Botanist's Exile from Eden. Floreant Press, Forestville, CA, USA. 218p. ISBN 0-9649497-6-8. $18.00. www.floreantpress.co

Peter, K.V. (ed.). 2007. Underutilized and Underexploited Horticultural Crops - Vol. 1. New India Publishing Agency, New Delhi, India. xiv + 378p. ISBN 81-89422-60-X. $99.50. www.bookfactoryindia.com

Peter, K.V. (ed.), Nybe, E.V. and Mini Raj, N. 2007. Spices. Akhil Books Pvt. Ltd., New Delhi, India. xii + 316p. ISBN 8189422448 (hardback). $85.50. www.akhilbooks.com

Raman, Saroja. 2006. Agricultural Sustainability: Principles, Processes, and Prospects. Food Products Press, The Haworth Press, Inc., New York. xxii + 474p. ISBN 1-56022-310-3 (hardback). $89.95. ISBN 1-56022-311-1 (paperback). $69.95. www.haworthpress.com

Sharma, S.K., Pramanick, K.K. and Kishore, D.K. (Eds.). 2006. Temperate Horticulture: Current Scenario. Akhil Books Pvt. Ltd., New Delhi, India. xxii + 530p. ISBN 8189422367 (hardback). $72.90. www.akhilbooks.com

Srinivasan, Ancha (ed.). 2006. Handbook of Precision Agriculture - Principles and Applications. Food Products Press, The Haworth Press, Inc., New York. xxvi + 684p. ISBN 1-56022-954-3 (hardback). $129.95. ISBN 1-56022-955-1 (paperback). $89.95. www.haworthpress.co

Wojtkowski, Paul A. 2006. Introduction to Agroecology: Principles and Practices. Food Products Press, The Haworth Press, Inc., New York. xxii + 404p. ISBN 1-56022-316-2 (hardback). $99.95. ISBN 1-56022-317-0 (paperback). $79.95. www.haworthpress.com

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ECOLIVA 2007 - Sixth International Conference on Agro-Ecological Olive Grove, 22-25 March 2007, Puente de Génave, Jaén, Spain. Info: ECOLIVA 2007, C/Mayor, s/n 23370 Orcera-Jaén, Spain, Phone: 953 482131, Fax: 953 480409, email: ecoliva07@ecoliva.net, web: www.ecoliva.info

Keukenhof, 22 March - 20 May 2007, Lisse, The Netherlands. Info: Keukenhof, Stationsweg 166a, 2161 AM Lisse, The Netherlands, Phone: +31 (0)252 465 555, Fax: +31 (0)252 465 565, email: info@keukenhof.nl, web: www.keukenhof.nl

Bundesgartenschau BUGA 2007, 27 April - 14 October 2007, Gera and Ronneburg, Germany. Info: Bundesgartenschau Gera und Ronneburg 2007 GmbH, Gagarinstraße 81, 07545 Gera, Germany, Phone: (03 65) 55 20 07, Fax: (03 65) 5 52 00 99, email: info@buga2007.de, web: www.buga2007.de

13th International Peat Congress, 8-14 June 2008, Tullamore, Ireland. Info: Abbey Conference Services, City Gate, 22 Bridge Street Lower, Dublin 8, Ireland, Phone: +353 1 6799144, Fax +353 1 6486197, email: ipc2008@abbey.ie, web: www.ipcireland2008.com

2007 In Vitro Biology Meeting, 9-13 June 2007, Indianapolis, IN, USA. Info: Marietta Wheaton Ellis, Meeting Secretariat, 514 Daniels St., Suite 411, Raleigh, NC 27605, USA. Phone: (1) 919-420-7940, email: sivb@sivb.org, web: www.sivb.org

Genomics in Business 2007, 17-19 June 2007, Amsterdam, The Netherlands. Info: KeyGene N.V., P.O. Box 216, 6700 AE Wageningen, The Netherlands, Phone: +31 (0)317 46 68 66, Fax: +31 (0)317 42 49 39, email: info@genomicsinbusiness.nl, web: www.genomicsinbusiness.com

Potato Russia 2007 - First International Russian Potato Congress and Exhibition, 21-23 August 2007, Moscow, Russia. Info: Europoint b.v. (congress), P.O. Box 822, 3700 AV Zeist, The Netherlands, Phone: + 31 (0) 30 6933489, Fax: + 31 (0) 30 6974517, email: esiebenhar@europoint.eu, web: www.europoint.eu, or APK VVC ltd. (exhibition and field demonstrations), All Russian Exhibition Centre Building 63 Mira pr., 129223 Moscow, Russia, Phone/Fax: + 7 (495) 544 35 01, Phone: + 7 (495) 748 37 70, email: olgadm@apkvvc.ru, web: www.apkvvc.ru

Australasian Postharvest Conference, 10-12 September 2007, Terrigal, NSW, Australia. Info: Dr. Jenny Ekman, Gosford Horticultural Institute, NSW Department of Primary Industries, Gosford, NSW 2250, Australia, Phone: (61) 2 4348 1900, Fax: (61) 2 4348 1910, email: jenny.ekman@dpi.nsw.gov.au, web: www.aphc2007.com.au

Proflora, 3-5 October 2007, Cartagena, Columbia. Info: Cristina Uricoechea, email: info_proflora2@asocolflores.org, web: www.proflora.org.co

HortiFair, 9-12 October 2007, Amsterdam, The Netherlands. Info: International Horti Fair, Postbus 1454, 1430 BL Aalsmeer, The Netherlands, Phone: +31 (0)297-344033, Fax: +31 (0)297-326850, email: info@hortifair.nl, web: www.hortifair.nl

8th African Crop Science Society Conference, 27-31 October 2007, El-Minia, Egypt. Info: Prof. Kasem Zaki Ahmed, Faculty of Agriculture, Minia University, El-Minia, Egypt, ET-61517, Phone & Fax: ++ 20 (86) 2 36 21 82, email: org-com@acss2007.org, web: www.acss2007.org

Info

INTERNATIONAL SEMINAR ON ECONOMICS AND MARKETING OF TROPICAL AND SUBTROPICAL FRUITS

Kuala Lumpur (Malaysia), 16-18 July 2007

This event of the International Tropical Fruits Network (TFNet) will be co-organised with Malaysian Agricultural Research and Development Institute (MARDI), International Plant Genetic Resources Institute (IPGRI) and Federal Agricultural Marketing Authority (FAMA).

The objective of this international seminar is to provide a forum for the private sector, public sector and other stakeholders in the tropical fruit industry to share their knowledge and views on issues related to the marketing and economics of tropical and subtropical fruits.

Contact

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

V INTERNATIONAL ISHS SYMPOSIUM ON EDIBLE ALLIACEAE (ISEA) & WORLD ONION CONGRESS

Lelystad (The Netherlands), 29 October - 1 November 2007

The 5th International ISHS Symposium on Edible Alliaceae (ISEA) will be held in the Netherlands, the largest onion exporting country of the world. The objective is to offer an international platform for the exchange of ideas and information on the scientific advancements on edible alliaceae. The call for papers has been closed.

Next to the ISEA symposium the World Onion Congress, a trade show and technical visits to various companies, will be organised.

The combination of these two events will reinforce both, since it enables science and practice to meet, to discuss and to learn from each other. The symposium will approach the subjects from a scientific point of view; the congress from a business point of view. In this way the whole product chain will be addressed.

Bookmark www.worldalliumassociation.com and stay up to date with this upcoming event.

Contact

World Allium Association (WAA), Ms. Tessa de Boer, P.O. Box 822, 3700 AV Zeist, The Netherlands, Phone: +31 (0)30 6933489, Fax: +31 (0)30 6917394, email: info@worldalliumassociation.com

Opportunities

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, CA, USA

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

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

For more information visit www.ishs.org/general/index.htm

Symposia and Workshops

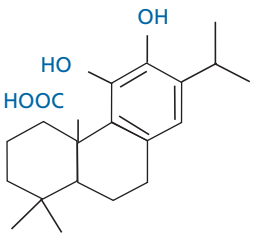
Section Medicinal and Aromatic Plants

Second Int'l Symposium on Natural Preservatives in Food, Feed and Cosmetics

Following the first successful meeting (Princeton, New Jersey, USA, 2005), a second International Symposium on Natural Preservatives in Food, Feed and Cosmetics was held in Amsterdam, The Netherlands, June 7-8, 2006.

The symposium was organized by Dr. Daphna Havkin-Frenkel of Bakto Flavors LLC, USA. Dr. Nativ Dudai (ARO, Israel) and Hans van der Mheen (W-UR, The Netherlands), organizing committee members, assisted with this task. The meeting was sponsored by several academic institutions, including Rutgers University, Wageningen-UR, ISHS, and industrial companies, namely, Vitiva (Slovenia) and Happs (Australia). Participants from 17 nations, such as Australia, Chile, Brazil, Norway and Denmark, numbering around 80, were from both academia and industry.

***Origanum vulgare* growing in Holland for the production of high carvacrol essential oil and high antioxidant content.**



Carnosic acid: main antioxidant in rosemary.

The program consisted of 20 oral presentations and 6 posters. A pre-meeting one-day workshop (June 5) on assay/screening methods for natural antioxidants was attended by 20 conferees and conducted by Dr. Karen Schaich, Rutgers University, New Brunswick, New Jersey, USA.

Attendance in the symposium and the pre-symposium workshop indicate current interest in natural antimicrobial and anti-oxidative preservatives in food, feed and cosmetics, as replacement for synthetic formulations currently in use.

The program consisted of two major sections; antimicrobial preservatives (first day) and natural antioxidants (second day). Each section dealt with applications, production, health benefits and use of natural preservatives in packaging.

The first session was opened by Michael Davidson, University of Tennessee, who gave an overview on common and newly developed antimicrobial agents derived from animal, plant, microbial and mineral sources. Natural antimicrobial preservatives appear to function well in the overall microbial inhibition and have advantages over synthetic preservatives when it comes to resistance development and food safety. Three lectures illustrating the production and usage of antimicrobials obtained by *Lactobacillus* and *Streptomyces* fermentation, such as poly-lysine, natamycin, nisin and lysozyme were presented by George Weber of Danisco, USA, Dr. Furukawa of Chisso Corp, Japan and Nicole Dutreux of DSM Food Specialties, The Netherlands. Most of them show bacteriostatic and bactericidal effects against specific microbial populations. In every specific application the food processing conditions, sensory attributes and antimicrobial effects against targeted organisms (Gram+/Gram- bacteria, moulds, yeasts) have to be considered.

Lynn Deffenbaugh, ABF International Inc., USA, lectured on the strong trends towards the use of natural preservatives in the pet food industry, concluding that there are lots of similarities (and interactions) between developments in the pet feed and the food industry. Willem Smink of Feed Innovations Services (FIS), The Netherlands, presented the scientific background and effects (both in in vitro and in animal experiments) of the antimicrobial activity of a commercialized feed additive based on oregano essential oil (known under the brand name Ropadiar).

Mrs. Janeta Orenstein, ARO, Israel, illustrated the promising use of a natural preservative in the inhibition of pathogenic fungi and bacteria in skin care/cosmetic products, based on an activated citrus peel extract (ACPE, commercialized by Citramed Company).

The first symposium day was closed by Mr. Earl Happ of Happs wineries, Dunsborough, Australia, who shared his experience in the development of techniques to produce and preserve wines without the use of sulfur dioxide.

Grapes growing in Australia for wine free of synthetic preservatives.

After his very interesting lecture about careful cultivation and picking of the grapes and advanced craftsmanship during processing and bottling, the audience was invited to taste his all natural (red and white) wines. This turned out to be a very exciting cocktail hour (without any allergic responses!), which brought the people together and resulted in interesting discussions.

On the second day the symposium focused on natural antioxidative preservatives. The first three lectures (Teris van Beek, Ric de Vos and Ingrid van der Meer, all researchers at Wageningen-UR, The Netherlands) gave the scientific background of (1) assays used in the antioxidant screening of herbs, (2) the genetic background in the levels of antioxidant compounds in plant tissues in specified (and in between different) genotypes and (3) the genetic regulation and modification of (iso)flavonoid biosynthetic pathway in plants.

Because there is an ongoing debate on which assay to use in a reliable determination of antioxidant activity of plant extracts, Maria Tsimdou (Aristotle University Thessaloniki, Greece), presented a highly specific, though traditional method (the Crocin assay), which she expensively studied and modernized.

Dr. Ze'ev Wiesman, Ben-Gurion University, Israel, gave a talk on the high level and wide range of phytosterol types in pomegranate

***Rosmarinus officinalis* growing in Israel, special variety selected to have high carnosic content.**

Pomegranate becomes an important fruit due to its high health benefits

being responsible for the strong ability to protect the fruit fatty acids from rapid oxidation. Pomegranate phytosterols may be used to treat cholesterol related cardiovascular disorders, hormonal imbalance and other physiological effects in humans.

An illustration on a commercialized anti-oxidative natural preservative was presented by Dr. Rina Reznik of Rad Natural Technologies, Israel. She gave the background for the development and application of their product Origanox, based on oregano/melissa extracts high in phenolic compounds. Dr. Madja Kolar of Vitiva company, Slovenia, presented their Inolens product based on rosemary extracts rich in carnosic acid.

An interesting lecture was given by Dr. Guido Haenen, a physician at the Faculty of Medicine, Maastricht University, The Netherlands. The lecture covered the potential health effects of antioxidants. Despite of the often very promising results in in vitro assays, the outcomes of many clinical studies on the health effect of antioxidants are rather disappointing, however. Patients seem to benefit more from supplementations than the healthy controls, and the results differ according to the tests. Haenen's group has developed appropriate study designs for determining the positive health effect of antioxidants in vivo, although noting that high intake of antioxidants (through neutraceuticals and food supplements) is not always beneficial and may even induce adverse side effects.

The last two lectures of the symposium were dedicated to the developments in the use of natural preservatives and the release thereof in packaging. Ulphard Thoden van Velsen of Wageningen-UR, The Netherlands, gave an overview of the challenges faced by the packaging industry by strong demands for new solutions to deliver fresh foods in a better quality to consumers. Natural preservatives can play a role in extending the shelf life of fresh foods, but there are limitations regarding (for instance) the volatility of natural components (such as carvacrol), the concentration needed and the effect on smell and taste. The last speaker, Dr. Karen Schaich, Rutgers University, New Brunswick, New jersey, USA, lectured on delivering natural antioxidants via controlled release packaging. A systematic study of the relationship between film morphology/polymer composition and its release properties of natural antioxidants (e.g. mixed tocopherols) provide encouraging evidence that effective new polymer packaging films, extending the shelf life for a wide range of foods, can be developed.

According to the positive response of participants, the fruitful discussions, personal contacts and exchange of ideas, this Symposium on Natural Preservatives in Food, Feed and Cosmetics answers the desire of the people in academia and industry to be informed, and stay up to date with the actual developments and knowledge in this highly specific field.

The symposium proceedings will be edited and published through ISHS during the first half of 2007.

The Third Symposium on Natural Preservatives will be organized by Bakto Flavors in 2007 and carried out in the USA.

Hans van der Mheen, Plant Sciences Group, Wageningen-UR, The Netherlands

Contact

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First Int'l Symposium on the Contribution of African Botanica to Humanity

The First International Symposium on the Contribution of African Botanica to Humanity was held October 2-5, 2006 in the Novotel Hotel in Conakry, Guinea. This first scientific conference on African botanicals brought together researchers and professionals interested in the use of indigenous African plants that could serve as 'Food and Nutrition' and as 'Medicinal Bioactive Agents'.

The conference was attended by over 150 attendees that included the Organizing Committee, visiting keynote speakers, registrants, students, and visiting government dignitaries. Attendees represented Benin, Burkina Faso, Cameroon, Congo, Ethiopia, Ghana, Mali, and Nigeria, as well as Belgium, France, and Holland, California, Massachusetts, Texas, and the Canadian provinces of New Brunswick and Quebec.

Dr. Patrick Van Damme, Laboratory for Tropical and Subtropical Agriculture and Ethnobotany, Ghent University, Belgium, presented the first keynote address titled "From African Ethnobotanical Biodiversity to Domestication of New Crops for Development". A second key paper titled "Customary Land Tenure Concepts and Issues in Africa" was presented by Dr. Dozie Ezigbalike of the Economic Commission for Africa (UN), Ethiopia.

Discussions related to future collaboration led to the formation of a working committee to examine "The Role of Nutrition for AIDS". To be chaired by Dr. Nianga Malo, the committee will consist of scientists from each African country represented at the conference, and draw from their combined expertise to more clearly define the role of nutrition in the treatment of HIV/AIDS.

Ms. Fatoumata Dabo, Conference participant and logistics organizer.

Symposium participants.

The conference was officially opened by the Honorable Minister Dr. Ahmed Tidiane Souaré - Ministère de l'Enseignement Pré-Universitaire et de l'Education Civique. Co-chairs were Dr. Nianga Nicéphore Malo, the Rector and President of UDECOM (Université pour le Développement Communautaire) in Guinea, and Dr. Kenneth E. Keirstead, the Director of Le Groupe Lyceum and Executive Vice President of UDECOM. Scientific direction was provided by Dr. Lyle E. Craker of the University of Massachusetts, representing the International Society for Horticultural Science (ISHS). Dr. Chris Bosch represented PROTA (Plant Resources of Tropical Africa) and the Global Horticulture Initiative.

Conference logistics were managed by Ms. Fatoumata Dabo of Le Groupe Lyceum in Conakry.

On the first evening of the conference, attendees gathered at the Le Rocher Hotel and Restaurant for the inauguration of Dr. Hans Stegmann Keirstead, Professor of Anatomy and Neurobiology at the University of California, Irvine as the first Vice Chancellor of UDECOM. This novel event featured professors and board members of UDECOM wearing traditional gowns representing the Forest Region of Guinea, where the university is located. The Mayor of N'Zérékoré, His Worship Mr. Cece Loua, attended the ceremony and bestowed on Dr. Keirstead an "Honorary Citizenship" and the keys of N'Zerékoré.

On the last day of the meeting, 60 participants took the opportunity to participate in a guided tour to the island of Tamara, the furthest of the Loos Island archipelago located nine kilometers offshore from the city of Conakry. Following a nine kilometer walk along the spine of the island to view the natural habitat, flora restoration programs and points of interest, participants enjoyed lunch and entertainment organized by the local Community Development Organization (CDO). This first "packaged" tour to the unspoiled island served to demonstrate to the local people the economic benefits of eco-tourism.

Dr. Kenneth E. Keirstead (left) and Dr. Nianga Nicéphore Malo (right), Symposium Co-Chairs.

The proceedings of the conference will be featured in an edition of *Acta Horticulturae* to be published by the ISHS early 2007.

The sponsors for this noteworthy meeting were the ISHS, UDECOM, IntelliPharmaCeutics, Le Groupe Lyceum, and USAID.

Kenneth E. Keirstead

Contact

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Second Int'l Symposium on Saffron Biology and Technology

Saffron has been cultivated for centuries under a low input sustainable system with almost no externalities. Based on its nature, it is a crop of small holdings with no sophisticated farming equipment and without chemical fertilizers and biocides. Saffron is adapted to water deficit areas and is the most effective crop in terms of water efficiency. Although it is a short lived plant, at the same time it is a so-called "hidden permaculture", which keeps the beauty and complexity of its generative phase under the ground during the hot months of summer. Saffron has been considered as a crop for the poor, and it is really a poor crop in a sense itself, because it is grown on small lands of poor families and it is dependent on the inputs available in the area. Saffron has been regarded as a handicraft miniature crop and is made exclusively by hand, hands of the young and the old, men and women, bringing people together at the time of harvest. Therefore saffron is environmentally friendly, economically feasible, socially justified and culturally valued and hence a sustainable treasure.

The Second International Symposium on Saffron Biology and Technology (ISSBT) was organized by the Center of Excellence for Special Crops (CESC), Faculty of Agriculture, Ferdowsi University of Mashhad from 28 to 30 October 2006 in Mashhad, Iran under the auspices of the International Society for Horticultural Science (ISHS), Section Medicinal and Aromatic Plants. The Saffron Symposium takes place every three years in a country associated with saffron and gathers people from scientific institutions and private sectors to discuss different issues on this valuable spice regarding production, processing, trade and marketing, quality control as well as use of saffron. During the 2nd ISSBT more than 113 national and 25 international delegates from India, Britain, Germany, France, Greece, Turkey, Spain, Morocco, Mexico, China and the representative of ISHS from Hungary participated and contributed to six scientific sessions, presenting 8 keynote, 44 oral and 63 poster papers. Selected papers will be published as a special issue of *Acta Horticulturae*.

Participants of the Symposium.

Akos Máthé (right) handing over the ISHS medal to Prof. Koocheki (left).

It was the second time that the international scientists and stakeholders associated with saffron were gathered to interact on the important aspects of this valuable crop. Such a diverse assembly of scientists from production technology to processing and packaging, from the dying industry to medicine and from molecular biology to trade marketing, where there are common interests in saffron, can rarely be found. It was therefore apparent that a holistic approach is needed to cover all aspects of this crop and the 2nd ISSBT was a platform for such a comprehensive dialogue.

This Symposium was not only a scientific gathering but also a socio-cultural event with side activities such as a Saffron Festival, a scientific and recreational tour to saffron producing areas, processing factories and also an exhibition.

Undoubtedly participants of the 2nd ISSBT will continue their efforts with new initiatives and ideas obtained during this event. Fruits of these efforts will be revealed during the next Symposium, which will take place in Greece in 2009. See you all there!

Mehdi Nassiri, Scientific Chairman

Contact

Prof. A. Koocheki, College of Agriculture, Ferdowski University of Mashhad, P.O. Box 91775-1163 Mashhad, Iran, Phone: +98 511 7610760, Fax: +98 511 8787430, email: akooch@ferdowsi.um.ac.ir

First Int'l Symposium on Pomegranate and Minor Mediterranean Fruits

The First International Symposium on Pomegranate and Minor Mediterranean Fruits was organized by Cukurova University, Agriculture Faculty, Horticulture Department and ISHS between 16-19 October 2006 and supported also by TUBITAK (Turkish Goverment Scientific Council). Because of suggesting this symposium to ISHS, the ISHS Working Group on Pomegranate and Minor Mediterranean Fruits was established.

At the beginning of the symposium, the importance of this symposium was presented by Ahsen Işık Özgüven, Symposium Convener.

Convener (Ahsen Işık Özgüven) with pomegranates during the symposium.

The Rector and the other scientists of Cukurova University.

Damiano Avanzato gave some information about the ISHS.

A keynote paper named "Punicology in the 21st Century" was presented by Angelos Bouritras. GFU Coordinator, Irmgard Hoeschle-Zeledon, presented the studies on a strategic framework for research and development of underutilized plant species reference to Asia, the Pasific and Sub-Saharan Africa, prepared by the International Plant Genetic Resources Institute - Global Facilitation Unit for Underutilized Species (IPGRI-GFU).

There were aproximately 200 participants including scientists from India, Iran, Israel, England, Spain, USA, Slovakia, Georgia, Australia, Greece, Argentina, South Africa, Italy, Turkey, students and growers.

In this symposium, subjects on horticulture, the potential of growing in different countries, varieties, germplasm conservation and genetic sources, physiology, breeding and genetics, food and health, the usage of some hormones, biotechnology, propagation and harvesting, postharvest technology, processing, marketing,

Presentation of ISHS medal to Ahsen Işık Özgüven (left) by Damiano Avanzato (right).

Pomegranate orchards in Tarsus.

Scientists and growers discussed the problems on pomegranate growing, postharvest and marketing.

economy, growing processing and general problems, diseases and insecticides were presented. There were 23 oral and 47 poster presentations.

In addition to pomegranate, the results of different species such as *Cornus mas, Carob, Morus nigra, Morus alba, Ziziphus jujuba, Cydonia oblonga, Capparis spinosa* and *Pistacia lentiscus* were discussed among scientists, growers and commercial companies.

The participants visited research areas in Horticulture Department, Agriculture Faculty, Cukurova University, and Vinary in Food Science Department, Alata Horticulture Research Institute, some pomegranate orchards in Tarsus and Mersin during technical tour and discussed with the growers about growing techniques and problems.

This symposium was very useful to give valuable information to scientists, researchers, growers, producers, representatives from medicine and agriculture, to share knowledge on pomegranate and minor Mediterranean fruits and to decide on the solution for problems on growing, postharvest, marketing and others.

The First International Symposium on Pomegranate and Minor Mediterranean Fruits was established by Horticulture Department of Cukurova University and ISHS. Participants decided that the second symposium would be organized in India.

Ahsen Işık Özgüven

Contact

Prof. Dr. Ahsen Işık Özgüven, Cukurova University, Agricultural Faculty, Horticultural Department, Ziraat Fakültesi Bahçe Bitkileri Bölümü, 01330 Adana, Turkey, email: ahsen@cu.edu.tr

Section Ornamental Plants

XXII Int'l EUCARPIA Symposium - Section Ornamentals

The XXII International EUCARPIA Symposium - Section Ornamentals was held in Sanremo, Italy (11-15 September 2006). The meeting title was: "Breeding for Beauty". Local organiser was the CRA-Experimental Institute for Floriculture of Sanremo.

The Symposium brought together about 200 people of breeding companies, science and administration from all over the world. This gave the opportunity to exchange and discuss new results and approaches with the common concern to promote research and practical work in ornamental plant breeding.

Four topics were selected for the Symposium:

1) Exploitation of biodiversity: in particular Dr. Tombolato (Brazil) and Dr. Chen (China) presented several native species that have potential as new floricultural crops (cut flowers, garden flowers, indoor foliage plants, etc.)

A. Mercuri (left) and T. Schiva (right).

2) In vitro manipulation: Dr. Mohan Jain presented an overview of mutation breeding of selected ornamental plants, and successful examples of ornamental mutants developed in Thailand, Malaysia and Indonesia.

3) Molecular methods in genetic improvement: of particular interest was the presentation of Dr. Tzfira that showed how *Agrobacterium* hijacks basic cellular processes and uses various plant factors for the transport of its DNA through the host-cell cytoplasm and nuclear membrane and for its integration into the host genome. These studies hold great promise for the future of plant biotechnology, as they can potentially be used to develop new techniques and methods, which will expand *Agrobacterium*'s host range to recalcitrant plant species. Dr. Vainstein showed the use of VIGS (virus-induced gene silencing) for large-scale iden-

Oral session.

tification of floral scent genes. The advantages of VIGS and of petunia as a model plant create a solid infrastructure for the future isolation of regulatory factors involved in floral scent production/emission. Knowledge gained from an understanding of mechanisms leading to floral scent production/emission should provide us with better insight into nature's way of ensuring evolutionary success, as well as with advanced tools for the metabolic engineering of fragrance.

4) Breeders' rights: molecular and phenotypical characterization: Dr. Button showed that one aspect of the UPOV Convention explored the provision for essentially derived varieties. The relationship between initial varieties and essentially derived varieties was explained and the role of the authorities in matters concerning essentially derived varieties was considered. An overview of the current situation with regard to the possible use of molecular techniques in the DUS (distinctness, uniformity and stability) examination was also presented by reference to proposals considered within UPOV.

In total nine invited speakers provided state of the art information of these topics, while 18 oral communications, selected by the Scientific Committee, dealt with special aspects. About 80 posters were presented and 17 of them were selected for a short oral presentation.

During the technical visits, some ornamental plant breeding companies from Italy and France gave an insight into their breeding activities.

The International Scientific Committee was composed by:

T. Schiva, CRA - Experimental Institute of Floriculture, Sanremo, Italy (Chairman)

A. Mercuri, CRA - Experimental Institute of Floriculture, Sanremo, Italy (Secretary)

G. Forkmann, Tecnichal University of Munchen, Freising, Germany

A. Vainstein, The Hebrew University of Jerusalem, Israel

A. Cassells, National University of Ireland, Cork, Ireland

A. Cadic, INRA - C.R., Angers, France

J. van Tuyl, Plant Research International, Wageningen, The Netherlands

E. Van Bockstaele, ILVO - Institute for Agriculture and Fisheries Research, Merelbeke, Belgium

We thank the Organizing and the Scientific Committees, who kindly took charge for the running of this Symposium, and the staff involved in preparing the various Symposium events. Moreover, our special thanks go to the sponsors whose gift and generous financial support have contributed to the success of the Symposium.

Poster session.

The next EUCARPIA meeting - Section Ornamentals - will take place in The Netherlands and the chairman will be Dr. Jaap Van Tuyl.

Antonio Mercuri and Tito Schiva

Contact

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Fifth Int'l Symposium on Irrigation of Horticultural Crops

The Fifth International Symposium on Irrigation of Horticultural Crops brought together a group of enthusiastic scientists from many countries to communicate and debate irrigation research. The symposium was held in Mildura, Australia from 28th August to 2nd September 2006 and convened by Dr. Ian Goodwin from the Department of Primary Industries Victoria. The symposium attracted over 160 delegates who had the opportunity to hear 10 keynote and 56 submitted oral presentations, and to view 32 posters. Complementing the plenary sessions was a field trip to local research institutes, an open forum discussion on irrigation scheduling and a post conference tour to several commercial horticultural operations.

The opening message from Dr. Bruce Kefford, Deputy Secretary of the Department of Primary Industries, positioned the conference in context of the current water crisis facing many countries. "Water is our most valued resource. Once, water was considered an unlimited resource. Now, there is enormous pressure on water resources from competitive users. Horticulture is one of the competitors for water resources because it relies on irrigation for maximum crop production and crop survival. Horticultural industries must strive for greater water use efficiency and clearly demonstrate practices that do not impact on the environment," said Dr. Kefford.

The technical program was divided into 10 themes with an invited keynote speaker addressing each of the following themes: irrigation sustainability, economics, technology transfer, new irrigation technology, deficit irrigation strategies, crop evapotranspiration, water relations, irrigation scheduling, fertigation, and irrigation with recycled and saline water.

Delegates viewing and discussing poster.

Conference delegates.

During his keynote presentation on the future of irrigated horticulture, Professor Wayne Meyer suggested there is a need to consider self-containment in horticultural regions with interspecies and mosaic plantings to better use water and nutrients. Horticultural production systems have been designed to generate more profit, make production easier and less labour intensive, and generally improve the asset value of the system. The result is that biophysical efficiency and off-site impacts are poorly managed and rarely costed. Professor Meyer emphasised the need for change.

The keynote presentation by Tim Cummins addressed the economics theme. The question presented to Mr. Cummins was: How much will horticulturists pay for water? The simple answer from Mr. Cummins was: "Horticulturists will pay as little as they can, as much as they have to, but no more than the fundamentals can justify. Profit is the cost of staying in business; horticultural businesses must generate a return. Those whose production costs (including water costs) are too high will go out of business."

Field demonstration by Steve Falivene of techniques to measure root-zone solutes in a citrus orchard.

The science of practice change in terms of irrigation scheduling in the horticultural industries was addressed by keynote speaker Chris Linehan. The message conveyed by Mr. Linehan was that it is critical to understand the market for the innovation (e.g. the use of plant based sensors to schedule irrigation) before sense can be made of barriers that prevent the adoption of innovations by primary producers.

A highlight of the conference was the presentation by Dr. Wim Bastiaanssen on satellite estimates of crop evapotranspiration and the potential for wide scale monitoring of irrigation, yield and water use efficiency. The method presented by Dr. Bastiaanssen used thermal infrared satellite measurements combined with full surface energy balance to compute evapotranspiration. The technology has the potential to manage water resources at farm and regional scale. For example, site specific crop coefficients can be calculated from satellite estimates of crop evapotranspiration and local estimates of reference crop evapotranspiration (from on-ground weather data) to improve on-farm irrigation scheduling.

Another highlight was the work presented on thermal imagery of horticultural crops for the detection of water stress by keynote speakers Drs. Amos Naor and Hamlyn Jones. The benefits from this technology to improve irrigation management well before visual crop water stress symptoms were clearly demonstrated. During the open forum session there was a strong consensus that remotely sensed canopy

Maxine Schache (DPI Mildura) discussing the usefulness of soil pits to improve irrigation management. Midway through the conference, delegates toured the three research institutes to see what local scientists were investigating.

temperature measurements should be the focus of future work. Thermal imagery has the potential to overcome the problems of single point measurements of soil and plant-based sensors.

Papers on deficit irrigation and crop evapotranspiration dominated the conference. Dr. Jordi Marsal presented an excellent keynote paper on regulated deficit irrigation (RDI). Dr. Marsal identified the recent advances in understanding the effects of RDI on long term production, the interaction with crop load and the impact of different levels of water stress. Many studies of RDI now focus on increasing fruit quality and water conservation where previously the emphasis was on a reduction in vegetative vigour. Despite the plethora of research papers on RDI, the general consensus was that wide-scale implementation of RDI by industry across many different environments is restricted because there is no simple robust tool to measure plant water stress.

A major contribution to the conference was the presentation of simple estimates of crop coefficients that account for variation in crop canopy cover. The keynote paper by Dr. Steve Green demonstrated that despite the complexity of methods required to accurately measure and model crop evapotranspiration, there is a simple relationship between leaf area and crop evapotranspiration. Furthermore, results from lysimeter studies in the USA showed that estimates of vegetative cover from aerial images of Normalised Difference Vegetative Index (NDVI) are linearly related to measures of crop evapotranspiration. These results have great potential to improve estimates of crop irrigation requirements.

The final two session themes of the conference were fertigation, and irrigation with recycled and saline water. Dr. Adriano Battilani presented an overview of fertigation to manipulate fruit quality. This is an exciting area of research with potential to manipulate human health benefits of fruit and vegetables. The keynote address by Dr. Anne-Maree Boland summarised the current knowledge in the use of recycled and/or saline water and some of the key management strategies. Dr. Boland emphasised "fit-for-purpose" water use where potable water is only used for drinking purposes and lesser quality water is utilised for irrigation. Water not suitable for drinking standard, however, often has salts as a major contaminant and this is a significant concern for irrigation. Dr. Boland presented management strategies to overcome the use of saline irrigation so that production is sustained.

The standard of presentations during the conference was outstanding, creating continuous vibrant discussion. Feedback from delegates has been very positive and many new stimulating ideas have evolved from the symposium. These and much more will provide the impetus for future irrigation research and the potential for international collaboration. The next International Symposium on Irrigation of Horticultural Crops will be in Talca, Chile.

Ian Goodwin

Contact

Dr. Ian Goodwin, DPI Tatura, PB 1 Tatura, 3616, Australia, email: Ian.Goodwin@dpi.vic.gov.au

Fourth Int'l Conference on Managing Quality in Chains

Commission Quality and Post Harvest Horticulture

Managing Quality in Chains (MQUIC 2006) held in Thailand on August 7-10, 2006 at the Radisson Hotel Bangkok was organized by the Division of Postharvest Technology, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi under the auspices of the ISHS Commission Quality and Post Harvest Horticulture. It is the fourth in the series of international conferences dedicated to understanding the distribution of fresh produce. This conference focused on steps needed to define and meet the requirement of consumers with the goal to supply quality produce at the cost affordable to consumers in a global economy.

At the opening ceremony, Assoc. Prof. Dr. Sirichai Kanlayanarat, conference convener, invited Assoc. Prof. Dr. Kraiwood Kiattikomol, President of King Mongkut's University of Technology Thonburi, to welcome 180 participants from more than 30 countries to the conference. Professor Errol Hewett, outgoing Chair of the ISHS Commission Quality and Post Harvest Horticulture, gave an update on ISHS activities. At the end of the opening ceremony, Dr. Robert Shewfelt (University of Georgia) delivered the first keynote presentation on

Keynote and invited speakers.

Dr. Sirichai Kanlayanarat at the welcome ceremony.

Defining and Meeting Consumer Requirements, which is an important representation of quality. He stressed the importance of quality to the initial purchase decision and consistent consumption quality in the continued purchase decision.

The conference brought together many eminent scientists and industry experts from several disciplines to discuss development and innovations in quality management with the goal to supply quality produce at costs affordable to consumers in a global economy. The first three days of the conference devoted to 26 keynote and invited speakers, 21 oral, and 80 poster presentations on a diversity of topics including defining and modeling quality, perceptions of quality, manipulating and monitoring quality control, handling systems, measurements of quality, physical treatments, and marketing and distribution systems.

There were considerable discussions among the conferees on demands of consumers from different regions of the world and the changes in consumer demands with changes in lifestyles, particularly in the fast paced societies. There were also discussions on the expectations of systems and challenges and opportunities to deliver high quality, ready-to-eat produce to consumers in such societies. Of particular interest was the presentation on the Overview of

Participants at the poster session.

Thai miniature puppetry featured at the dinner reception.

Agriculture-Product Supply Chain in Thailand by Mr. Paichayon Uathaveekul, President of Swift Co., Ltd., a successful produce export company. He discussed the mission set for his company at its inception in 1986, which called for fair sharing of benefits, derived from its operation, by all stakeholders in the supply chain. His company success could easily serve as a model for others who aspire to supply fresh produce in a global market.

The final day of the conference was a study tour to Thailand wholesale market for agricultural product just outside Bangkok to see the handling of Thai agricultural product. Participants also had an opportunity to sample many exotic fruits.

Participants and accompanying persons were entertained at a welcome reception featuring a wide variety of Thai foods and Thai entertainment including Thai classical music and dance, performed by Thai students, and Thai miniature puppetry, which has been a part of Thai culture for hundreds of years.

This series of international conferences on Managing Quality in Chains is highly valued, exemplified by the world crops section of participants from many countries. This conference emphasized that postharvest technology by its nature involves many disciplines and is clearly focused on delivery of healthy and enjoyable fresh foods to people who increasingly reside in large cities. All of this must be done in an economically sustainable and environmentally friendly way. Participants recommended that the fifth conference in this series be held in New Zealand in about three years time.

The proceedings of the conference were published in 2006 in *Acta Horticulturae* 712. Copies of the proceedings were available to the conferees during the conference and are also available from the ISHS.

Sirichai Kanlayanarat

Contact

Assoc. Prof. Dr. Sirichai Kanlayanarat, Division of Postharvest Technology, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Tha-kham Bangkhuntien Bangkok 10150, Thailand, Phone: +662-470-7721, Fax: +662-452-3750, email: sirichai.kan@kmutt.ac.th

A Chance to Amend the International Code of Nomenclature for Cultivated Plants

The seventh edition of the *International Code of Nomenclature for Cultivated Plants* (ICNCP) was published as *Acta Horticulturae* 647 by the ISHS in 2004. A process of revision and the publication of a new edition takes place, usually every four to five years, following deliberations on proposals to make amendments to the current edition. This is the responsibility of the IUBS Commission for the Nomenclature of Cultivated Plants which meets at International Horticultural Congresses or at International Symposia on the Taxonomy of Cultivated Plants.

The next meeting of the IUBS Commission is planned to take place in Wageningen, The Netherlands, immediately following the 5th International Symposium on the Taxonomy of Cultivated Plants on October 15-19, 2007. In preparation for this meeting proposals to amend the Code may be sent to the Chairman of the Editorial Committee as indicated in the Preface to the 2004 Code.

All formal proposals will be collated and made available on the International Society for Horticultural Science (ISHS) and the Hortax websites prior to the Wageningen Symposium. **Proposals to amend the Code should be submitted not later than May 31, 2007**. Informal comments and suggestions relating to improving the Code are also welcomed by the Commission.

For further information visit www.ishs.org/taxonomy

New ISHS Members

ISHS is pleased to welcome the following new members:

NEW ORGANISATION MEMBERS:

Australia: Charles Sturt University, Wagga Wagga NSW 2678

NEW INDIVIDUAL MEMBERS:

Australia: Dr. Simon Craig, Mr. John Eggleston, Dr. Louis Glowinski, Dr. Sammy Heng, Mr. Vinod Kumar, Mr. Colin Lye, Ms. Lexie McClymont, Dr. Rachel Poulter, Mr. Benedetto Scaravilli, Mr. Adam Sherry, Mr. Thomas Shew, Ms. Nannette Thiel, Mr. Michael Travers, Mr. John Underhill; **Austria:** Mr. Ulf Moser, Mr. Hannes Wechner; **Belgium:** Dr. Yves Dejaegher, Mr. Bert Desmet, Mr. Norbert Drese, Danny Geelen, Mr. Johan Laeremans, Luc Peeters, Dr. Pierre Van der Vaeren, Dr. Johan Van Vaerenbergh; **Brazil:** Gelson Lima, Prof. Dr. Marcio Silveira, Prof. Dr. Renato Vasconcelos Botelho; **Bulgaria:** Dr. Stela Dimkova, Mr. Deyan Kiryazov; **Canada:** Mr. Trevor Acott, Omar Al-Haimi, Christopher Andrewes, Mr. Normand Kevin Aubin, Mr. Pierre-Luc Beaubien, Mr. A Bonnyman, Dr. Stewart Cameron, Mr. Chris Chang, Andrea Dhas, Mr. Matt Edgar, Ms. Yuncai Gao, Jim Hansen, Clare Kirkland, Dr. Denise Neilsen, Julie Ms. Nichols, Mr. Nicolas Paillat, Mr. Forrest Scharf, Mr. Elias Tabello, Mr. Albert ter Meer, Mr. Richard Vollebregt, Ken Wall, Dr. Qifa Zheng; **Chile:** Mr. Fernando Calvo Gonzalez, Prof. Ana María Coronata, Maria Escalona; **China:** Hongxiang Shen; **Colombia:** Mr. Dalmiro Rodriguez, Daniel Uribe; **Costa Rica:** Felipe Arauz, Mr. Jan Tuinstra; **Cyprus:** Michalis Omerou, Ms. Loukia Vassiliou; **Czech Republic:** Dr. Jaroslav Dolezel, Dr. Jiri Zamecnik; **Denmark:** Mr. Kaj Nedergaard Jepsen; **Dominican Republic:** Dr. Emanuele Ciani; **Ecuador:** Mr. Marco Rueda Romero; **Egypt:** Mr. Tamer Okail; **El Salvador:** Ms. Jose Cuellar; **Finland:** Ms. Sanna Kukkonen, Ms. Anja Lätti; **France:** Mr. Bernard Gout, Ms. Magali Guy, Ms. Marjolaine Meyer, Ms. Marie-Lucie Pierrat, Mr. Pierre-Philippe Trinez; **Germany:** Dr. Odunayo Clement Adebooye, Prof. Dr. Renate Horn, Tina Meyer, Alberto Puglia, Ms. Eleonore Wall; **Greece:** Mr. Haralambos Hrisohoidis, Mr. George Ntaskas, Dr. Manolis Souliotis; **Guatemala:** Katheryn Plocharski; **Honduras:** Dr. Marco Castro; **India:** Dr. Ram Asrey, Prof. Partha Sarathi Munsi, Mr. Manoj Nair, Mr. Radharamanan Panicker, Mr. Balasubramanian Ramamurthy, Mr. Vivek Rangarajan, Mr. Mallesh Tigali; **Indonesia:** Tony Djohan, Dr. Iteu Hidayat; **Iran:** Ms. Azadeh Rashidi; **Ireland:** Mr. Fiann Ó Nualláin, Ms. Hazel Proctor, Mr. Bob Smith; **Israel:** Mr. Itzhak Ayalon, Mr. Ali Badarneh, Dr. Alon Ben-Gal; **Italy:** Prof. Dr. Guglielmo Costa, Prof. Pierluigi Donini, Dr. Romano Grilli, Dr. Roberto Kron Morelli, Dr. Stefano La Malfa; **Jamaica:** Mr. Chad Gardner; **Japan:** Mr. Vathana Keomany, Ms. Puangkaew Lurhathaiopath; **Kenya:** Ms. Mary O. Abukutsa Onyango, Mr. Joseph Chepsoi, Mr. Jeremy Cordingley, Dr. Christopher Ojiewo; **Latvia:** Dr. Andris Bite; **Malaysia:** Prof. Dr. Masuri Othman; **Mali:** Ms. Assétou Kanouté; **Mexico:** Raul Bribiesca, Mr. Heriberto Godoy Hernandez, Emmanuel Herrera, Mr. Orlando Lopez, Mr. Esteban Macías, Dr. Eduardo Valencia; **Netherlands:** Dr. Rob Baas, Dr. Hugo Bink, Ms. Eefje Bloed, Mr. Erik Bongers, Mr. James Kim, Jos Olijve, Mr. Aike Post, Mr. Gerard van 't Klooster; **New Zealand:** Ashley Berrysmith, Ms. Chris Cowell, Dr. Robert Henriod, Dr. Kate Maguire; **Norway:** Ms. Mette Goul Thomsen, Dr. Inger Martinussen; **Pakistan:** Mr. Ahmad Khan; **Peru:** Ms. Caro Rios Carolina Myluska, Gustavo Guerrero, Mr. Thomas Williams; **Philippines:** Ms. Czaryl Violeta Escalona-Mendoza; **Poland:** Grzegorz Hoffman; **Portugal:** Dr. Konstantin Chudinov; **Romania:** Mr. Gheorghe Giosu, Prof. Dr. Erol Murad; **Saint Lucia:** Ms. Paula James; **Serbia:** Prof. Dr. Mihailo Nikolic, Brankica Tanovic; **Slovenia:** Mr. Marko Zuljan; **South Africa:** Mr. Graeme Barnhoorn, Mr. Arnold de Wet, Boitshepo Giyose, Mr. Heinz Reinstorf, Dr. Altus Viljoen, Mr. Keith Wilson; **Spain:** Dr. Luis Miguel Albisu, Mr. Jorge I. Barmaimón Abudara, Jose Benavent, Ferran Contreras Arguelles, Mr. Frans Pinos; **Sri Lanka:** Mr. A.H.M. Sampath Abeyrathne, Dr. Hemal Dhammike Fonseka, Dr. Kamaranga H.S. Peiris; **Suriname:** Dr. Maureen Silos; **Sweden:** Prof. Torbjörn Jilar, Maria Runnerstam; **Switzerland:** Dr. Adalberto Villa, Dr. Ewald Weber; **Taiwan:** Dr. Srinivasan Ramasamy; **Tanzania:** Dr. Agnes Nyomora; **Thailand:** Dr. Siriwan Bureekam, Ms. Jeerawan Chamsungnoen, Ms. Sojiwat Sukhswasdi, Dr. Pariwat Udomsakdhi; **Tunisia:** Dr. Olfa Zarrouk; **Turkey:** Ms. Melahat Atilgan, Mr. Josef Levi, Mr. Birol Oncel; **Ukraine:** Mr. Ivan Dutchak; **United Arab Emirates:** Mr. Masih Ferdosi; **United Kingdom:** Ms. Sarah Anderson, Mr. Antony Augustine, Mr Barton, Dr. Angela Berrie, Karen Cleave, Mr. Martin Crawford, Mr. Robin Dean, Ms. Amanda Farrow, Mr. Jordi Gine Bordonaba, Dr. Paul Hamer, Mr. Krasimir Hristov, Dr. Gordon Jamieson, Ms. Sofia Kourmpetli, Ms. Judith Lonnon, Mr. Nigel MacDonald, Ms. Helena McGinty, Mr. Chris O'Toole, Mr. J B L Parsons, Mr. Benjamin Shaw, Mr. Colin Shaw, Mr. Francisco Stargardter, Ms. Eva Tallentire, Mr. David Taylor Taylor; **United States of America:** Dr. Scott Arnold, Kean Ashurst, Yacov Assa, Janina Berrios, Jessica Bolwell, Tom Branson, Ms. Lynn Butler, Thomas Callaghan, Joel Canestrino, Alfred Carl, Allan Dick, Theresa Donham, Mike Donovan, Prof. Dr. John Dunley, Dr. Jennifer Embury, Dr. Mike Farmwald, Mr. Tye Fleming, Dr. Barry Flinn, Dr. Carsten W. Glaeser, Mengmeng Gu, Bob Hall, Valerie Hannig, Stephen Harrow, John J. Haydu, Dr. Frederick V. Hebard, Ms. Jiyoung Hong, Miriam Jacintho, Mr. Brian Jackson, Prof. Dr. Norman B Javitt, Mr. Earl Kelso, Mr. Travis Kodani, Robert Lauri, Ms. Michelle Le Strange, Laurie Lineberry, Kenneth Martin, Joshua McPherson, Denise Molyneux, Rachel Mordhorst, Dr. Madhugiri Nageswara Rao, Karla Noyes, Gregory Quinn, Thomas Reardon, Sarah Reiter, Dr. Jeanne Romero-Severson, Mr. Schoen Safotu, Karnail Sandhu, Christopher Sann, Andy Schaeffer, Dr. Alexander Schauss, Prof. Dr. Bill Sciarappa, Dr. Vincent Sewalt, Ryan Smith, Sherrie Smith, Dr. Jaya Soneji, Ms. Rebecca Tashiro, Jane Trolinger, Ms. Adriana Van Hall, Phillip Waitkus, Mr. Gerard Weis, Karen Weiss, Mr. Paul Wilson, Mr. Ryan Zaninovich.

In Memoriam

CHARLES JOHNSON BISHOP (1920-2006)

C.J. Bishop in 1982

Canadian agriculture and the world of horticultural science benefited in many important ways from the life and work of Dr. C.J. Bishop who passed away in Ottawa on October 31, 2006. Raised in a fruit growing family in the Annapolis Valley of Nova Scotia and educated as a botanist and geneticist (PhD, Harvard University, 1947), Bishop was amongst the first to apply irradiation breeding techniques to apple. He also made important contributions to the development of early-ripening tomato cultivars for Eastern Canada. While primarily a scientist and research manager, his lifelong interest in horticultural crop improvement through cytology and genetics was passed along to the next generation of plant breeders. He found a way to balance his early work as a fruit breeder and ultimately Superintendent of the Kentville, Nova Scotia Agricultural Experiment Station (1947-1958) with being a professor of genetics at Acadia University. Later in life he was to be feted by Acadia University with an Honorary Doctorate of Science.

However, it was between 1960 and 1985 that Dr. Bishop was in a position to profoundly influence horticultural science and industry across Canada. Based in Ottawa, he served Canada's re-organized federal department of agriculture (re-named Agriculture Canada and then Agriculture and Agri-Food Canada) as a research coordinator, first focussing completely on horticultural crop research and then on all crop research supported by the Department. He proved to be highly influential in determining both direction and quality of plant science research within the organization. Furthermore, through leadership of Canada's Expert Committee on Horticulture, he had great influence on the entire horticultural research, education and extension community of Canada.

A quiet thoughtful man, Dr. Bishop worked tirelessly and strategically to strengthen horticultural science and industry in Canada. He was particularly influential in mentoring the Canadian Society for Horticultural Science for which he became a Life Member and Honorary President in 1968. The C.J. Bishop Award honours the best paper on horticulture in the *Canadian Journal of Plant Science*. His service to horticultural science and industry nationwide was recognized by the Canadian Horticultural Council with its Award of Merit (1972) and by Life Membership in 1985. Bishop was the first Canadian scientist to become a Fellow of the American Society for Horticultural Science (1968). The Agricultural Institute of Canada recognized him as a Fellow in 1977. His ongoing academic interest in cytology and genetics led to his election as President of the Genetics Society of Canada and a term as President of the Science Section of the Royal Society of Canada. He was recognized as a Fellow of the Royal Society in 1958.

As Canada's representative to the Council of the International Society for Horticultural Science, Dr. Bishop played an important part in the early development of ISHS. While unable to travel to the inaugural Council meeting (The Hague, 1960), he was an active participant in meetings at Brussels (1962), Edinburgh (1964) and Beltsville (1966) where the present-day form and function of ISHS was largely established. He continued in this role until 1980. He was profiled in *Chronica Horticulturae* in the July, 1970 issue.

Charlie Bishop was a well-mannered gentleman who always listened carefully and responded generously. He was an avid gardener and collector of orchids. He was an enthusiastic amateur musician (piano), enjoyed the sport of curling and was an accomplished bridge player. He served his community through Rotary International where he was an Honoured Life Member of the West Ottawa Club. He is survived by Kay, his wife of 55 years, and by their son John Bishop of Lanark, Ontario.

Norman E. Looney

CARL W. CAMPBELL (1929-2006)

Carl W. Campbell

Dr. C.W. Campbell died in Homestead, Florida on 25 November 2006.

Born in Wagner, Illinois in 1929, Dr. Campbell grew up in an agricultural environment in Illinois and was educated in Midwestern Universities. After receiving his PhD at Purdue University, he moved to Florida and worked for the U.S. Department of Agriculture at Miami for three years and, for the next thirty years, at the University of Florida. There he conducted a program of research, teaching, and extension on many aspects of the cultivation of mango and other important tropical fruits. Upon retirement from the University of Florida, Dr. Campbell worked for 10 years as a private consultant on the establishment of the mango as a commercial export crop in 25 countries of Central and South America, and the Caribbean. At the time of his passing, he was also a Research Associate of Fairchild Tropical Botanic Garden. He worked within the tropical fruit industry of South Florida for nearly 50 years and was active in international horticulture throughout tropical America, Africa and Asia. He became Executive Secretary Treasurer of the Interamerican Society for Tropical Horticulture in 1983 and held this position until 1997.

If my memory serves me correctly, I first met Dr. Campbell in 1976 during the First International Tropical Fruit Short Course The Avocado, held in Florida, although his reputation as one of world's foremost specialists in tropical fruits preceded that meeting. I recall being impressed not only by his knowledge, but particularly by his amiability and warm smile. From that moment we became friends and shared many activities related with tropical fruits. Over these last 30 years, I learnt from him many things about tropical fruit cultivation and research. He was also very cooperative with us, as he was with many other countries, as we were establishing our collections of plant material, which would eventually benefit tropical fruit industries all over the world.

One of the last times we were to meet personally was in 2004, at the Mango Festival organized by his son Richard at the Fairchild Tropical Botanic Garden, where both were invited speakers. I enjoyed, as always, the enthusiasm he projected during his lecture: a consummate teacher and raconteur, he never failed to captivate his audience.

But Carl was not only a great scientist; he also created a great family, with three of his sons also active in horticulture. No one who knew Carl can forget the strong union between him and his wife Becky, who always worked at his side, especially promoting all the aspects dealing with the gastronomy of tropical fruits, an example of which was the workshop they organized together during the Mango Festival. She may wonder why Carl has left the earth so early. I believe that there is only one reason. He wanted to take tropical fruits to heaven. As a good horticulturist he knows that to adapt new crops to new environments requires some breeding and that this takes time, but be sure that you will harvest together many fruits in the future and that the inhabitants of heaven should not only be very happy to learn about and taste tropical fruits, but also would be delighted to enjoy the smile of the tropics that Carl always carried with him.

I know that I join many others when I say that I was indeed privileged to know Carl Campbell. Our memories serve to keep him with us all a little bit longer, but surely his work will deservedly endure long after we ourselves are gone from this earth and that, I believe, is one of the greatest tribute one can render to such a good man.

Víctor Galán Saúco, Ex Chairperson
ISHS Section Tropical and Subtropical Fruits,
Vice-Chair ISHS Section Banana and Plantain

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

- March 20-23, 2007, Macon, GA (USA): **International Symposium on Medicinal and Nutraceutical Plants.** Info: Dr. Anand K. Yadav, Agricultural Research, Fort Valley State University, Fort Valley, GA 31030-4313, USA. Phone: (1)4788256830, Fax: (1)4788256376, email: yadava@fvsu.edu web: www.ag.fvsu.edu/ishsmanp.html

NEW
- April 16-19, 2007, Nadi (Fiji): **I International Symposium on Breadfruit Research and Development.** Info: Dr. John Woodend, CTA - Technical Center for Agricultural and Rural Cooperation ACP-EU, PO Box 380, 6700 AJ Wageningen, Netherlands. Phone: (31)317467100, Fax: (31)317460067, email: woodend@cta.int

- April 29 - May 4, 2007, Antalya (Turkey): **I International Medicinal and Aromatic Plants Conference on Culinary Herbs.** Info: Prof. Dr. Ibrahim Baktir or Prof. Dr. Kenan Turgut, Department of Horticulture, Faculty of Agriculture, Akdeniz University, 07058 Antalya, Turkey. Phone: (90)2423102469 or (90)2423102414, Fax: (90)2422274564, email: ibaktir@akdeniz.edu.tr or kturgut@akdeniz.edu.tr web: www.mapc2007ant.org

- May 22-26, 2007, Oeste Region (Portugal): **X International Pear Symposium.** Info: Dr. Armando Torres Paulo, c/o Pears 2007, COTHN, Estrata de Leiria s/n, 2461-997 Alcobaça, Portugal. Phone: (351)213602053, Fax: (351)262507659, email: info@pears2007.com web: www.pears2007.com

- 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: 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

NEW
- 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: isirarat@kmutt.ac.th web: www.kmutt.ac.th/QMFCP2007/ UPDATE: Deadline for abstract submission extended till January 31, 2007

- 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

- 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

- 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

NEW
- 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/

- 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

- NEW 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: isirarat@kmutt.ac.th web: www.kmutt.ac.th/QMSCO2007

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

- NEW 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

- April 6-11, 2008, Izmir (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

- NEW April 27 - May 1, 2008, Westminster, London (United Kingdom): **International Symposium Plants, People and Places.** Info: Prof. G.R. Dixon, Hill Rising, Horsecastles Lane, Sherborne, Dorset DT9 6BH, United Kingdom. Phone: (44)01935816684, Fax: (44)01935816684, email: 113541.1364@compuserve.com

- NEW 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

- 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

- 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

- 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

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Chronica Horticulturae
Author Information

Chronica Horticulturae is the quarterly publication of the International Society for Horticultural Science (ISHS) and is received by all members of the Society and numerous libraries throughout the world. Members and non-members are urged to contribute articles for consideration. However, it needs to be understood that *Chronica* is not to be construed as a scientific journal that publishes original research. Research articles appropriate for *Acta Horticulturae* or horticultural science journals are usually inappropriate for *Chronica*. We seek horticultural articles of interest to a broad audience composed of ISHS members and the horticultural, scientific, and academic communities.

Chronica Horticulturae is currently made up of seven sections as follows:

News from the Board. This section is usually confined to editorials from Board Members as well as general announcements of the Society.

Issues. Articles of a broad focus that often involved controversial topics related to horticulture including broad social issues and economic development are appropriate for this section. These articles are intended to stimulate discussion. Often, guest writers are asked to contribute articles, which usually range in size from 1000 to 2000 words.

Horticultural Science Focus. This section is intended for in-depth articles on a topic of horticulture, generally, but not always, scientific in nature. Many articles are mini-reviews, and bring current topics of interest to the horticultural community up to date. Articles may be up to 6000 words. We encourage these articles to be illustrated.

Horticultural Science News. Shorter current articles about particular topics including horticultural commodities and disciplines are welcome. Articles vary from very short notes (about 500 words) to 2000 words.

The World of Horticulture. This section highlights articles on horticultural industries and research institutions of particular countries or geographic regions throughout the world. They are meant to be profusely illustrated with figures and tables. This section also includes book reviews, which are requested by the Science Editor. Members who wish to recommend a book review should arrange for a copy of the book to reach the Secretariat.

Symposia and Workshops. Meetings under the auspices of ISHS are summarized, usually by a participant of the meeting. These articles are delegated by the symposium organizers.

News from the ISHS Secretariat. This section contains information on membership, memorials for deceased ISHS members, and a calendar of ISHS events. Brief memorials (up to 500 words) should be sent to the Secretariat.

Authors who wish to contribute articles for *Chronica* should contact headquarters and their request will be transmitted to the Science Editor or another appropriate editor. Authors should be aware that most articles should have a broad international focus. Thus, articles of strictly local interest, are generally unsuited to *Chronica*. There are no page charges for *Chronica Horticulturae*. Photographs submitted should be of high resolution. We encourage electronic submission. Send articles or ideas for articles to:

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