CHRONICA HORTICULTURAE

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Symposia and Workshops

New Floricultural Crops • Pear Growing • Root and Tuber Crops • Modelling of Plant Growth, Environmental Control and Greenhouse Environment

Horticultural Highlights

Europe's Organic Fruit Industry • Seed Treatments for Horticultural Crops • Low Carbohydrate Diets and Horticulture • Mediterranean Greenhouse Technology • Greenhouse Cultivation of Bananas

ISHS

CHRONICA HORTICULTURAE

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Editorial Office and Contact Address:

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

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Cover photograph: Plastic tunnels on the Western Coast of Central Italy (see article on Mediterranean Greenhouse Technology - Picture by courtesy of J.P. Leymonie, New Ag International)

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

ISHS

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ISHS Finances: Sound and Safe

Robert J. Bogers, ISHS Board member and Treasurer

Rob Bogers

The International Society for Horticultural Science is enjoying good financial health. Also as a result of the prudent policy of my predecessor, Richard Zimmerman, and the skills of our Executive Director, Jozef van Assche and his staff, the problems that have troubled us in the past are no longer a matter for concern. Our aim, to have a reserve of one-year's budget, is gradually coming closer; at the moment we have reached about 80% of that goal. This gives us a sound financial basis to fulfil our legal requirements, our moral imperatives to our profession and our obligations to our employees at Leuven in the case of unexpected events. We continue to follow a conservative investment policy. Our cash situation has improved, as the loans for the Toronto Congress have been repaid.

As explained by the Secretary of the Board, Uygun Aksoy, in Chronica Horticulturae 44(1) the individual membership of the ISHS has steadily increased over the last few years. This accounts for an important part of the rise in revenues of our Society in the years 2002 and 2003. Also the sales of *Acta Horticulturae* and on-line sales of articles showed a considerable increase. On the expense side, this of course meant higher costs for printing, mailing and personnel.

The year 2002 closed with a balanced result of revenues and expenses. This result became final after an amount of 86,636.11 Euro had been taken up as an exceptional provision. This provision had been made as a precautionary measure against some uncertainties related to part of the publication activities of the Society. Finally, further in 2003, it became clear that this provision had only been necessary for a very minor amount.

In 2003 the revenues reached 882,986 Euro, while expenses were 847,977 Euro; thus, the year closed with a positive net result of just over 35,000 Euro. This result became final after about 75,000 Euro of unused provisions of 2002 had been transferred to the profit-and-loss account of 2003 and taken up again as provisions for the same amount for the year

Table 1. Overview ISHS Revenues and Expenses 1999-2003.

	1999	2000	2001	2002	2003
REVENUES					
Contribution members (dues)	175,118	182,599	198,924	245,873	242,159
Sales	558,565	653,765	550,345	633,131	620,242
Other Income	11,271	12,550	13,503	12,358	20,585
Total	**744,954**	**848,914**	**762,772**	**891,362**	**882,986**
EXPENSES					
Costs books	188,591	217,824	185,560	209,604	259,422
Personnel costs	261,205	256,389	287,398	308,093	324,584
Office costs	101,035	109,329	107,842	110,656	122,086
Depreciation	6,300	5,106	2,861	4,998	4,528
General management costs	78,953	87,818	63,604	136,919	137,357
Changes in Provisions	57,104	72,342	63,899	121,092	0
Total	**693,188**	**748,808**	**711,164**	**891,362**	**847,977**
Result: Revenues over Expenses	**51,766**	**100,106**	**51,608**	**0**	**35,009**

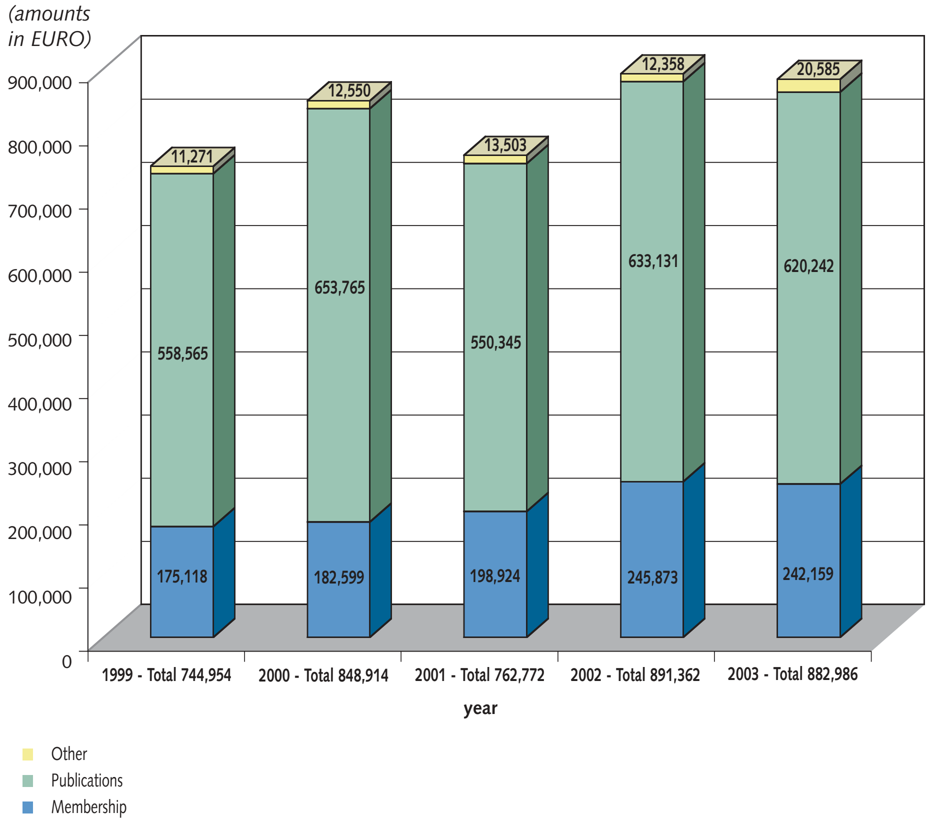
(amounts in EURO)

Table 2. ISHS Balance Sheet 1999-2003.

	1999	2000	2001	2002	2003
ASSETS					
Current Assets					
Cash and Deposits	447,207	572,245	514,966	657,309	862,511
Accounts receivable/prepayments	107,994	63,099	189,054	128,798	68,319
Inventories	58,228	71,353	63,124	89,399	55,911
Total	613,429	706,697	767,144	875,506	986,741
Long Term Assets					
Long-term receivables	51,671	50,803	13,504	13,504	2,408
Property, plant and equipment	8,401	5,130	2,268	5,853	3,736
Intangible fixed assets	0	0	0	0	4,430
Total	60,072	55,933	15,772	19,357	10,574
TOTAL ASSETS	**673,501**	**762,630**	**782,916**	**894,863**	**997,315**
LIABILITIES AND EQUITY					
Current liabilities					
Accounts payable & accrued charges	231,424	220,448	189,126	301,073	366,516
Equity	442,077	542,182	593,790	593,790	628,799
TOTAL LIABILITIES AND EQUITY	**673,501**	**762,630**	**782,916**	**894,863**	**995,315**

(amounts in EURO)

Figure 1. ISHS Revenues in Graphs 1999-2003.



2004. The reasons for taking up these provisions for 2004 were the expected costs of the Board, Council and Executive Committee meetings in Australia this year, the final expenses for the publication of the Proceedings of the XXVI International Horticultural Congress, and important new initiatives such as the Committee on Research Co-operation and new internet developments.

During its recent meeting in Crete the Board of the Society has given approval to the balanced budget for the year 2004. The results and actions mentioned above should in the future allow the Society to finance new initiatives. Thus, the Board expects to contribute to the long-term prosperity, both scientifically and financially, of the ISHS in particular and to the benefit of horticulture world-wide in general. Strengthening our relations and involvement with, and increasing our membership in, developing countries is seen as an issue that deserves a special effort. We look forward to meeting our members at many challenging symposia in these countries.

A Call for Nominations: ISHS Honorary Membership and Fellowship

Nominations for new Honorary Members and Fellows of the ISHS will be considered by the Council at its meeting in Australia later this year. Any nomination for this should be received at the Secretariat not later than July 15th, 2004, for consideration by the ISHS Nomination and Award Committee and the ISHS Board prior to the meeting of the Council.

ISHS HONORARY MEMBERSHIP

Honorary Membership, the Emeritus Award of the ISHS, is given by the Council to a person who is a member of the ISHS, at the end of his/her career, in recognition of his/her outstanding service to the Society. A certificate will be given to the recipients of this ISHS Award.

ISHS FELLOWSHIP

The ISHS Fellowship is presented to any person, regardless of his/her age, ISHS member or non-member, in recognition of this person's outstanding contribution to horticultural science worldwide and/or for his/her meritorious service on behalf of the Society. A precious metal pin and a certificate is given to the recipients of this ISHS award. The total number of ISHS Fellows should not exceed 1% of the total membership, averaged over a period of 4 years.

PROCEDURE

The ISHS Nominations and Awards Committee (hereafter: 'The Committee') invites the members of the Society, through this announcement in Chronica Horticulturae, to bring possible candidates for an ISHS Honorary Membership and Fellowship to the attention of the Society. Nominations should be accompanied by five letters of support, giving reasons why a nominee is considered worthy of an honour; these letters must come from members in no less than three different countries. Nominations must be received by the Executive Director at least one month prior to the Council meeting. The Executive Director will collect the suggestions and will send these, together with the letters of support, to 'The Committee'. After consideration by 'The Committee' and the ISHS Board, the suggestions received and motivated recommendions will be presented to the Council, which will decide who will receive the Awards. The presentation ceremony will take place at the next Congress (IHC2006 Seoul, Korea) during the General Assembly of the ISHS.

Letter to the Editor

Pineapple Wars Redux

I read with great interest the article "Pineapple Wars" that appeared in *Chronica Horticulturae* 43(4):17. Rarely, if ever, has an industry been changed so significantly by the introduction of a single new cultivar as has been the whole pineapple fruit business. Millions of dollars have been made, the recognized world leader has been toppled, and lawsuits have filed by the dozen. Even the *Wall Street Journal* has gotten into the act with a "cloak and dagger" front-page expose, while the present situation seems confusing; in actual fact most if not all of the salient facts are known.

The world leader in the production of pineapple fruit is, and has been for several years, Thailand. The Philippines and Brazil are second and third respectively. Costa Rica only leads in the production of fresh fruit, the exportation of "Golden" fruit, and is the biggest exporter to the US. The Philippines would rank second with its massive export tonnage to Japan.

Now a little history. A new cultivar, named by Del Monte as CO-2, was a cross of a Pineapple Research Institute hybrid clone #58-1184 with pollen of Pineapple Research Institute hybrid clone #59-443. The seeds were cultivated at the Pineapple Research Institute on the island of Maui in Hawaii. The breeders were Dr. David D.F. Williams, Director of the institute, originally from England, now resident in Fort Collins, Colorado, and Calvin H. Oda of Hilo, Hawaii, a graduate of the University of Hawaii and now an employee of Del Monte. The CO in the variety name came from his initials.

Neither of the parent cultivars were new, and both were known to be exceptional in some way. PRI#58-443 was given plantation trials as early as 1967 being described as "superior to Cayenne", "leading mechanically harvestable hybrid" and "a leading fresh fruit hybrid". PRI#58-1184 was field tested as early as 1969 and was noted to be of low yield but tolerant to the physiological disorder, Internal Browning.

Del Monte applied for a Plant Patent for the clone on August 23, 1993 describing it as "generally resembles the parent varieties, but is distinguished therefrom in that this plant produces a sweeter, more vitamin C rich fruit". It was also claimed to be more resistant to Internal Browning.

The patent, Plant Patent # USPP08863, was granted on August 16, 1994. This patent was obtained wrongfully as the clone was already being sold on the market by Maui Pineapple Company as "Hawaiian Gold". Maui also introduced this variety into Costa Rica and exported it under the "Royal Coast" label. This plantation has recently been sold to Dole.

In 2003 Del Monte had to back down from a lawsuit it had brought against Maui for patent infringement. It acknowledged that the cultivar was grown and marketed by Maui previous to the patent being applied for. Del Monte also agreed to "withdraw" the patent. However the US patent office states that the patent was not withdrawn but "not maintained". This means that the fees to keep a patent alive were not paid. There is a subtle difference here that the lawyers will argue over for years. Both companies also settled various other legal disputes that had arisen because of the new variety such as trademark infringement.

Actually CO-2 did not live up to Del Monte expectations and the company introduced MD-2 instead. This cultivar came from the same parentage as CO-2 and indeed was bred by the same two scientists, Calvin H. Oda and David D.F. Williams. The MD was the initials of Mary Dillard, the wife of a senior Del Monte executive in Hawaii.

Del Monte marketed the MD-2 under the name "Del Monte Gold Extra Sweet". However at no time did the company patent it. Furthermore they fulfilled none of the legal requirements of a patented fruit such as placing the patent number on the label. Del Monte was well aware that this cultivar was not patented.

Recent lawsuits against Del Monte allege that the company has stated that MD-2 was the cultivar patented. This will have to be settled in the courts of course. However there is no doubt at all that Del Monte waged a vigorous (but losing) war to prevent the spread of MD-2 planting material to other growers.

The actual source of the Dole Fruit Company's gold cultivar, Premium Select, was in dispute. Del Monte claimed it was illegally obtained MD-2. However this cannot be as there is nothing illegal about growing MD-2 as it was never patented. Furthermore Del Monte openly sold the crowns with the fruit in the marketplace without any notice that it was a protected clone. Eventually Dole and Del Monte made a confidential settlement.

There were reports of various Costa Rican growers flying to Miami, buying boxes of fruit, discarding the actual fruit and taking the crowns back to Costa Rica to start propagation plantations.

What is interesting is that the original Pineapple Research Institute was co-owned by all three of these companies at the time that the parents of the new "Golden" clones where developed. Dole Fruit left the organization about 1972. Del Monte and Maui kept it going until 1986.

So far the market for the Gold fruit continues to grow with no sign of saturation. Thousands of acres are still being planted. As it takes about 18 months to produce the first fruit from a planting, there is going to be considerable production for the foreseeable future.

The large banana producer, Chiquita, is also tapping into this huge market through suppliers in Mexico and Costa Rica, and the large fruit company, Fyffes, is also expanding production and marketing. Many other smaller marketers are desperately seeking supplies to market.

Recently Del Monte upped the ante again by announcing that they had another new cultivar, MA-2, to be marketed under the name of "Honey Gold". It is described as being sweeter than MD-2. Although the company announced that it was applying for a patent for this cultivar, the patent office states that no such application has been received so far.

That all of these antagonisms have come about is somewhat saddening as it has obscured the fact that by using modern technology, first class scientists, and a venturesome spirit, a company has been able to reinvigorate an entire fruit industry. Almost the entire worldwide industry had used the same cultivar, 'Smooth Cayenne', or selections thereof, for the last 50 years or more.

The general public has been well served by the results of the horticultural research. Consumption is up over 300%. In addition, many of the workers in some of the poorer nations of the world now have a better standard of living in the employment of the producers.

Ian Greig

Contact

Dr. Ian Greig, P.O. Box 273508, Tampa, Florida, USA,
email: iang@ag-consult.com

Situation Report

Europe's Organic Fruit Industry

Silviero Sansavini

The organic fruit industry is currently undergoing a boom throughout Europe. Nowhere is this more true than in those countries with long experience in organic and integrated crop management protocols such as bio-control and integrated pest management (IPM). Indeed, the positive impact of these approaches has made public opinion more aware of, and responsive to, environmental and food-safety issues. Countries like Switzerland, Austria, Germany, Denmark and the Netherlands had even by the early 1990s clearly shown avid interest in organic fruit produce, a support stimulated in consumer-oriented campaigns promoted by organic grower associations, new "boutique" retailing, and the demand from supermarket chains (Sansavini and Wollensen, 1992). To these initiatives are to be added the proactive efforts undertaken to disseminate, educate, and even regulate the sector at various levels by the International Federation of Organic Agriculture Movements (IFOAM) dating back to 1972.

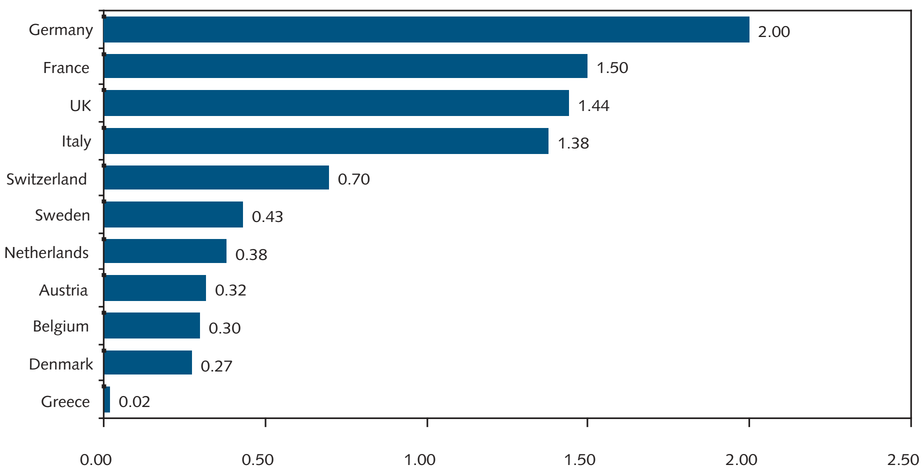
The 2004 data (Table 1) clearly show that Italy is the European leader in all organic crop sectors, with almost 50,000 ha of organic (or undergoing conversion) holdings, mostly small family-run farms and orchards, for a total crop area of almost 1.2 million ha. It is estimated, however, that tree-fruit crops account for only 1-2% of total fruit production, although there are peaks of 5% in certain regions because of olive and citrus fruits. Italy's supremacy in both total area and number of holdings is largely due to cereals and industrial crops in the central-south and islands (Sicily leading the growth trend thanks to its favourable environment) and the forage crops and livestock industry in the northern regions. While Austria has the lead in Europe in the organic industry's share of the total farm sector at over 11.3%, Italy is second or third with 7.9%. While these rates have notably increased over the last few years, organic fruit and vegetables still remain a niche market despite the energetic advertising campaigns by the large supermarket chains (e.g. Coop Italia and Esselunga in Italy) and grower associations (e.g. Apo Fruit, Apo Conerpo). The total organic food market value in Italy is estimated at US $264 million, as

Table 1. Number of holdings and surface of organic agriculture in Europe.

	N° of holdings	%	Area (ha)	%
EU 15	139,314		4,792,381	
Austria	18,560	9.2	297,000	11.6
Belgiun	700	1.2	20,241	1.5
Danmark	3,714	5.9	178,360	6.7
Finland	5,071	6.8	156,692	7.0
France	11,177	1.6	509,000	1.7
Germany	15,628	4.0	696,978	4.1
Greece	6,047	0.7	28,944	0.9
Ireland	923	0.7	29,850	0.7
Italy	49,489	2.1	1,168,212	8.0
Luxembourg	48	2.0	2,004	2.0
Netherlands	1,560	1.7	42,610	2.2
Portugal	1,059	0.3	85,912	2.2
Spain	17,751	1.5	665,055	2.3
Sweden	3,530	3.9	187,000	6.1
UK	4,057	1.7	724,523	4.2
East Europe	7,068		568,683	
Others countries	27,263		205,535	
Total	**174,257**		**5,566,599**	

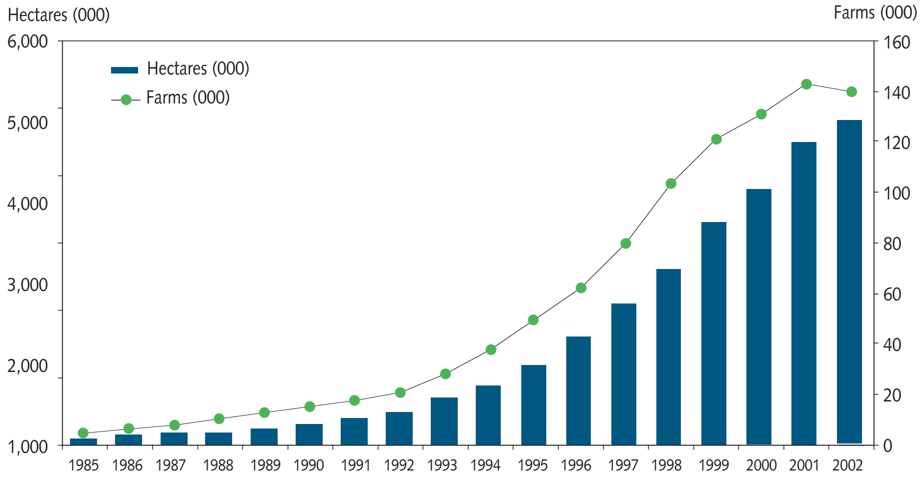
(from World Organic Agriculture, 2004)

Figure 1. Sales of organic products in Europe (2002) (billions of Euros).



(from World Organic Agriculture, 2004)

Figure 2. Trend of organic agriculture in Europe (1985-2002). Area (ha, in columns) and holdings (n°, in line).



Source: Yussefi and Willer, 2004

Table 2. Surface of fruit cultivation in Europe, 2002 (in official data).

Country	Biological surface (ha)				
	Apple	Pear	Strawberry, small fruits	Other species	Yield difference from conventional
Austria	298	28	120	56	-
Denmark	184	-	115	n.n.	-30 – 40%
France	1,060	195	15(4)	1,717(1)	-
Germany	1,600(2)	-	600	400	-15 – 30%
Greece	29	27	-	224(3)	-20 – 30%
Italy	2,000	500	100	2,130(5)	-20 – 30%
Netherlands	310	36	-n.	15(4)	-
Portugal	-	-	-	1,000(7)	-
Switzerland	244	49	34	27	-15 – 40%
Spain	-	-	-	3427(6)	

Data elaborated the University of Bozen

(1) France: other species include peach (210 ha), apricot (440), plum (623), cherry (217), kiwifruit (221)
(2) Germany: includes pear
(3) Greece: other species include peach (10 ha), apricot (15), plum (16), cherry (13), kiwifruit (41), small fruits (7)
(4) Netherlands: other species mainly includes plum
(5) Italy: other species include peach (800 ha), nectarine (400), apricot (400), cherry (100), plum (10), kiwifruit (100) and persimmon (50)
(6) Spain.This value includes all fruit species except olive (92,246 ha), citrus (909), vineyards (11,841) and nuts (33,100).
(7) Portugal. This value includes all fruit species.

compared to $378 million in Germany and $300 million in the UK (Kortbech-Olesen, 2000 and 2001) and the market value of the only primary producers are about 50% of these amounts (Fig. 1). Despite these trends there has been a re-evaluation of the outlook for organic produce due to a number of factors that have slowed market demand and, hence, grower supply (Fig. 2). The blame has fallen at various times on overly high prices, poor quality of certain produce (especially for apple, pear, peach that are harder to cultivate organically), consumer disorientation due to less-than-truthful marketing episodes and even improper labeling. These trends and factors, as well as other germane issues connected to the organic produce industry, were the basis for a European Union-wide survey undertaken by the Free University of Bozen (Kelderer et al., 2004). Only data reported for ten countries that were considered reliable and thorough are included here. The questionnaire employed to gather the data was sent to experiment stations and acknowledged industry experts, most of whom gathered the information and submitted estimates on an unofficial basis. Table 2 provides a summary of the findings expressed in terms of area for apple, pear and small fruits grown organically in these ten countries. These data may be underestimated, compared to the national statistical data, but they are realistic in terms of the importance of each fruit species.

AUSTRIA

Austria is at the forefront of organic fruit crops with 300 ha of organically grown apple, about 100 ha of other tree-fruits and as many again of blackcurrant. More than 90% of organic produce is earmarked for domestic markets and the rest exported to Switzerland and Germany. Scab, codling moth (*Cydia pomonella*), aphids and postharvest rots are the industry's main problems.

'Topaz', 'Golden Delicious' and 'Idared' are the most widespread apple cultivars being grown organically. Yields are very low: about 10 tonnes (t)/ha for apple, a figure largely due to the high number of orchards not yet bearing and 16 t/ha for pear. The farm-gate prices in 2001 ranged from 0.60-0.85/kg for apple, 0.75/kg for pear, 2-3/kg strawberry and 1.50 for blackcurrant. These were above the prices for conventionally grown fruits.

DENMARK

The country's total organic apple area currently stands at 184 ha, along with about 60 ha for strawberry and as many again for blackcurrant. Yields are notably low: less than 7 t/ha for strawberry and 2.5 t/ha for blackcurrant, 30% and 40% lower, respectively, than under conventional regimes. The 2001 farm-gate prices were € 1.30-1.60/kg for apple, up to € 1.90/kg for blackcurrant and € 3.80/kg for strawberry, constantly above the price of conventionally grown fruit. The fact that holdings are small and some growers are part-timers explains why little or nothing is invested in soil-management machinery. The range of authorized chemicals for crop protection is also notably limited.

The main apple cultivars are 'Discovery' (naturally resistant to scab) 'Ingrid Marie', 'Aroma' and 'Boskoop', although the new orchards feature 'Topaz', 'Elstar', 'Cox's Orange' and 'Holsteiner'. *Hoplocampa testudinea* is the main insect pest and scab the main disease. Fruit thinning in apple is manual; most orchards are low-density with non-dwarfing rootstocks and natural storage or standard refrigeration is employed. Strawberry is a good cash crop, although production costs are also high (e.g. weeding is manual). The most widely grown cultivars are 'Honeoye' and 'Symphony'; *Botrytis* rot is the main disease problem. 'Ben Lomond' is the main blackcurrant cultivar; the main protection problems are due to *Sphaerotheca macularis*, codling moth and *Cecidophyopsis ribes*, the virus-vector mite.

FRANCE

Although data are hard to come by, France has a fairly well developed organic fruit industry: more than 1,700 ha, mostly apple (1,060 ha). The main apple cultivars are 'Golden Delicious', 'Melrose' and Elstar; the main pear cultivars (almost 200 ha) are 'Dr. Jules Guyot', 'Williams' and 'Comice'. The industry is more extensive in the south than in the north. Indeed, the Midi boasts most exports of organic fruit and is the base for at least 20 researchers, most affiliated with GRAB (which is under ITAB, the organic fruit and vegetable technical institute) and some with INRA and the University of Montpellier. Although most of the research funds originally came from growers, today regional and EU financing are the main investment sources.

The main pest and disease problems in apple are two aphids, *Disaphis plantaginea* and *Eriosoma lanigerum*, scab, and shoot canker (*Nectria galligena*). The main stone-fruit enemies are *Monilia*, bacterial diseases and sharka or plum pox virus (more insect vectors are found in organic orchards), as well as aphids, (*Hoplocampa testudinea*) and medfly (*Ceratitis capitata*).

GERMANY

In 2000, there were 1,600 ha of apple and pear, 400 ha of stone fruit (mostly cherry and plum), over 250 ha of strawberry, and 350 ha of raspberry and blackberry. The farm-gate figures for 2000 were € 1.19/kg for apple, € 1.50/kg for pear, € 3/kg for strawberry and for cherry, and € 6/kg for raspberry and blackberry. The domestic market absorbs 90% of this organic production and 10% is exported to Scandinavia.

Apple yields in the mostly extensive orchards are low, about 15-30% below standard orchards. The main cultivars are 'Elstar', 'Cox's Orange', 'Jonagold', 'Gloster' and 'Roter Boskoop'. The principal pear cultivars are 'A. Lucas', 'Conference, 'Clapps Favorite' and 'Williams'. The main disease and pest problems in apple are from scab, fire blight, codling moth, *Hoplocampa*, aphids and mites; those in pear, apart from scab and fire blight, include *Pseudomonas*, psylla and *Phytoptus pyri*; in the European plum they are *Pseudomonas syringae* and leaf russeting; in cherry *Monilia*, aphids and medfly; in strawberry *Botrytis* and the insect *Anthonomus rubi*; and in the other small fruits *Phytophthora*, *Didymella*, *Leptosphaeria* and the insect *Byturus tomentosus*.

GREECE

The 2001 data indicate just over 290 ha total organic fruit area – 29 under apple, 26 pear, 18 peach and nectarine, 75 apricot, 16 plum, 73 cherry, 47 kiwifruit and less than 6 for strawberry, raspberry, persimmon and other small fruits. The yields average 20% lower in most stone fruits and 30% lower in pome fruits than those of conventional orchards, but the decline is barely 10% for apricot and kiwifruit.

The main apple cultivars are: 'Delicious' ('Starking', 'Starkrimson', 'Red Chief') and 'Golden Delicious'; 'Coutula', 'Kristali' and 'Duchess' in pear; 'Loadel', 'Andross' and 'Evarts' for cling peach and 'Redhaven', 'Marie Louise' and 'Maria Bianca' for freestone peach; 'Bebeco' and 'Diamante' for apricot; 'D'Agen', 'Stanley', 'President' for European plum and 'Beauty' and 'Black Star' for the Japanese-American plums. The main pathogens and pests include: scab, *Carpocapsa* (*Cydia*) and *Monilinia* and other rots in apple and the same with the addition of *Psylla* in pear, *Taphrina deformans*, *C. beijerinckii*, *Monilinia laxa* and *M. fructigena* in cling peaches; *C. beijerinckii*, *Monilina* and medfly (*Rhagoletis cerasi*) in cherry; and *Alternaria* in kiwifruit.

Almost all the fruit is for fresh market, although a small share of cling peaches is earmarked for processing; about 30% of the kiwifruit is exported to Germany and about 20% of the peaches to Germany and the UK. The 2001 farm-gate prices were € 0.80-0.90/kg for apple, € 0.50-70/kg for peach, € 2-2.50/kg for cherry, € 0.40-55/kg for kiwifruit and up to € 10/kg for raspberry. The Greek organic industry shows solid potential for growth.

ITALY

In 2002, the organic area of pome and stone fruits stood at 36,400 ha (with 14,300 ha under conversion). To these are to be added the 10,800 ha of walnut, hazelnut and other nuts, 18,900 ha of citrus, 102,000 ha of olive and 37,400 ha grapevine. In other words, Italy's organic area, as Spain's, exceeds the total of all other EU countries taken together (which in 2000 stood at 41,000 ha of which 28,000 ha was in France alone). However, while these figures might warrant a good deal of optimism, the apparent slow-down in the growth rate makes for a more guarded outlook. It should also be noted that, about 65% of the country's entire organic fruit supply goes through the Apofruit consortium at Cesena, and that the VOG (the main cooperative in Bozen Province) and other marketing arms in the South Tyrol's Bozen area accounts for about 800 ha of organic apple orchards.

Cultivar choice is another key element in organic regimes. The use of scab-resistant cultivars in Italy's organic orchards is modest at best (e.g. only 20 ha in the South Tyrol), especially when compared to what growers are doing in north-central Europe. It should also be noted that scab-resistant apple cultivars are rare even in integrated production systems. Evidently mirroring market trends, growers prefer to employ the most popular consumer and industry cultivars, despite their being highly susceptible to a number of diseases. This might seem paradoxical until one recalls that conventional growers aim for high quality standards that organic regimes can only deliver in certain years and at high risk. Yet it is worth noting too that there are districts like the Val Venosta where organically grown 'Golden Delicious' do fairly well and far better than in valley floors or in the lowlands. Organic 'Gala' and 'Braeburn' clones also do well in Alpine districts and, in the south, 'Annurca' usually responds well to organic regimes.

THE NETHERLANDS

In 2001, the total apple area was 310 ha, with average yields at 12 t/ha, i.e. 40-70% lower than in conventional orchards (a situation aggravated by alternate bearing). The main apple cultivars include 'Elstar', 'Cox's Orange Pippin', 'Jonagold', 'Boskoop' and 'Santana' (only the latter scab-resistant and new). Pear area stands at 36 ha, with average yields of 7 t/ha and that for European plum at 15 ha. Overall, the organic yield drop, including that for stone fruits, ranges between 20-50%. The usual pests and diseases are also found along with an alarming increase in postharvest rots. The 2001 farm-gate prices were € 1.10/kg for apple and € 1.35/kg for pear.

PORTUGAL

There are about 1,000 ha of organic apple, pear, peach and cherry. Most of the apple cultivars are old local ones – 'Bravo de Esmolfe', 'Porta da Loja', 'Pipo de Barto' and 'Riscandinha' – and the main pear cultivar is the well known 'Rocha'. The key problems facing the organic industry here appear to be inadequate crop-management skills, a high risk-inducing factor, and excessively high production costs such as energy inputs and lack of sufficient infrastructures jeopardizing growers' returns on investment.

SPAIN

Spain has seen a surge in organic area: over the five years 1997-2001. Total area went from

150,000 to nearly 500,000 ha under duly registered crops, or about 25% yearly, with approximately 16,000 holdings. However, if we add to these figures the number of holdings undergoing conversion to organic management, the total jumps to more than 1 million ha. The leading regions are Extremadura and Andalusia (280,000 ha combined), followed by Catalonia and Aragon, each at about 50,000 ha. Cereals account for 70,000 ha, olive 82,000, grape and nuts like almond and walnut about 33,000 ha each, but tree-fruit crops for only 3,500 ha, with vegetables a bit lower still and citrus at less than 1,000 ha. Note that, contrary to what might be assumed, almost all of Spain's organic crops are grown for export, Germany being the prime customer. Spain's environment, especially in the south where rainfall is scant in spring-summer, is highly favourable to organic crops and it is promoting massive advertising campaigns backed by large supermarket chains throughout Europe.

SWITZERLAND

The organic apple area jumped tenfold in the decade ending 2001 to 244 ha, with yields of about 16 t/ha, i.e. about 15-30% lower than that for conventional orchards. About the main cultivars, the most surprising fact here is that the scab-resistant cultivars now account for 14% of the total (with Topaz representing a third), a probable record share in Europe. Pear, on the other hand, accounts for about 50 ha 'Conference', 'Buona Luisa', 'Alexander' and 'Williams' the main cultivars; cherry stands at about 6 ha, the main cultivars being the local 'Langstieler' and 'Baster Adler' and the new ones 'Kordia' and 'Regina'. The 19 ha of organic strawberry show 20-40% lower yields than with conventional ones. There are 6 ha of organic peach, 2 ha of apricot and plum and about 15 under small fruits. Farm gate figures show € 1.36/kg for apple and € 4/kg for strawberry, with about 80% of the latter earmarked for processing.

Crop protection measures in apple are mainly focused on pathogen attacks of scab, mildew (*Podosphaera leucotricha*), *Pseudomonas syringae*, and of codling moth and aphids in preharvest and *Gleosporium* rots in postharvest on 'Pinova', Topaz' and 'Maygold'. *Monilinia* is the main problem in stone fruits, although *Xanthomonas pruni* and various aphids also are a problem in cherry.

MANAGEMENT SKILLS AND EXPERIMENTATION

Growers employing organic regimes are expected to bring greater attention to details, greater commitment and be more proactive both as to their protocols and to their work in general than those who are committed to integrated production (IP) systems. This is because every new season brings new challenges, especially in terms of crop protection. For example, a treatment that may have worked the previous year, can readily turn out to be inadequate the next. There is also the fact that while most growers are, at least, potentially capable of successfully applying IP protocols, this is true only for some when it comes to organic regulations. There is, unfortunately, even a certain mind-set among a segment of growers who think, wrongly, that sitting back and letting nature take its course is the best rule of thumb to get the desired results with organic production. Upgrading both crops and growers' skills will need more research and experimentation targeted to each district and extension services that are up-to-date with the proper know-how.

Nonetheless, the overall view of the supply and demand trends for organic crops and produce are still fundamentally expanding. As Zanoli and Micheloni (2003) have noted, the Mediterranean countries have little weight they can bring to bear in the EU's decision-making process here, a fact due in part to the dearth of experimental data and to organizational shortcomings of the organic industry's pipeline and regulatory mechanisms. This can

Figure 3. Logos of private or state organic marketing labels in Europe.

Austria (state)	Belgium (private)	Czech Republic (state)
Denmark (state)	Finland (state)	France (state)
Germany (state)	Netherlands (state)	Norway (private)
Spain (state)	Sweden (private)	Switzerland (private)

Figure 4. Organic pears in the Italian market.

Figure 5. 'Topaz' apple is the most widespread scab-resistant cultivar in European organic production.

be seen, for example, when it comes to setting out trade and marketing standards and in determining promotional measures and incentives for organic produce. Yet, as the economists have pointed out, it is best for organic produce to carve out its own share of the market in competition with other kinds of produce without having to rely on market-distorting subsidies. The Fig. 3 shows several of the most spread logos of organic producers and Fig. 4 and 5 show packages of organic fruits.

Italy, along with France and Spain, due to the large area of organic produce, has been developing new marketing strategies. This is especially true for organic strawberry and peach. These crops all have a season ranging over 3-4 months and an area stretching from the Piedmont and Veneto all the way to the September-October picking dates in Sicily – a seasonality span calling for a continuous supply flow and a sectoring of the market that go well beyond the usual characteristics of a niche trade. Indeed, another key facet of the supply picture is the lack of planning by the marketing arm as well. Wholesalers like APOs, which are also responsible for applying policy directives, are not strong enough to develop by themselves strategic marketing plans without taking into account the policy system the individual EU countries are supposed to promote, encouraging consumer demand for organic produce being the first step.

Another noteworthy item for the organic agenda is greater use of hardy cultivars resistant to pests and diseases with good adaptability to a range of growing districts. In fact, if one were to think solely in terms of apple, this could even lead to a whole new marketing line in itself. Another important effect would be to educate and habituate consumers to fruits of this type, which the public believes are safer and healthier, as well as distancing themselves from the usual cultivars by their different pomological profiles, appearance and lower price range. This strategy could also be extended to the promoting of certain local cultivars having a long-standing tradition among a district's growers and consumers and endowed with certain quality traits, although at least for the moment such a tack would remain a niche within a niche.

The initial research conducted so far has not resolved the controversial quality comparison between organic and integrated/conventional fruit. While Weibet et al. (2000) and Weibel and Grab (2001) report that organically grown 'Golden Delicious' apples in Switzerland were crispier and qualitatively superior to their conventional counterparts, Gaiani et al. (2004) found for the same cultivar in Italy's Trentino district better quality under integrated management, although both regimes exhibited wide variability depending on plant status and year.

A glance at the organic industry in North America appears to show sustained growth. According to Kortbech-Olesen (2003), this situation points to an equally favourable outlook in the trends: *"With sales of organic produce almost at US $9.5 billion in 2001, the United States is the largest worldwide market for this product group. Industry sources note that in the last few years the rate of growth has been notably high (of the order of 20% or more yearly) and that it is expected to continue in the short and long terms. According to some analysts, sales of organic produce might even hit the $20-billion dollars by 2005, although other, less optimistic observers claim that it will take longer to reach this target."*

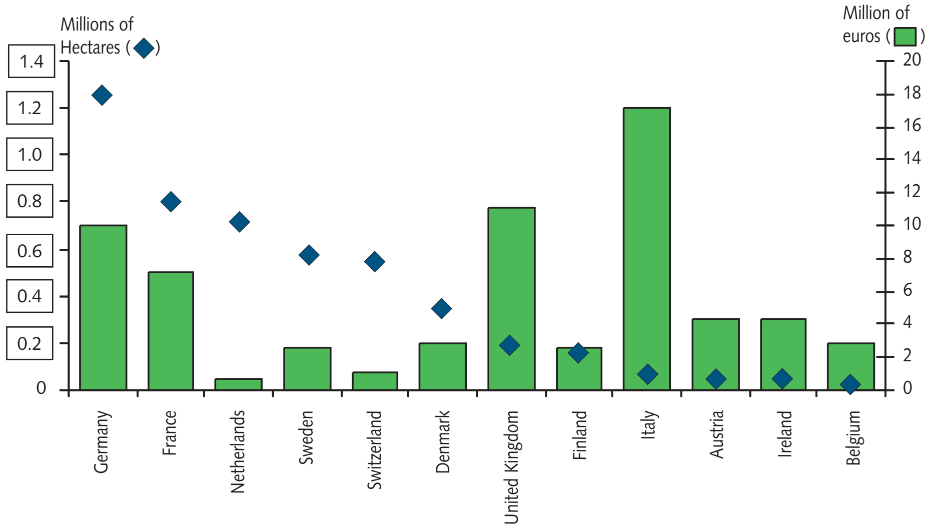
The overall picture that emerges from this review and overview is that there are certain problems and potential risks. Surpluses of certain products, a drop in consumer prices, and competition from other sustainable crop-management systems are key examples underscoring the relative uncertainties possibly looming in the future of the organic food industry. Estimated sales of organic produce in all western countries, including North America, for 2001 were $20-25 billion and the 2002 forecast for the key markets here is $22.5-27.5 billion.

CONCLUSIONS

Because the organic fruit orchards are less productive and more exposed to pests and diseases, the price must be higher than conventionally produced fruits. Due to the production, distribution and saturation of the market as well as marketing problems in the last few years, Europe needs a special "plan of action" in order to harmonize and revise several items: guidelines, laws, rules and controls, marketing and promotion in order to advance the demand for organic produce and to go beyond the niche market that organic produce finds itself.

We believe that in this situation, there is a large role for research in many fields: (1) plant protection using new biological and biotechnological tools and methods; (2) soil management and organic fertilization methodologies; (3) genetics and breeding to obtain natural resistance and to overcome biological stress; and (4) to work deeply on fruit quality maintenance (Sansavini and Kelderer, 2004). However the amount of funds for organic research differ significantly from country to country (Fig. 6). Germany provides more than 16 millions euros annually, The Netherlands and Switzerland spend 8-10 millions euros, while Italy and Ireland provide less than 1-2 ml euros.

Figure 6. Total financial support for organic agricultural research in 2002 (billions of Euros, points) and surface of organic culture (millions of hectares, columns) in 12 European countries. (from Willer and Yussefi, 2004)



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About the Author

Silviero Sansavini

Dr. Silviero Sansavini, President of ISHS from 1996 to 2000, is Chairman of the Department of Fruit Tree and Woody Plant Science, University of Bologna, Italy

(fruitseg@agrsi.unibo.it)

Horticultural Science Focus

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Advances in Seed Treatments for Horticultural Crops

Jung-Myung Lee

INTRODUCTION

Seed treatment technology has been undergoing rapid changes concomitant with the development of new concepts, methods, materials, machines, growing structures, and cultural practices. Seed treatment can never be an independent technology but rather involves a series of procedures from seed harvesting to sowing. Rather simple and less expensive processing or treatment technology can be applied for field crops that require a large quantity of seeds and where, in most cases, germination takes place without much difficulty. In contrast to field crops, horticultural crop seeds are extremely variable and expensive and the germination behavior is much more complicated mainly because of its extreme diversity of crops, species, and cultivars. The purpose of this paper is to introduce some of the recently developed seed treatment methods and discuss benefits and disadvantages related to the newly devised seed-treatment technology with special emphasis on agrochemical-free seeds and labor-saving cultural practices for horticultural crops.

Definitions

Seed treatment is defined here as a part of seed processing which includes a series of procedures from harvesting of seeds or fruits, after-ripening of fruits in some cases, extraction and fermentation, cleaning and pre-drying treatments, drying and sorting (or separation), various treatments for dried seeds such as physical, chemical, and biological treatments, several enhancement methods such as dormancy breaking, priming, pregermination, and possibly other treatments. For value-added horticultural seeds, several of the treatments listed above can be applied as an integrated treatment or integrated enhancement processing (Khan, 1992; PJB, 1994; Desai et al., 1997; Taylor, 1997; McDonald et al., 2001; Halmer, 2003). With the rapid increase in utilization of plug seedlings being produced in modern greenhouses with fully or semi-automated management systems as well as the also explosive use of grafted seedlings for some vegetables worldwide, farmers or seedling growers are now willing to pay more for those high-valued seeds when specific requirements are satisfied. This is especially true for horticultural crops in which uniformity and vigor of seeds and seedlings, and finally the produce, are regarded as the key components for successful production. Therefore, optimum seed treatment methods vary not only with the kind of crops and cultural practices but also with the preference of the farmers or growers. For example, ordering a certain amount of horticultural crop seeds, either primed and/or pelleted, has become one of the routine cultural practices for many growers. Pelleted seeds of lettuce, carrot, petunia, or tobacco will be vital for efficient mechanical sowing (Cantliffe, 1997). Supply of virus-inactivated seeds is the major prerequisite for solanaceous crops (pepper and tomato), cucurbitaceous crops (watermelon, cucumber, melon), and various rootstocks for watermelons and cucumbers (Hopkins et al., 2001; Hopkins and Thompson, 2002; Lee and Oda, 2003; Lee et al., 2003), tomatoes and peppers (MISSING), and *Brassica* crops (Hwang et al., 2001; Lee et al., 2003). Uniform germination and high vigor are vital for grafting, especially for machine or robot grafting, since overgrown and smaller seedlings cannot be used (Lee and Oda, 2003). Therefore, integrated treatments, rather than a specific single treatment, are being applied to most of the value-added horticultural seeds (Khan, 1992; Greathead, 2003; Lovic and Hopkins, 2003).

Benefits of Seed Processing Treatments

Some seed treatments such as heat and scarification are familiar practices and have been used by growers at sowing time. Some recently developed treatments are still being researched. The benefits of seed treatments vary with crops and cultural practices (Table 1), but can be summarized as follows (George, 1999; Khan, 1992; Khan et al., 1995; McDonald et al., 2001; Desai et al., 1997; Taylor, 1997):

1. Reduce or inactivate seed-borne pathogens such as viruses, bacteria, and fungi.
2. Control and/or prevention of soil-borne diseases.
3. Enhancement of seed and seedling vigor.
4. Facilitate handling and mechanical sowing.
5. Efficient and accurate addition of agrochemicals, nutrients, plant bioregulators, and others.
6. Supply useful microorganisms.

Table 1. Major benefits of seed treatment methods (1).

Treatment	Major category	Major purpose or application	Horticultural crops
Physical	Separation	Seed quality upgrading	Most crops
	Scarification	Fast & uniform germination	Hard seeded crops
	Partial removal	Fast and higher rate of germination	Cotton, carrot, others
	Irradiation	Sterilization seed-borne diseases	Some crops, if needed
	Heat treatment	Sterilization seed-borne diseases	Many vegetables
	Dry heat treatment	Sterilization of seed-borne diseases including tobamovirus and others	Solanaceous & cucurbitaceous vegetables
	Film coating	Facilitate handling and others	Most seeds
	Pelleting	Facilitate mechanical sowing and handling	Small seeds such as lettuce, carrot, petunia
	Seed tape or pad	Facilitate mechanical sowing	Radish, carrot, onion
	Pericarp removal	Partial or complete removal	Spinach
	Prehydration (2)	Seed soaking or humidification	Many vegetables
Chemical	Pesticides treatment & Insecticides treatment	Control of seed-borne diseases and insects in seeds and seedlings	Most vegetable and field crop seeds
	Plant bioregulators treatment	Dormancy breaking, overcoming secondary dormancy, seedling growth control	Selected vegetables and medicinal plants
	Dormancy breaking chemicals	Dormancy breaking and fast & uniform germination	Peppers and others (use of KNO_3)
	Chemical scarification	Partially soften hard seed coat	Crops having hard seed coat or pericarp
	Nutrients enrichment	Fast and uniform seedling growth	Small-seeded crops
	Seed coat treatment	Virus & other pathogens inactivation (Na_3PO_4, methybromide, NaOCl)	Peppers & melons
Biological	Useful microorganism	Root nodule bacteria	Legumes
	Other microorganism	*Trichoderma*, *Bacillus*, *Rhizobia*, *Pseudomonas*, and others	Most crops
Physiological	Stratification	Dormancy breaking	Fruit trees & ornamentals
	Chitting	Pre-germination	Growers level mostly
	Osmotic priming	Priming with osmoticum,	Most crops (small seeded)
	Solid matrix priming	Priming with solid materials	Most crops (large seeded)
Integrated	Any combination of the treatments listed above	Priming and film coating Scarification and pelleting	Priming and pelleting Usually small seeded crops such as lettuce, pepper, petunia, salvia, etc.
	Synthetic seeds	Produced by tissue culture method and treated with several means	Carrot, sweet potato

(1) Refers to those applied to dried seeds for immediate sowing or a long-term storage.
(2) May be physiological.

Table 2. Seed-borne vegetable diseases that can be inactivated by heat treatment (HT), dry heat treatment (DHT), hot water treatment (HWT) or other heat-related treatment.

Crop	Disease	Seed treatment
Radish	*Alternaria brassicae*	50°C HWT for 10-40 min after 6 hr cold water soaking; 75°C DHT for 72 hr
Brassicas	Black spot (*Alternaria*)	50°C HWT for 30 min after 6 hr cold water soaking; 75°C DHT for 72 hr
	Rhizotonia root rot	50°C HWT for 30 min after 6 hr cold water soaking
	Bacterial leaf spot	50°C HWT for 30 min after 6 hr cold water soaking
	Xanthomonas campestris	50°C HWT for 15-25 min after 6 hr cold water soaking
	Black ring spot	50°C HWT for 20 min
Lettuce	*Cercospora* leaf spot	40°C HWT for 30 min
Celery	Early light	50°C HWT for 25 min
	Erwinia carotovora	50°C HWT for 25 min
Eggplant	Brown spot (*Phomopsis* blight)	50°C HWT for 30 min
Tomato	Leaf mold	70°C DHT for 48 hr
	Stem canker	45-50°C HWT for 30 min
	Damping-off	50°C HWT for 30 min
	Bacterial canker	50°C HWT for 1-2 min followed by 55°C for 25 min & washing
	Tobacco mosaic virus (TMV)	70°C DHT for 48 hr
Pepper	Tobacco mosaic virus (TMV)	70°C DHT for 48 hr
Cucurbits	Anthracnose	50°C HWT for 15 min
	Cucumber green mottle mosaic virus (CGMMV)	70°C DHT for 48 hr or a long-term storage
	Fusarium root rot	55°C HWT for 15 min
	Scab (*Cladosporium* sp.)	70°C DHT for 48 hr
	Fusarium in bottle gourd	75°C DHT for 7 days
Carrot	Bacterial blight	50-53°C HWT for 20 min
Sweet corn	*Ustilago zeae*	45°C steam for 3 hr
	Bacterial wilt	53°C DHT for 3 hr

(*) Numerous other pathogens could be inactivated by higher DHT.

Table 3. Comparison of several detection methods for CGMMV in the heavily infected bottle gourd seeds after various seed treatments.

Treatment	Detection (%)			
	HDLPAT (1)	RT-PCR	ELISA	Bioassay (2)
Control	100.0(24/24³)	100.0(24/24)	95.8(23/24)	50.0(12/24)
Dry heat treatment (4)	100.0(24/24)	41.7(10/24)	54.2(13/24)	0.0(0/24)
Na_3PO_4 10% + Wash (5)	8.3(2/24)	20.8(5/24)	29.2(7/24)	16.7(4/24)
K3PO4 10% + Wash	16.7(4/24)	29.2(7/24)	29.2(7/24)	25.0(6/24)
NaOCl 1.0% + Wash	16.7(4/24)	8.3(2/24)	0.0(0/24)	33.3(8/24)
$Ca(OCl)_2$ 1.0% + Wash	16.7(4/24)	20.8(5/24)	8.3(2/24)	33.3(28/24)
Benomyl 0.5%	100.0(24/24)	41.7(10/24)	33.3(8/24)	16.7(4/24)
Topsin M 1.0%	100.0(24/24)	8.3(2/24)	37.5(9/24)	8.3(2/24)

(1) High density latex particle agglutination test (Kim and Lee, 2000).
(2) The sap extracted from a bottle gourd seed was inoculated on the leaf of *Chenopodium amaranticolor*.
(3) No. of seeds infected/no. of seeds tested.
(4) Seeds were treated with dry heat at 35°C for 24 hr, followed by 50°C for 24 hr, and finally by 75°C for 72 hr, respectively.
(5) Seeds were soaked in each solution for 60 min followed by washing with water.

7. Reduce labor needed for pest management.
8. Increase tolerances of seedlings to adverse environmental conditions.
9. Reduce the total amount of agrochemicals for crop protection.

The most common purpose of seed treatment for many field crop seeds as well as for many horticultural crop seeds had been confined to control diseases, especially seed-borne. Different treatments are imposed on seeds depending upon the seed sources such as crops, cultivars and seed lots, seed quality, presence and severity of seed-borne pathogens, and other factors. Field crops are not usually subjected to extensive treatment mainly because of the bulk of planted seeds, high expenses required for treatment, difficulties in applying modern seed treatment technology, safety problems associated with the improper use of treated seeds, residue problems, possible phytotoxicity or growth inhibition effects, and environment-related issues.

SEED TREATMENT METHODS

Dry Heat Treatment

Dry heat treatment (DHT) is one of the extensively used physical treatments of seeds. Hot water treatment, alternative treatment with cold and hot water, or high temperature treatment have been practiced rather extensively by growers, but not extensively by seed companies or seed producers mainly because of the problems associated with seed soaking in water. However, dry heat treatments of high-valued seeds are extensively applied to certain crops (Jang, 1998b; Kim and Lee, 2000; Kim et al., 2003), especially to high-priced hybrid seeds of vegetables. Seeds safely treated with dry heat include cucurbits (watermelon, melon, cucumber, squash, gourd, and various rootstocks), solanaceous crops (tomato, pepper, eggplant, true seeds of potato), and *Brassica* crops (cabbages and Chinese cabbages, radishes, etc.) and other vegetables such as lettuce, spinach, and carrot (Table 2).

Table 4. Seed germination of cucurbitaceous crops as affected by dry heat treatment.

Treatment	Watermelon 'Bitna'	Squash 'Hongtozwa'	Squash 'Geumsul'	Cucumber 'Baeknok'	Bottle gourd 'Partner'	Melon 'Wonderful'
Early germination % (5 days after sowing)						
Control	96.7 a[2]	95.0 a	96.7 a	98.3 a	73.3 a	98.3 a
35-50-65[1]	98.3 a	96.7 a	95.0 a	85.0 b	66.7 a	100.0 a
35-50-70	100.0 a	100.0 a	96.7 a	86.7 b	66.7 a	100.0 a
35-50-75	95.0 a	95.0 a	98.3 a	86.7 b	43.3 b	95.0 a
35-50-80	95.0 a	76.7 b	88.3 b	78.3 c	30.0 b	93.7 a
35-50-85	91.7 a	41.7 c	86.7 b	51.7 d	5.0 c	90.0 a
Final germination % (10 days after sowing)						
Control	96.7 a	98.3 a	96.7 a	98.3 a	80.0 a	100.0 a
35-50-65	98.3 a	100.0 a	96.7 a	95.0 a	80.0 a	100.0 a
35-50-70	100.0 a	100.0 a	96.7 a	93.3 a	88.3 a	100.0 a
35-50-75	98.3 a	98.3 a	98.3 a	96.7 a	85.0 a	95.0 a
35-50-80	100.0 a	100.0 a	96.7 a	91.7 a	88.3 a	100.0 a
35-50-85	98.3 a	98.3 a	93.3 a	76.7 b	81.7 a	93.3 a

(1) Seeds were treated with 35°C for 24 hr followed by 50°C for 24 hr, and finally 65 to 85°C for 72 hr.
(2) Mean separation between treatment within a cultivar by DMRT at 5%.

Table 5. Effects of DHT on seed germination of various vegetables. Seeds were treated with dry heat at 35°C for 24 hr followed by 50°C for 24 hr and finally at 75°C for 72 hr.

Crop and number of cultivars tested	Germination in petri dish (%)	Seedling emergence percentage in seeds sown in cell trays in greenhouse (%)			
		Dry heat treated seeds		Control seeds	
		7 DAS (1)	14 DAS	7 DAS	14 DAS
Pepper (30)	80.0	96.5	98.0	96.8	98.3
Eggplant (2)	59.5	68.5	80.2	55.7	75.3
Tomato (5)	88.5	80.0	92.3	78.8	95.5
Lettuce (12)	98.0	95.0	97.6	96.7	99.0
Radish (11)	95.9	95.6	98.4	96.0	99.0

(1) DAS = days after sowing

The major advantages of DHT, despite the requirements of special equipment and considerable time (Jang, 1998a; Jang, 1998b; Lee et al., 2003), include:

1. Complete inactivation of certain noxious seed-borne viruses, such as tobacco mosaic virus (TMV), cucumber green mottle mosaic virus (CGMMV), lettuce mosaic virus (LMV), and others (Kim and Lee, 2000; Lee et al., 2000 & 2003).
2. Safe and complete inactivation of noxious seed-borne bacterial diseases such as *Erwinia*, and fungal diseases such and *Fusarium*, *Alternaria*, *Cladosporium*, and others (Table 3).
3. Safe large-scale operations by seed producers.
4. Easy applications of additional seed treatments such as priming after DHT, if needed.
5. Ideal for supplying healthy seeds for organic growers since seeds are not treated with agrochemicals.
6. Specific DHT machines have been developed and are commercially available (Joung et al., 2002).

Seeds are routinely treated with maximum temperatures of 70°-75°C for 3-5 days, although the maximum temperature and duration of treatment vary slightly with the crop and seed sources (Table 4). Since seeds are negatively influenced by extreme high temperature, lowering the seed moisture contents is reduced to below 4% before exposing the seeds to the maximum temperature. Gradual increases in temperature from 35° to 75°C (or maximum temperature) are important for successful DHT. For example, seeds are initially treated at 35°C for 24 hours followed by 50°C for 24 hours and finally by 75°C for several days.

Gradual decrease in temperature, gradual increases in seed moisture contents up to 6%, and a certain period of post-treatment conditioning of the treated seeds are also important for successful DHT. Continuous airflow in the DHT machine is important for even and fast drying. Even distribution of temperature among the seeds located in the different places within the chamber is the key function of the DHT machine (Joung et al., 2002; Lee et al., 2003). If properly treated, complete inactivation of the target seed-borne virus and some seed-borne fungi such as *Fusarium* can be obtained with little or no injuries to seed and seedlings (Tables 4 and Table 5).

Improper DHT often results in slight to severe incidence of phytotoxicity, i.e., twisting of cotyledons to complete killing of seed. Seedling emergence is considerably delayed by DHT even though final germination percentage is little or not influenced (Fig. 1). However, most of these phytotoxicity symptoms can be minimized by using DHT machines, specifically designed to control the temperature gradually with time changes and moisture control during the DHT (Fig. 2). Seed priming of the dry heat treated seeds greatly promotes early germination thus resulting in even and faster growth as compared to the non-treated seeds (Fig. 3).

The presence of seed-borne viruses can be easily detected by ELISA. The seed-borne virus can also be partially inactivated or reduced by other methods but complete inactivation is possible only with DHT. However, even seeds treated with dry heat show positive response to ELISA and bioassays have been the only means of confirming the virus inactivation

Figure 1. Phytotoxicity symptoms associated with inadequate dry heat treatment of cucurbitaceous crop seeds. Left: Various phytotoxicity symptoms caused by improper treatment of dry heat (A: cotyledon twisting; B: Check; C: Holes in cotyledon; D: Cotyledon tip contraction; E: Chlorotic spot in cotyledon, F: White streaks in cotyledon; Right: emergence of intact bottle gourd seedlings in cell tray (left) and significant delay in seedling emergence in dry heat treated ones (right), respectively.

Figure 2. Dry heat treatment machine manufactured by Koregon, Korea. From left: Large, medium, and small machines.

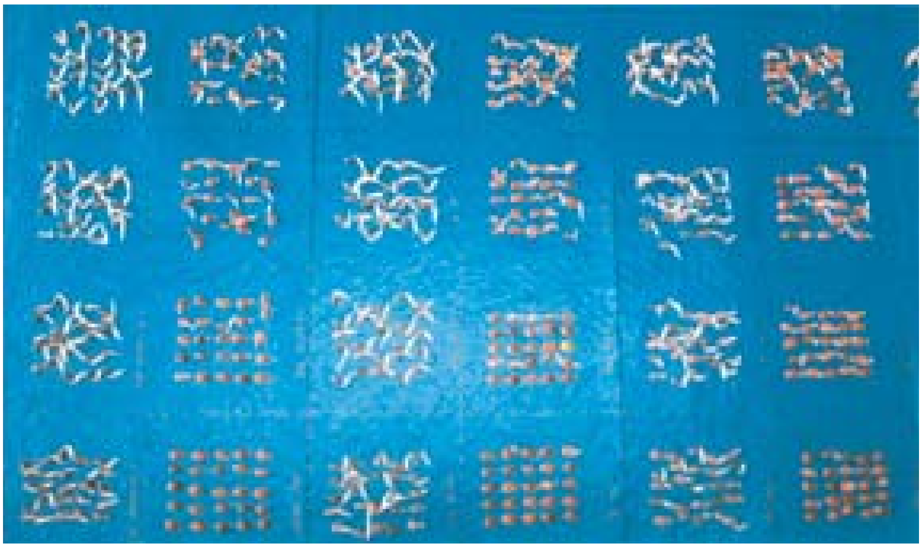

Figure 3. Effects of dry heat treatment on ‘Festival’ watermelon seeds and promotion of seed germination by solid matrix priming treatment. From top row to bottom: Germination temperatures in thermogradient table; 24.5, 23.0, 21.5, and 20.0°C, respectively. From left to right: Germination of seeds treated with DHT+Fungicides+SMP, DHT+fungicides, DHT+SMP, DHT only, Check+SMP, and Check only.

Figure 4. Seed germination of cucurbits treated with inadequate dry heat treatment. Left: Significant delay in early germination in cucumber (up), bottle gourd (middle), and watermelon (down); Right: Root soft rot caused by *Mucor* and Rhizopus fungi aggravated by dry heat treatment.

(Kim and Lee, 2000; Lee et al., 2003). Recent development of RT-PCR method has been proven to be effective for the confirmation of virus inactivation, thus greatly saving the time and technologies required for the conventional bioassays (Kim et al., 2003).

Slightly different DHT should be applied for other diseases. For example, an extended period of DHT at 75°C or higher may be required for *Fusarium* spp. in cucurbits, whereas lettuce mosaic virus needs 3-day DHT at 80°C (Lee, 2003). Seeds treated with dry heat may thus have different populations of seed-borne pathogens, if any, since not all the pathogens are inactivated by DHT. Occasional secondary infection with air-borne diseases such as *Mucos* and *Rhizopus* has been reported with dry heat treated seeds of cucurbits, especially under laboratory conditions (Fig. 4; Jang, 1998a). Addition of fungicide, if needed, effectively reduces the secondary infection. DHT can be repeated once, but not twice, for the same seed, if required. It is recommended that dry heat treated seed should be used within a year after the treatment since dry heat treated seeds frequently show reduced longevity because of the extreme stress during the DHT. However, many seed lots of cucurbits treated with dry heat and stored with silica gel in sealed boxes showed normal germination even after 4-year storage at 15-25°C.

Chemical and Biological Treatment

Brief descriptions on various chemical and biological treatments (PJB, 1994; McDonald et al., 2001; Greathead, 2003; Lovic and Hopkins, 2003) are summarized in Table 6. Because of the large number of registered chemicals in the present market, the chemicals included are based upon the registered and suggested use for horticultural crops; the bulk of chemicals for cereals and other field crop seeds are not listed in this table.

Table 6. List of chemicals and commercial products registered for seed treatment (PJB, 1994; Thompson, 1995; PGRSA, 1990; KACIA, 2003) (1).

Kind	Active ingredients (2)
Fungicides	Benomyl, bitertanol, captan, carbendazim, carboxin, difenoconazole, diniconazole, fenpiclonil, iprodione, mancozeb, metalaxyl, metconazole, oxine-copper, pencycuron, quintozene, tebuconazole, thiabendazole, thiram, triadimenol, triazoxide
Insecticides	Acetamiprid, bendiocarb, benfuracarb, carbofuran, carbosulfan, chlorpyrifos, imidacloprid, isofenphos, tefluthrin
Plant growth regulators	Gibberellic acid, tecnazene, N-acetylthiazolidin-4-carboxylic acid + folic acid, triazoles including those listed in fungicides, zeatin, plus many more
Safeners	Fluxofenim, oxabetrinil
Bacteriocides	Bronopol, copper hydroxide, kasugamycin, oxolinic acid, streptomycin
Nematicides	Fenitrothion, fenthion, cartap, benomyl
Nutrients	Manganese, copper, molybdenum, zinc
Microorganisms	Fungi: *Streptomyces griseoviridis*, *Trichoderma*, *Bacillus subtilis*, Bacteria: *Pseudomonas cepacia*, *Rhizobium*
Peroxide	Calcium peroxide (CaO_2)
Repellents	Aluminum ammonium sulphate, anthraquinone, methiocarb

(1) Selected from the list based on horticultural crop use.
(2) Various commercial products can be formulated alone or in combination with other chemicals.

Figure 5. Film coating machine (left) and various vegetable seeds film-coated.

Seed Coating

Seed coating is one of the most useful and handy means of seed treatment. Seed handling and placement can be greatly simplified by altering seed shape. Placement of agrochemicals on the seed coating materials that regulate and improve germination greatly enhances seedling growth. Two types of seed coating are in commercial use: film coating and seed pelleting.

Film Coating. A seed coating is a substance that is applied to the seed but does not obscure its shape. Chemicals such as fungicides, insecticides, safeners, micronutrients, microorganisms, dyes, and other compounds such as plant bioregulators can be added to the coating materials. An ideal seed coating polymer should be water-soluble, with a low viscosity and a high concentration of solids, an adjustable hydrophilic-hydrophobic balance, and a capability of forming a hard film upon drying (Khan, 1992). The addition of the coating is very different from pelleting since it only represents an increase of 1-10% of the seed weight and the shape of the seed is still retained. The seeds are dipped or sprayed with the dissolved polymer and then immediately dried (Fig. 5). Multi-layers of coating composed with different formulations can be applied. Film-coated seeds have several major advantages as compared to non-coated seeds. They allow a marked reduction in dust emission and active ingredient losses from treated seeds at the seed operator level and at the farm level, thus significantly reducing the possible risks of exposure to agrochemicals. Coated seeds have significantly improved coverage and active distribution on the seed surface. Coated seeds are shiny and attractive and therefore allow more control over sowing quality and crop and cultivar identification (Bayer CropScience Ceres Seed Technology, 2003). Even though a slight delay in seed germination is inevitable because of the nature of film-coating materials, the use of film-coated seeds, especially vegetable seeds, has been rapidly increasing in recent years.

Seed Pelleting. Many seeds, particularly

Figure 6. Pelletizing machine (right) vegetable seeds pelletized and colored. From left: Raw (top) and pelletized (bottom) seeds of lettuce, onion, and pepper, tomato, lettuce, and carrot seeds, respectively.

Figure 7. Carrot seeds intact (top left) and debearded (top right); spinach seeds intact (left on bottom left photo) and pericarp removed naked seeds (right on bottom left photo); handy planting machine for seed tape (3 rows at once) (bottom right), respectively.

vegetable seeds, are not uniformly round or uniformly shaped, which hinders precision planting for optimum crop yields. Seed pelleting is applied to a seed to improve plantability and performance. In order to facilitate the free flow of these seeds in planters, many seed companies provide seeds with coatings of materials that change the shape and size of the seed so that it becomes heavier and rounder. A seed pellet is characterized by its ability to totally obscure the shape of the encased seed (Copeland and McDonald, 1995). Seeds are introduced into a coating drum or pan that resembles a cement mixer. An amalgam of fillers (clays, limestone, calcium carbonate, talc, vermiculite, chalks, perlite, sand, peat and wood fibers) and cementing additives (gum Arabic, gelatin, ethylcellulose, polyvinyl alcohol, polyoxylethylene glycol-based waxes) are used to form the pellet and other compounds such as inoculants, fungicides, micronutrients, calcium oxide, peroxides, and even microorganisms can be added to the seed pellet. The pelleting material must be compatible with the seeds so that the seed quality is maintained and germination is not hindered. Pellets can be formed in different sizes, shapes, and colors (Fig. 6). Even though there are some problems associated with the extended use of pellet seeds, pelleting of seed is recognized as an important addition to the precision planting for many small-seeded vegetables such as suger beets, carrots, celery, chicory, endive, leeks, lettuce, onions, peppers, super-sweet corns, tobacco, tomatoes, *Brassica* crops and various flowers such as begonia, petunia, and lobelia (Halmer, 2003). Several different types of pelleting have been developed for commercial uses (www.germain.com; www.seedburo.com; www.incoteck.com/products/vegetables.htm; www.seedprocessing.nl; www.ballseed.com; www.seminis.com).

Other Types of Coating. Some vegetable seeds such as carrots and radishes that have to be directly sown are wrapped in a water-soluble polymer and processed like seed tape or string (Fig. 7). Seeds can be positioned at a desired distance depending upon the crops, cultivars, and cultural practices. Handy machines for planting the processed seed tapes also have been developed for field planting in small scale. Seed mats (or pads), in which the seeds are placed in regular intervals, are also being used in the greenhouse bench. After planting the seed tapes or seed pads, the film can be removed by slight irrigation. No thinning or additional planting is required. The seeds inside the tape or on the mat can be primed or even pelleted with necessary additives.

Seed Coat Removal. Partial removal of seed coat, either by chemicals such as sulfuric acid or by sharp knife or sandpaper, can significantly increase the seed germination and seedling establishment. Seeds of triploid watermelon are frequently processed this way and nail clippers are frequently used by growers for seeds of triploid watermelons and some hardseeded rootstock seeds such as star cucumber (*Sycios angulatus*). Removal of spines or beards from carrot seeds greatly enhances early seed germination. Elaborated removal of the pericarp from spinach seeds, botanically fruit, greatly enhances the seed germination of spinach, thus resulting in early harvest of uniform produce (Fig. 7).

Priming

Seed priming is a general term that refers to several different techniques used to hydrate seeds under controlled conditions, but preventing the completion of germination. During priming, seeds are able to imbibe or partially imbibe water and achieve an elevated seed moisture content. Seeds may be kept for a while to maintain the priming effect or may be dried for long term storage. Priming temperatures of 15 to 20°C for several days are most commonly used. Osmotic priming and solid matrix priming techniques are the two types commonly applied to crop seeds (Taylor, 1998; Wien, 1998), even though there are other types of priming (Khan, 1992; McDonald et al., 2001).

Osmotic Priming (OP). Osmotic priming refers to the soaking of seeds in aerated low water potential osmotica such as polyethylene glycol (PEG), KNO_3, K3PO_4, $MgSO_4$, and other salts. The benefit of such salts is to supply the seeds with nitrogen and other nutrients essential for protein synthesis during the early stages of seed germination. Successful applications were obtained with small seeded crops such as carrot (Fig. 8), tomato, onion (Khan, 1992; Khan et al., 1995), and pepper (Bradford et al., 1990). Even though salts are the commonly used osmoticum, the most preferred one is PEG. Proper supply of oxygen is needed during the priming because of the low solubility of oxygen to PEG solution. Priming has been able to overcome thermodormancy in lettuce.

After successful priming treatment, the seeds may be dried back to enable normal handling, storage, and planting. The drying treatment frequently depresses the germination enhancement gained during priming. In addition, use of rapid drying rates or excessive temperatures can cause seed injury. Primed seeds can be stored successfully for short periods without losing the benefits gained from the priming treatment. However, long storage periods cause faster loss of vigor and viability compared to even non-treated seeds (Alvarado and Bradford, 1988; McDonald et al., 2001).

Solid Matrix Priming (SMP). The use of solid-osmoticum or solid matricum (Khan, 1994) for the priming purpose has shown benefits for improving seed vigor and seedling emergence and rate under a wide variety of environmental conditions. The use of SMP follows the same principles as described for osmotic priming above. The substances for SMP should ideally have a high matrix potential and a negligible solute or osmotic potential, negligible water solubility, low chemical reactivity, higher water-holding capacity, high flowability, high capacity to remain dry, free flowing powder form, high surface area, high ability to adhere to seed surface. Celite (diatomaceous silica) and Micro-Cel were widely used initially, but many other substances such as vermiculite and expanded calcined clay may be effectively used as solids. Seeds are commonly primed at 15°C for 7-14 days in the light or dark. The ratio of seed: carrier: water is important for proper SMP. A higher ratio of water often results in germination whereas a low amount of water reduces the effect. The ratio of seed to carrier also varies with solid materials and crops (Tables 7 and 8).

A major advantage of SMP as compared to osmotic priming (OP) is that the SMP effect

Figure 8-A. Emergence of ‘Nantes’ carrot as affected by osmo-conditioning of seeds.

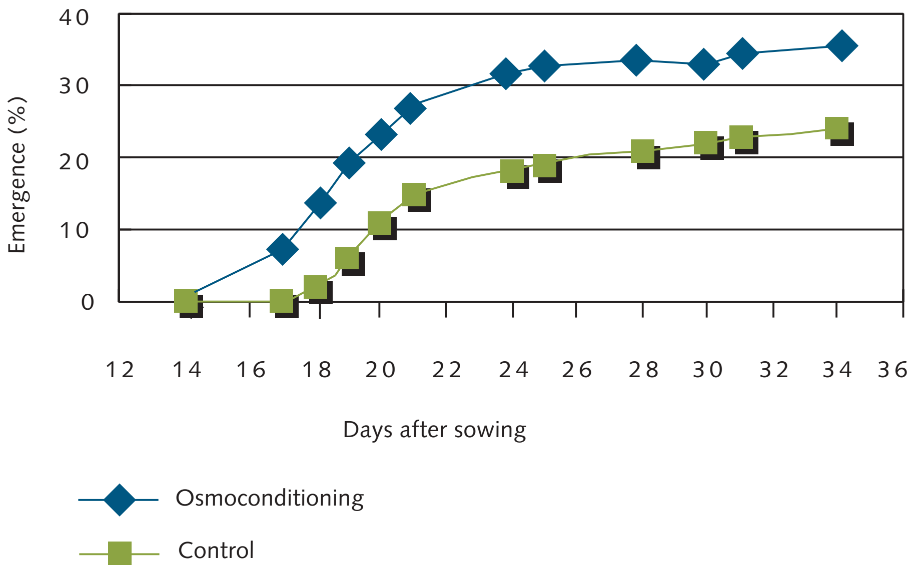

Figure 8-B. Yield of carrot cultivars as affected by osmo-conditioning of seeds.

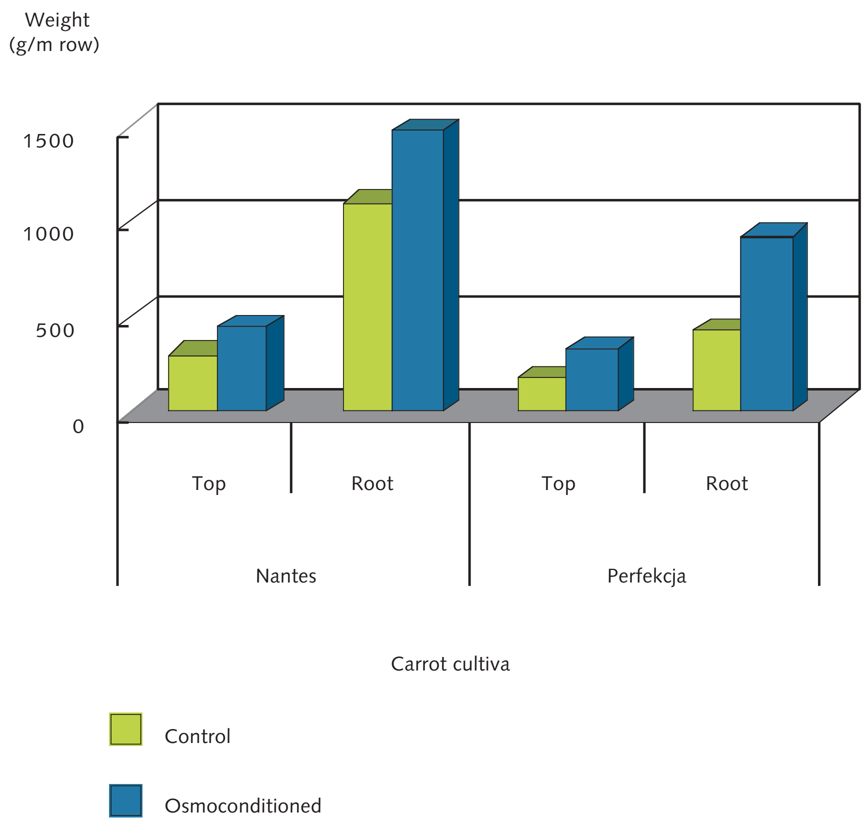

Table 7. Effects of solid matrix priming in Micro-Cel E on the performance vegetable seeds at 20/10°C (revised from Khan et al., 1992).

Seed and cultivar	Treatment (1)	Total emergence (%)	T50 (2)	Top fresh weight (3)
Red beet	SMP (16:3.2:18 4)	155a	3.8c	1.29a(13)
'Cardinal'	SMP+Dried	156a	3.9c	1.25a(13)
PEG 8000 priming	140b	5.5b	1.03b(13)	
Untreated	131b	7.5a	0.81c(13)	
Sugarbeet	SMP (16:3.2:12)	88ab	2.3c	1.46a(13)
'E-4'	SMP+Dried	95a	3.4b	1.38a(13)
PEG 8000 priming	88ab	3.6b	0.94c(13)	
Untreated	82b	4.9a	0.72d(13)	
Onion	SMP (16:4.8:20)	98a	3.9c	0.62a(15)
'Texas Early Grano'	SMP+Dried	97a	4.0c	0.61a(15)
PEG 8000 priming	92b	6.8b	0.48b(15)	
Untreated	93b	7.9a	0.36c(15)	
Tomato	SMP (16:4.8:24) 95a	4.3d	1.32a(15)	
'FM Jackpot'	SMP+Dried	94a	5.3c	1.12b(15)
	PEG 8000 priming	88a	8.2b	0.80c(15)
	Untreated	89a	11.8a	0.69d(15)
Pepper	SMP (16:4.8:24)	96a	7.4b	2.26a(21)
'Rino'	Untreated	82b	14.1a	1.18b(21)
Carrot	SMP (16:8:32)	88a	5.0b	0.58a(18)
'Nantes'	SMP+Dried	74b	8.5a	0.42b(18)
	PEG 8000 priming	78b	8.4a	0.36b(18)
	Untreated	89a	9.3a	0.31b(18)
Celery	SMP (16:12.8:64)	92a	6.9c	0.19a(17)
'FM 1218'	SMP+Dried	68c	9.4b	0.10b(17)
PEG 8000 priming	86a	9.3b	0.06bc(17)	
Untreated	78b	13.8a	0.03c(17)	

(1) Solid matrix priming (or matri-conditioning) was conducted at 15°C in light in a mixture of seed:carrier:water for 7 days except for celery (14 days). The initial moisture contents of seeds were 5-7%.
(2) Number of days to 50% emergence.
(3) Fresh weight of 15 tops. Data in parentheses are days after sowing.
(4) Mean separation within a cultivar within a column by DMRT at 5% level.

Table 8. Emergence rate (ER), final emergence percentage (FEP) of 7 watermelon cultivars as affected by solid matrix priming (Kim et al., 1998).

Cultivar	Early emergence percentage (%)					Final emergence percentage (%)				
	Seed treatment (1)					Seed treatment (1)				
	Check	10:1:3	10:1:4	10:1:5	10:1:6	Check	10:1:3	10:1:5	10:1:5	10:1:6
Gamro	84.7	88.4	91.2	95.8	94.4	95.8	94.4	94.4	97.2	98.6
Sambok	84.7	100.0	100.0	100.0	98.6	100.0	100.0	100.0	100.0	98.6
Creampia	80.6	87.5	93.1	94.4	93.1	100.0	95.8	98.6	98.6	98.6
Bingre	95.8	97.2	98.6	100.0	100.0	100.0	98.6	100.0	100.0	100.0
Hongilpum	77.8	86.1	86.1	95.8	95.8	97.2	94.4	88.8	95.8	94.4
Houseilpum	48.6	72.2	93.1	90.3	90.3	84.7	87.5	97.2	94.4	93.1
Surowang	80.6	81.9	72.2	90.3	90.3	90.3	90.3	87.5	98.6	94.4

(1) Ratio of seed: Microcel E: water by weight. Seeds were primed for 5 days.

persists much longer than OP even after the drying and considerable storage of dried seeds. OP is frequently applied to small seeded crops whereas SMP is usually applied for large seeded crops, even though there is no clear distinction between these classifications.

Integrated Treatments

Combined treatments rather than a single seed treatment have become more popular in recent years and seeds treated with several types of combined or integrated treatments are now available from major seed companies around the world. Vegetable seeds are most frequently processed but seeds of many flowers are also treated (Table 9). The purpose of integrated treatment is to maximize improvement in germination and seedling establishment and therefore the techniques vary considerably depending upon seed sources and cultural practices. Some of the more-widely used integrated treatments (Khan, 1992) include:

- OP or SMP with pregerminated seeds;
- stratification with OP;
- plant bioregulators (PBRs) with seed coating;
- OP with seed coating;
- presoaking, OP, or pregermination with bioactive chemicals-fungicides (Maxim®, Celest®, Dividend®, Apron®XL, Dynasty™ and insecticides [Cruiser®, Imidacloprid (Gaucho®)];
- SMP with plant growth regulators, mostly gibberellins and triazole chemicals;
- OP or SMP with microbes: Fungi (*Trichoderma harzianum*, *Phythium oligandrum*, *Chaetimiumglobosum*) and bacteria (*Bacillus subtilis*, *Pseudomonas putida*, *Rhizobia*, *Azospspirillum brasliense*);
- OP or SMP with pregerminated seeds; stratification with OP, and plant bioregulators with OP.

CONCLUSIONS

Seed treatment techniques have been developed mainly by large seed companies that produce and distribute seeds. Producing the high quality seeds and applying proper fungicide treatments have been the most common treatments. However, increasing concern about the chemicals added to the various seeds and possible residual effects need more sophisticated and safer methods of seed treatment such as dry heat treatment. Upgraded seeds of high quality, proven to show higher and more uniform germination as well as vigorous and uniform seedling growth, became vital prerequisites for some of the cultural practices especially for the direct seeding to the field in addition to the machine sowing into cell trays under greenhouse conditions. The numbers of horticultural species commercially primed and available to growers is rather small mainly because of the higher price of seeds and unstable persistency of priming effects. Lack of recognition of the benefits of the primed and/or pellet seeds by growers is another problem to be solved in the near future. In spite of the some of the problems, explosive increases in upgraded and agrochemical-free seeds are expected especially for horticultural crops such as vegetables around the world including many developing countries.

Table 9. Several enhanced seeds of floricultural crops from Ball Seed Company, USA.

Product type1	Processing method	Flower crop
Genesis"Seed (GS)	Primed	Cleome, pansy, phlox, primula, verbena, vinca, viola
SpeedSeed (Multi-seed pellets-MPL)	Multi-seeded pellets for greater efficiency in sowing	Gypsophila, helichrysum, lobelia, ornamental grasses, portulaca
SpeedSeed (Pelleted-PL)	Single pellet for easy sowing and faster germination	Ageratum, begonia, bellis, campanula, coleus, dianthus, dusty miller (Genesis"-Pelleted), Exacum, gloxinia, linaria, lisianthus, mimulus, nicotiana, pentas, petunia, snapdragon, strawberry, torenia, trachellium, verbascum, veronica
SpeedSeed (Coated-CT)	Film-coated for easy handling and machine sowing	Dahlia, gerbera, marigold, ranunculus, zinnia
High Energy Seed (HE)	Carefully selected seeds	Cosmos, impatiens, salvia, strawberry

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Related websites:
www.seedburo.com;
www.incoteck.com/products/vegetables.htm;
www.seedprocessing.nl;
www.ballseed.com;
www.seminis.com;
www.usda.gov; www.apsaseed.com.

About the Author

Jung-Myung Lee

Dr. Jung-Myung Lee is Professor of Horticulture at Kyung Hee University, Suwon 449-701, Republic of Korea, email: jmlee@khu.ac.kr
Dr. Lee is the President of the XXVII International Horticultural Congress to be held in Seoul, Korea, in 2006.

Low Carbohydrate Diets and Horticulture

Jules Janick

In the United States, obesity has been a growing problem and many are succumbing to a growing epidemic of Type II diabetes. As a result, low carbohydrate diets are causing a revolution in diet conscious, overweight Americans and this diet change clearly has important implications for horticulture. Low carbohydrate diets are not new but have been popularized by the late Dr. Robert Atkins and his Atkins® diet is all the rage at the moment. In the preceding decade, a number of diets focused on no fat or low fat and there was a tremendous expansion of these types of processed food. The problem was that many of them did not measure up in taste, but more important, the replacement of fats by carbohydrates resulted in weight gain rather than weight loss. Dr Atkins' low carbohydrate diet /high protein/high fat, had long been criticized by the nutrition community but recent evidence indicates this diet clearly works to reduce weight without the feeling of food deprivation. The tide seemed to turn with an article by Gary Taubes entitled The Soft Science of Dietary Fat (*Science* 291(5513):2536-2545; 2001), and later a feature article by the same author in the influential (*New York Times Magazine* (July 7, 2002) entitled What If It's Been a Big Fat Lie? At the same time, the release of a number of longer term studies and growing successful reports seemed to indicate that the low carbohydrate/high protein/high fat diet worked to reduce weight if followed strictly, and more astounding, was often accompanied by a decrease in cholesterol level. The rationale of the diet is that low carb diets decrease insulin levels which prevent storage of fats. Indeed, research at Harvard indicates that mice fed diets with the same calories, differing only in the amount of carbohydrates, show increase fat deposits with high carbohydrates. Clearly more than calories are involved in fat deposition. At the present time variations that have come on the scene include the South Beach diet and the Paleolithic diet, but all are characterized by reducing refined carbohydrates, especially those that increase the glycemic index, substituting increased protein, and allowing considerable fat, especially monounsaturated.

According to Pierce Holingsworth in an article in the 2004 January issue of *Stagnito's NewProducts Magazine* entitled Dr. Atkins is Dead, Long Live Dr. Atkins, 3.6% of Americans are on low carb diets, up more that 33% from six months earlier. More importantly, 40% of Americans identified carbs as a dietary no-no as compared to 11% last year. The food technology industry is responding vigorously with new low carb selections now estimated to racking up 1 billion dollars in sales. Low carb breads are appearing at very high prices with soy flour replacing wheat and low carb beers are booming (can low carb wines be far behind?). The fast food industry has also reacted and Burger King is offering its whopper (a large hamburger with lettuce, tomato, and onion in a mayonnaise sauce) without the bun, replacing it with a lettuce leaf. The restaurant industry has been quick to join the bandwagon with low carb choices or Atkins®-approved menus.

It is already apparent that the low carohydrate trend is affecting and will affect horticultural industries. For example the consumption of potato, especially French fries is decreasing while there is an increase in salad vegetables. I predict an increase in turnips as dieters seek a lower carbohydrate replacements for potatoes. Low carbohydrate fruits such as strawberry, raspberry, blueberry and blackberry are increasing probably at the expense of apple, pear, and orange juice. The low-carb phenomenon has many of the characteristics of the low-fat boom a decade ago, but it may have more staying power because it does work. Of course, dieters going off the low carb diet quickly gain the weight back. While the correct and healthy answer is a sensible diet, reduced portion intake, and reduced intake of highly refined starches and sugars combined with increased exercise, this is easier said than done. Overweight people who are serious will find a few months on a low carb diet will knock off 10 to 15 pounds but they must in the end be sensible in their intake and somehow increase their physical activity. The only thing that all nutritionists seem to agree is that fruits and vegetables are healthy and being overweight is a serious impediment to long life and good health.

Contact

Dr. Jules Janick, Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, Indiana 47906-2010,
email: janick@purdue.edu

Symposia and Workshops

Section Ornamental Plants

Fifth Int'l Symposium on New Floricultural Crops

In search of potential new or poorly known flowering plant species for commercialisation, the fifth International Symposium on New Floricultural Crops was organized under the umbrella of the International Society for Horticultural Science (ISHS). The conference took place for the first time in a tropical country, at Iguazu Falls, State of Paraná, Brazil, where the three nations Brazil, Argentina and Paraguay join.

The symposium focused on multidisciplinary subjects related to the question how all could benefit from the commercialisation of new unexplored flowering germplasm material. Internationally there is a great deal of discussion about this subject. Are the world's resources and traditional knowledge common heritage? Greatly involved are first of all the natural owners of native exotic plant species, which are indigenous people and/or nations often in developing or third world countries, followed by the scientists who investigate how to improve these species using advanced technological methods and finally the international trade that promotes the flow of these new flowering crops into the markets.

Medal award to Dr. Tombolato for the successful organization of NFC conference. (From left to right: F. Tombolato, E. Maloupa, R. Criley and R. Bogers).

A total of 96 participants from 18 countries of different ethnic, cultural and religious backgrounds attended the meeting, which was held from 26 to 30 August 2003. A number of 95 scientific papers was presented, 36 as oral communications and 59 as posters. These globally covered diverse topics including biotechnological issues, new techniques for new products, native flora, tropical mystique, physiology, genetic resources and market trends. Twelve invited speakers introduced these subjects extensively, complemented by worldwide talented scientists coming from far-away Australia till exotic Hawaii.

The thematic issues interconnected each other, making many valuable considerations intended to provide broad strategic guidelines. These guidelines should involve the local communities, international and governmental organizations, scientists, investors and traders in order to build flexible long-term collaborative bonds in commercial floriculture. Therefore, the role and the rules established at the Convention on Biological Diversity (CBD) during the last decade in order to protect commercialised plant genetic material were extensively mentioned. Several techniques such as AFLPs, RAPDs and microsatellites were presented to show how to develop molecular markers to

Participants of the Symposium at Iguazu Falls.

protect and genetically certify plant germplasm. These methods were favoured and supported by the CBD organization.

Many new or poorly known flowering species from diverse climatic environments and regions of the world were presented during the conference as potential new ornamentals for commercialisation. These included genera and varieties from (I(Asterostigma, Bognera, Dracontioides, Gearum, Zomicarpa, Philodendron, Anthurium, Griffinia, Worsleya(P(and many others. For instance, gingers, which have already been spread in the world food market for their rhizomes, have been introduced in the US market as cut-flowers and pot-plants for their colourful flowers and foliage. The new techniques presented mainly focused on post-harvest longevity and efficient propagation of these plants. The parameters investigated were related to temperature, photoperiod and chemical treatments with different plant growth regulators in order to increase quality and commercial value. Little emphasis was put on phytopathological problems indicating the advanced knowledge of people about systematic use of healthy disease-resistant varieties and efficient pest control.

Rio Botanic Garden.

The social programme of the symposium included fantastic ethnic dances from Brazil, Argentina and Paraguay in colourful dresses attracting most of the participants to join and enjoy the local culture and traditions. The memorable dinner offered plenty of wine and beverages, exotic appetizers, delicious sweets and many other traditional Brazilian dishes.

Two technical tours were arranged during the conference. The first lead to Argentinean Falls and gave the participants the opportunity to hike across the river and meet many poorly known tropical endemic species, with many raccoons and exotic birds living in the same habitat. The other technical and touristic tour went to the Hydroelectric Itaipu Binacional, 20 km from Iguazu downtown; the participants had the chance to visit an exhibition of native orchids and flowering species from Paraná State (Brazil) and Misiones Province (Argentina). It was also interesting to see a presentation of historical pictures showing how local people were living next to the river and the way they were cultivating different crops, fishing and hunting.

It was a valuable, high quality and productive conference directed professionally by Dr. Tombolato and his Organizing Committee. Everybody enjoyed the hospitality of the Brazilian people. ISHS greatly appreciated the efforts of the organizers, a reason why Dr. Eleni Maloupa (Chair of the Working Group of New Floricultural Crops) presented Dr. Fernando Tombolato with the ISHS-medal, in the presence of Dr. Richard Criley (Chair of the ISHS Section for Ornamental Plants) and Dr. Robert Bogers (Treasurer of ISHS).

It was decided to arrange the next ISHS meeting on New Floricultural Crops in Funchal, Madeira Island, Portugal, in April 2007.

Eleni Maloupa and Georgios Tsoktouridis

Iguaza waterfalls.

Contact

Dr. Eleni Maloupa and Dr. Georgios Tsoktouridis, National Agricultural Research Foundation, Laboratory of Conservation and Evaluation of the Native and Floricultural Species, GR-570 01 Thermi, Thessaloniki, Greece,
email: maloupa@compulink.gr
and gtsok1@yahoo.co.uk

Ninth Int'l Symposium on Pear Growing

The Ninth International Symposium on Pear Growing was held at Spier Estate near Stellenbosch, South Africa (40 km east of Cape Town). Stellenbosch is centred within the Mediterranean-type climate fruit production region of the Western Cape Province, and is surrounded by vineyards. The main pear-growing areas are situated to the north and south-east where chilling units are higher. The Symposium was hosted by the University of Stellenbosch and attracted 130 participants from 23 countries.

Participants of the Pear Symposium visiting the campus of the University of Stellenbosch.

During the course of the week (2-5 February 2004), current advances in pear breeding, reproductive biology, orchard management and improvement of fruit quality were presented in 49 oral papers and 43 posters. After an official welcome by Prof Karen Theron (convenor: organising committee), Prof L. van Huyssteen (Dean of the Faculty of Agricultural and Forestry Sciences, University of Stellenbosch), and Dr. Tony Webster (Chair ISHS Section Pome and Stone Fruits), two keynote speakers opened the Symposium. Prof (em.) Fritz Bangerth presented an overview of the role of growth regulators in pear flowering and fruiting, a challenging task indeed! The regulation of reproductive processes in deciduous fruit trees is highly complex, and more basic research is required. The lack of suitably experienced researchers in this field worldwide is of concern. Prof (em.) Daan Strydom (South Africa) then discussed the development of pear training systems in South Africa. The climate and soils of the Western Cape present problems which have been overcome fairly successfully using local research. However, the choice of rootstock remains critical and the options not satisfactory.

Animated discussion amongst participants at the campus reception.

The plenary session continued with invited overviews of the status of the pear industries in North and South America, Europe, Asia, Australasia and Africa. A viable industry and favourable market conditions are the foundations upon which research and development rest. Globally, pear production has stabilised or is in slight decline, with only a few production areas showing growth. However, novel or otherwise prized cultivars with above-average eating quality still yield good returns.

Fruit quality was addressed during the first scientific session, and focused on methods to enhance and predict fruit size, colour and storage quality. This was followed by a series of papers on reproductive biology, which highlighted the value of both conventional (pollination strategies) and advanced (molecular) scientific approaches to improving fruit set and yield.

On the second day, delegates were taken on a full-day excursion to pear farms across the region. Experienced fieldsmen presented information on cultivars, rootstocks, planting and training systems, and problems associated with low chilling units. Since the symposium fell within the peak pear harvest period, a dedicated pear packhouse was visited. There was ample opportunity for exchange of information and questions, and delegates were able to appreciate the scenic beauty of the Western Cape on a route which took them through 500 km of farmland and mountainous terrain clad in the diverse indigenous "fynbos" vegetation, and ended with a wine tasting at Nietvoorbij-Infruitec Institute of the Agricultural Research Council.

Tom Deckers, Karen Theron and Tony Webster in high spirits at the closing banquet.

The third day of the symposium was devoted to issues around breeding and evaluation, genetics and biotechnology, and postharvest quality and technology. Worldwide, the unsatisfactory progress on breeding of improved pear cultivars and rootstocks remains a real problem. New cultivars must meet the demand for excellent external fruit appearance, exceptional eating quality as well as disease resistance. Molecular approaches hold promise but will take many years to yield results. It was agreed that the current decline in consumer interest can be halted and reversed if new selections become available which meet modern consumer preferences. This includes sensory experience and health benefits, but not at the expense of attractiveness.

Storage quality of pears and methods to extend shelf-life, such as the use of 1-MCP (1-methylcyclopropene), were also discussed.

The last day was reserved for practical orchard management issues. Planting and training systems and growth regulation depend on the vigour experienced on the available rootstocks, and approaches differ across different regions. The use of prohexadione-Ca, root pruning or girdling as vigour-controlling measures was discussed, particularly in light of the search for effective techniques which are environmentally sensitive.

All except one of the presented papers on pest management focused on codling moth, the biggest problem worldwide. Progress is being made in the control of codling moth, especially as part of areawide integrated programmes. Papers were also presented on disease management, specifically fireblight, pear scab and powdery mildew.

Enjoying the wine tasting at Nietvoorbij- Infruitec Research Institute.

The symposium closed with a banquet at the Kirstenbosch Botanical Garden in Cape Town. At the business meeting which took place on the third day of the symposium, Prof Karen Theron of South Africa was elected as the new chairperson of the European and Asian Pear Working Group of the ISHS, taking over the reins from Tom Deckers of Belgium. The Tenth International Pear Symposium will be held in Portugal in 2007.

S.J.E. Wand

Contact

Dr. S.J.E. Wand, Department of Horti-cultural Science, University of Stellenbosch, Private Bag X1, Matieland 7602, South Africa, e-mail: sjew@sun.ac.za

Int'l Root and Tuber Crops Symposium - "Food Down Under"

Over 70 delegates from throughout the world attended the First International Root and Tuber Crops Symposium (Food Down Under) at Massey University, Palmerston North, New Zealand from 9-12 February 2004. Organised jointly by Massey University and the New Zealand Crop & Food Research Institute, the meeting began with a getting-to-know-you barbecue at Wharerata (the University's Staff Club) on the Sunday evening, and formal proceedings commenced the following morning.

The meeting was opened by Professor Ian Warrington (Vice President ISHS), in his role as Deputy Vice-Chancellor of Massey University, while ISHS Root and Tuber Crops Chair Dr. Stan Kays (USA) represented ISHS.

The formal opening was actually in the afternoon, and was undertaken by Hon. Damien O'Connor, New Zealand's Associate Minister of Agriculture. He emphasised the importance of the root and tuber crops for New Zealand's local and export economy, and the Maori links with the original transfer of the plants from South America.

A total of 42 papers were presented and ranged from a cultivar evaluation study with sweet potatoes in Irian Jaya, Indonesia, to the sophistication of crop modelling, molecular biology and flavour analysis.

The first day's programme was oriented very much towards crop production, with the objective of attracting growers, while the following days had a more "scientific" content.

On the first day key-note papers by David Hudson (David Hudson Potato Services-UK) and by Mark Heap (Simplot, Australia) did not provide a good prognosis for the future of the industry. There was been a 33% reduction in fresh potato consumption over the decade 1989-99. Initially sheltered by the increasing consumption of processed potatoes (mainly

French fries) in the last few years with increasing affluence many consumers are looking towards "healthier" fast food options like salads and pasta rather than burgers. The Australasian scene is likely to be similar, with processors seeking functional foods with novelty and excitement.

Pete Jamieson (NZ Crop & Food RI) presented the software tool, "the potato calculator" to assist in making management decisions on nitrogen fertilizer applications. Preliminary field tests suggest that nitrogen application rates can be halved (compared to the petiole testing strategy) without reducing yields by using the potato calculator!!

The importance of quality assurance for vegetables to ensure that the consumer receives safe food, produced in an environmentally sound environment is becoming increasingly important, particularly where exports are involved. Keith Budd (Agrichain, New Zealand) presented an overview of the New Zealand initiatives, within an International context. The merging of legislation and retailer initiatives, and the importance of traceability and auditing lead naturally to the presentation by Tim Jones (Muddy Boots Software) with electronic systems of recording and integrating information from a wide range of sources.

Stan Kays then provided an overview of the world sweetpotato scene, with an emphasis on the dichotomy which is sweetpotato. A subsistence food in many developing countries, it's strong flavour precludes it's use in many situations in developed countries.

Carrots next came under the microscope, when Peter Wright (from Watton Produce (UK)) provided an overview of the UK/European scene, and David Martin (also UK) provided us with 10 steps to grow good carrots. This actually ended up as a single recommendation "- Attention to detail in all areas".

Stephan Halloy (NZ Crop & Food) then presented a paper on the traditional cultivation of

Stan Kays presents his keynote paper.

Field trip potatoes.

Andean tuber crops, and the final paper of the day was by Garry Elliott (Elliott Chemicals Ltd) who gave us an insight into future developments in spray technology.

The day was completed with a Cocktail party.

New Zealand has a history of commercialising new crops (e.g. kiwifruit), and a number of papers at this meeting offered an introduction to a number of less common tuber crops being researched in New Zealand, including Yacon (*Smallanthus sonchifolius*), Oca (*Oxalis tuberosa*), Ulluco (*Ullucus tuberosus*), Konjac (*Amorphophallus konjac*), and Japanese Taro (*Colocasia esculenta*).

There was a technical tour on the Tuesday afternoon to the important volcanic ash soil root crop production area at Kiwitea near Palmerston North. This enabled delegates to view crops of potatoes for processing, for fresh market, and also a seed crop of a new Crop and Food bred variety "Moonlight" with both late blight and nematode resistance.

One unique part of the tour visit was to the largest commercial planting in the world (at Halfords Exotics) of the South American Tuber crop "Oca" - some 35 ha. The company has bred and selected and been granted Plant Variety Rights for a number of exciting clones - red, yellow and also bicoloured, and is also developing another South American tuber plant "Ulluco" as a crop for New Zealand. We learnt that the major problem with these crops is that the tuberisation is linked closely to a 12 hour photoperiod, which limits the range of environments in which they can be successfully grown.

The conference dinner was held at the former Vice-Regal mansion "Caccia Birch", where the guest speaker was Ron Gall from New Zealand's Vegetable Growers Federation.

Following the symposium several of the invited speakers addressed grower meetings. Attracting top quality keynote speakers, while at the same time keeping conference fees to an acceptable level requires sponsorship. Our sponsors were happy to support us provided that we made some of these speakers available at industry meetings. The symposium thus provided a valuable link between industry and science. This is possibly a strategy other symposium organisers might wish to consider.

Finally we chose the right week for the meeting, because the following week the Palmerston North district had it's 100 year flood and was inundated with raging rivers, damaged bridges, and flooded farms.

Mike Nichols

Contact

Dr. Mike Nichols, Massey University, Palmerston, New Zealand, email: m.nichols@massey.ac.nz

Int'l Workshop on Modelling of Plant Growth, Environmental Control and Greenhouse Environment

From 25 to 28 August 2003, Potsdam, Germany, was the venue for a workshop organized by the ISHS Working Group 'Modelling of Plant Growth, Environmental Control and Greenhouse Environment'. The meeting was hosted by the Institute of Vegetable and Ornamental Crops Großbeeren.

Twenty-six oral contributions and 26 posters were presented by 59 participants from 20 countries. The conference was organized in four sessions, each highlighted by an invited speaker.

In the first session Ep Heuvelink (Wageningen University, Netherlands) gave a comprehensive overview about modelling product quality in horticulture. In recent years this topic has attracted an increasing number of modellers. Therefore, compared to previous meetings many more papers and posters dealt with modelling quality, whereby both internal and external quality were considered.

Models for plant growth and management in the field were covered in the second session, introduced by Clive Rahn (Horticultural Research International, England). Clive Rahn highlighted the use of models to optimise crop production, particularly with regard to minimising the impact on the environment. He concluded that there are already some very useful models on the market. A part of the target audience however, such as consultants and growers, are still reluctant to use the models.

The session about plant growth and management in the greenhouse was introduced by Beni Bar-Yosef (Agricultural Research Organization, Israel). Beni Bar-Yosef too placed the emphasis on models as bases for decision support systems and presented a complex approach for controlling closed irrigation systems in the greenhouse.

An excursion to the Institute of Vegetable and Ornamental Crops was arranged for the evening and all participants took the opportunity to visit the labs, greenhouses and experimental fields.

Next morning Hartmut Stützel (University Hannover, Germany) commenced the final session with the challenging question "Do we need new approaches for horticultural crop modelling?" As expected the participants did not agree on a final answer but the question provoked an active discussion, especially about the incorporation of 3D plant structures in plant growth models.

Participants listening to a guide on a tour through 'Sanssoucci Park' in Potsdam.

In addition to the scientific program all participants found enough time to explore Potsdam, a charming city famous for its palaces and gardens. We also enjoyed a tour across Berlin by boot, which revealed new perspectives even for those who knew the city before.

During the business meeting the former chair of our working group, Hans-Peter Liebig (University of Hohenheim, Germany), informed the participants that he will retire from his position. We thank Hans-Peter Liebig for his long-standing commitment for our working group. The group members present at the business meeting elected Ep Heuvelink (Wageningen University) as new chair. Possible dates and locations of the next meeting were discussed, but no definite decisions were made.

Matthias Fink

Contact

Dr. Matthias Fink, Institute of Vegetable and Ornamental Crops, Großbeeren, Germany, email: fink@igzev.de

THE WORLD OF HORTICULTURE

Mediterranean Greenhouse Technology

Alberto Pardossi, Franco Tognoni and Luca Incrocci

Greenhouse cultivation can provide high-quality product all-year round with an efficient use of resources, such as water, fertilisers, pesticides and hand-labour. Consequently, in the last decades protected cultures have developed rapidly in many regions, in particular (but not only) in the Mediterranean Basin countries, where the mild temperature during winter makes it possible to produce low-cost vegetable crops in very simple shelters. The low-technology protected horticulture industry has allowed the economic development of several marginal (poor) regions, such as Almeria, Spain. However, in the Mediterranean Basin there is need for technological updating of greenhouse industry in order to face the increasing competition arising from globalisation of both production and marketing. Moreover, the enhanced awareness of environmental pollution provoked by agriculture, the increasing demand of healthy foods and - last, but not least - the shortage of resources like water, are forcing the growers to introduce more sustainable growing techniques. The reduction of production costs and an improved marketing of traditional vegetables seem more needed than looking for new crops. In general, Mediterranean Basin greenhouse growers must aim to produce, in an environmentally friendly way, high quality standard products, rather than low-price commodities; the use of modern greenhouses (with better climate control and more advanced growing technologies such as drip fertigation, hydroponics and integrated pest management) and seawater for irrigation are the most relevant aspects of this development. Proper education and training of growers are also needed, and eventually a new generation of entrepreneurs, less conservative and more professional.

HISTORICAL

Commercial protected horticulture appeared first in Northern Europe in the early decades of the last century and developed broadly after World War II. By using heated glasshouses equipped with sophisticated cultivation systems, growers intended to overcome the problem of cultivating cold-sensitive species during most of the year. After the advent of plastics in the early 1960s, greenhouse crops started to move to mild-winter regions such as Mediterranean Basin countries (in particular, Italy, Spain and Morocco). The rise in oil prices in the 1970s, which increased the heating costs, further enhanced the diffusion of greenhouse crops in the Southern countries. More recently, protected crops expanded to some Asian countries such as India, Korea and, especially, China (Jiang et al., 2004).

Reliable statistical data of protected horticulture at a world level are quite difficult to find, since the sector is quite dynamic and changes rapidly. Moreover, in many countries (including most of the Mediterranean Basin) there is not a central council in charge of recording the area of protected crops; data are generally provided by sources such as growers associations and public institutions, often with little consistency. According to one of the most recent and comprehensive reports (Jouet, 2001), by 2000 there were nearly 700,000 hectares covered by greenhouses and large tunnels and nearly another million of hectares using low tunnels or direct covers. However, this value did not consider the quite recent explosion of greenhouse industry in China, which now has something like 1.5 million of tunnels and greenhouses (Jiang et al., 2004). Therefore, we estimate more than 2.0 millions hectares for worldwide protected horticulture.

The huge growth of worldwide protected horticulture in the last decade (the sector has increased by 30-40% since 1991) is the result of three main factors. Firstly, the demand of high-quality horticultural products, including out-of season and exotic products (not only food!), has increased substantially, particularly in Europe. Secondly, the improved technology of transportation and postharvest storage has allowed the production in areas far from the main markets and the commercialisation of many products all-year round. Thirdly, greenhouse industry may lead to economic development of marginal regions in mild-winter climate, as it makes economically-efficient use of many resources, such as land, labour and water. The gross income from protected horticulture may reach values of $50,000-$100,000/ha, up to more than $500,000/ha in case of potted ornamental plants. The relevance of greenhouse industry for economic development is not limited to cash-earnings: besides links to other industries (food processing, supply of technical means and services)

Figure 1. The satellite image of the protected crops located in Almeria (Spain). (Image courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center, http://eol.jsc.nasa.gov, image number: ISS005-E-6663.JPG).

protected crops may provide good opportunities for job in regions of emigration (e.g. Northern Africa).

Almeria, Spain with more than 30,000 hectares of plastic greenhouses (the largest concentration of greenhouses in the Mediterranean Basin) is an outstanding example of the economic influence of protected culture (Fig. 1). Protected horticulture is responsible for the astonishing economic growth of this province in the last 20 years (from third from the bottom to third from the top in the economic ranking of Spanish provinces) (Stanghellini et al., 2003). The sector now provides employment to more than 80.000 people and produces roughly 40% of the Gross Provincial Product (Costa and Heuvelink, 2000). The province of Ragusa (Fig. 2), in Sicily (Italy), is another area where greenhouse horticulture is one important source of income for local population; since the 1960s about 6,000 hectares have been covered by plastic greenhouses and tunnels, mostly for vegetable production.

Compared to field crops protected horticulture markedly increases water use efficiency (WUE), as expressed both in terms of yield (Table 1) and gross income (up to some tens of euros per cubic meter of irrigation water). This is the result of reduced potential evaporation since the indoor climate is characterised by higher humidity and less radiation and wind than outside, increased crop yield, and the application of advanced irrigation technologies (such as drip irrigation and hydroponics).

Figure 2. Plastic greenhouses and tunnels in Pachino (Ragusa, Sicily, Italy) in the 1960s.

Table 1. Water use efficiency (WUE) of tomato crops carried out under different climatic conditions and using different growing systems.

Growing conditions	Country	WUE (kg m^{-3})
Field	Israel (soil culture)	17[1]
	France (soil culture)	14[2]
Unheated plastic greenhouse	Spain (soil culture)	25[1]
	France (soil culture)	24[2]
	Israel (soil culture)	33[1]
	Italy (open substrate culture)	23[3]
	Italy (closed substrate culture)	47[4]
Climate-controlled soilless greenhouse	France (open-system)	39[2]
	Netherlands (open system)	45[1]
	Netherlands (closed system)	66[1]

Source: [1] Van Os, 2001; [2] Baille, 2001; [3] Malorgio et al., 1991; [4] Malorgio et al., 2001

Greenhouse Cultivation Technologies

Different kinds of protection are currently used for growing vegetables, cut flower, pot plants, propagation materials (seedlings, rooted cuttings, ex vitro young plants, etc.), and fruit crops. According to Tognoni et al. (1999), three main greenhouse types can be identified, as follows.

Low-technology greenhouses (LTG). The investment cost is lower than 25-30 $/m². LTG have very simple structure, plastic covering, poor climate control and, very often, lack heating system. Vegetables and low-value cut flowers are grown under this kind of shelters with simple growing methods that are similar or just the same as those used in open field.

Medium-technology greenhouses (MTG). The investment cost ranges between 30 and 100 $/m². MTG use metal structure and both plastic (often, rigid pans) and glass as covering materials. Climate control is more efficient compared to LTG, thus the internal environment is relatively independent from the external one. More advanced growing technologies, including hydroponics, are used in MTG, where many operations are partially or fully automated. MTG are quite flexible from the technical viewpoint and are generally employed for out-of-season vegetables, high-value cut flowers (roses, for instance) and ornamental pot plants.

High-technology greenhouses (HTG). The investment is higher than 100 $/m² and may reach 200 $/m² and more. HTG are generally built with galvanised iron support structure and glass as covering material. HTG have a sophisticated climate control system based on both air and root zone heating, forced ventilation, evaporative cooling, humidity control, light conditioning (shading and artificial lighting) and carbon dioxide enrichment; thus, the indoor climate can be completely independent from outdoors (Fig. 3). In HTG growing systems are set up to maximise space-use efficiency and minimise hand labour for product unit. HTG are used mostly for ornamentals and nursery production in cold winter regions.

At the world level, the scientific and technological development in protected horticulture is currently directed to the design of more sustainable cropping techniques that must supply high-quality products to more and more exacting consumers. The trend is towards the application of a more advanced technology for better climate control and a lesser use of water and agrochemicals. Integrated management of pest and diseases (IPM), drip irrigation and fertigation are increasingly used, while soilless cultures are spreading very slow because of the huge investment costs, which are too risky for small-scale enterprises in the current economical scenario. The application of fertigation has resulted in the installation of many automated systems for the preparation and the delivery of the culture solution. On the contrary, the computer-assisted climate control is still rare and mostly restricted to the cultivation of pot plants.

Figure 3. High-tech greenhouse for soilless production of tomatoes in Almeria (Spain).

Table 2. Protected horticulture (area in hectares) in the Mediterranean Basin.

Country	Greenhouses & large plastic tunnels (a)	Glasshouses (b)	Total walk-in structures (a+b)	Low tunnels	Total protected area	Soilless culture
Algeria	5,000		5,000	800	5,800	
Cyprus	285		285	300	585	
Egypt	1,350		1,350	50,000	51,350	10
France	9,000	2,300	11,300	16,000	27,300	
Greece	3,000	2,000	5,000	4,500	9,500	200
Israel	4,530	150	4,680	15,000	19,680	1,200
Italy	61,900	5,800	67,700	24,000	91,700	700
Morocco	10,000	550	10,550		10,550	
Spain	51,000	4,800	55,800	17,500	73,300	4,000
Tunisia	1,300		1,300	11,000	12,300	30
Turkey	20,900	6,200	27,100	1,500	28,600	
Total	168,265	21,800	190,065	140,600	330,665	6,140

Source: Jouet, 2001

Table 3. Production cost and income for sweet pepper crop in Holland and in Almeria.

Variable	Soil culture (Almeria)	Soilless culture (Almeria)	Soilless culture (Holland)
Yield (kg/ha)	105 000	160 000	260 000
Market price (€/kg)	0.53	0.66	1.62
Gross income (€/ha)	56 000	106 000	421 000
Variable costs (€/ha)	31 000	38 000	265 000
Fixed costs (€/ha)	13 000	27 000	55 000
Capital costs (€/ha)	4 000	8 000	60 000
Net income (€/ha)	8 000	33 000	41 000

Source: Stanghellini et al., 2003

THE MEDITERRANEAN BASIN GREENHOUSE INDUSTRY

Area and Crops

In the Mediterranean Basin, the world's most important vegetable production district, the area devoted to protected horticulture crops went from nil in the 1950s to some 120,000 ha in 1985 and nowadays there are about 170,000 hectares of greenhouses and large tunnels (Table 2). The countries with the largest area are France, Italy, Spain, and Turkey. Protected horticulture extended on more than 300,000 hectares, if low tunnels are considered; low tunnels are most common in Egypt, France, Italy and Turkey. Including temporary protections, like direct covers with wooden-nonwooden material, will increase further the area of Mediterranean Basin protected horticulture. The use of glasshouses is quite limited (something like 10,000 ha, according to Castilla, 2002) and restricted to ornamentals and nursery crops.

Vegetable crops are more important than floriculture, although the cultivation of cut flowers is quite extended and rapidly increasing in some regions, such as Israel, Turkey and Sicily. In Israel, cut flowers and ornamentals are grown on nearly half of the greenhouse acreage. There are also examples of protected fruit crops like banana (Morocco, Spain and Turkey), peach, plum and table grape. Protected culture of table grapes is necessary in many countries, particularly Italy; temporary protections are used with the aim to anticipate or postpone the harvest and to protect the grape from rain.

Solanaceous fruits (tomato, pepper and eggplant) and cucurbits (melon, zucchini, watermelon) crops account for more than 80% of the protected area. The reasons for the diffusion of these crops are the large market demand, the adaptability to variable climatic conditions of unheated shelters and to long-distance transportation, and the extended cycle that enhances the exploitation of the greenhouse. Typically, growers start their crops planting hybrid-seed transplants that are increasingly produced by specialised nurseries. Tomato (round, cluster, cherry, long-shape types are most common) is the most important product, which is predominantly marketed to Northern Europe. Strawberry is another important crop grown under unheated plastic shelters (both walk-in and low tunnels).

From the economic point of view, vegetable products are constantly increasing, but their relative prices are decreasing (La Malfa and Leonardi, 2002). The production costs are reduced compared to the North-European regions due to the lower cost of land, labour and shelters (Table 3). Furthermore, there are less environmental restrictions or, at least, there is a less rigid control by public authorities. However, transportation cost is much higher; for vegetables its incidence may reach up to more than 50% of the overall cost, compared to 20-25% for Northern productions. Finally, many areas are increasingly afflicted by the problem of water scarcity and salinisation.

In most countries, greenhouse producers are family companies, which are characterised by the low cost of hand-labour and the strong motivation for work. However, the ever-increasing importance of big supermarket chains and the high quality standards they have imposed on the global market, are resulting in an increase of the average unit size of greenhouse holdings, which may allow higher quality management during all the production and commercialisation steps.

Figure 4. Productivity of a few greenhouse crops in some Mediterranean countries and in The Netherlands. Data were provided by different institutions in the selected countries.

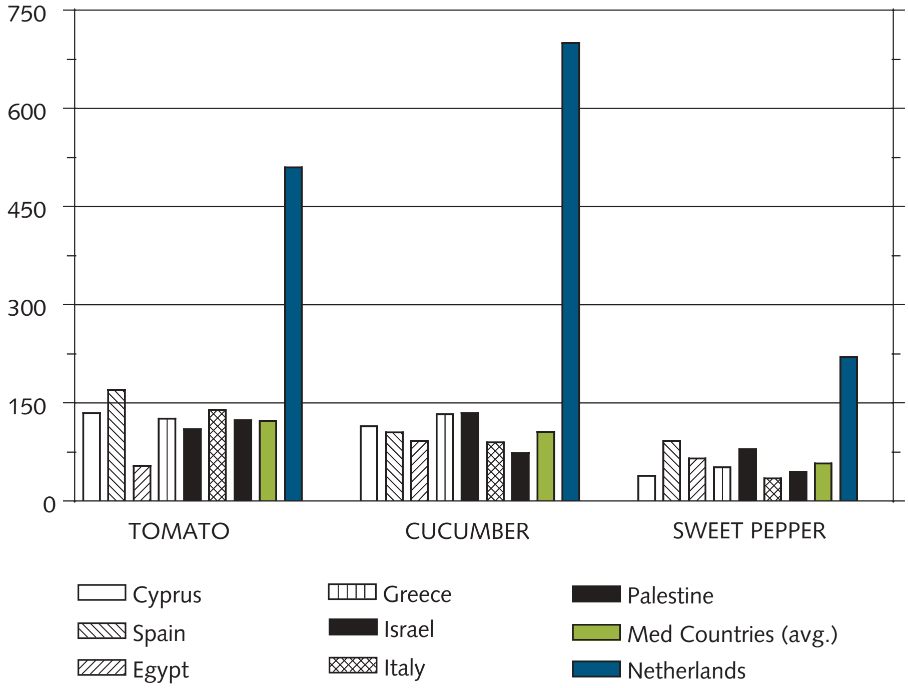
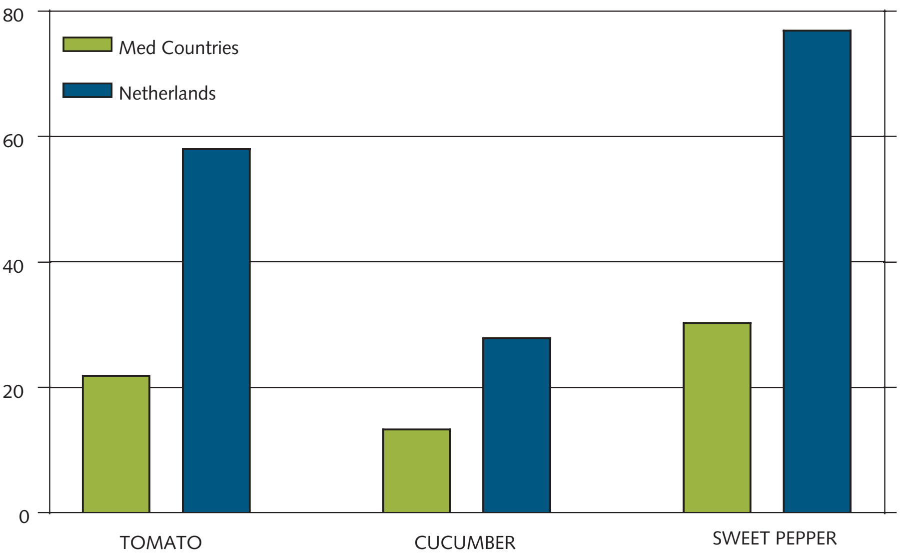


Figure 5. Water use efficiency (WUE) of some greenhouse crops in the Mediterranean countries (soil culture; mean value for Cyprus, Egypt, Greece, Israel, Italy, Spain) and in The Netherlands (soilless culture). Data were provided by different institutions in the selected countries.



Technology

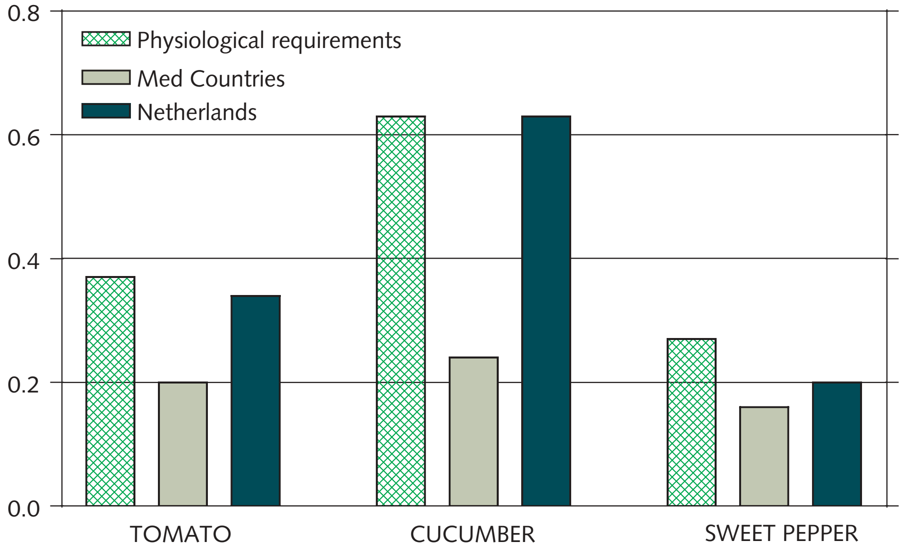
LTG predominate in the Mediterranean Basin countries. They have a reduced volume/area ratio, are poorly ventilated and covered by plastic materials that have lower light transmission compared to glass, particularly when dirty and aged. Roof vents are scarcely employed, although its diffusion is increasing. On account of mild winter temperature, heating is generally auxiliary, but high temperature and radiation in summer make cultivation almost impossible without evaporative cooling and forced ventilation. In general, greenhouse crops in the Mediterranean Basin are adapted to non-optimal environment that, on the contrary, is optimised as much as possible in the Northern countries. Compared to Holland, crop yield (Fig. 4) and the use efficiency for both water (Fig. 5) and nutrients (e.g. nitrogen; Fig. 6) are lower in the Mediterranean Basin due to the less advanced growing technologies.

Growers' interest in hydroponics is increasing and these techniques are rapidly expanding in some areas, like Almeria (Fig. 4). Nonetheless, cropping is still based on soil, which very often is characterised by low organic matter, high lime and salinity.

Although the simplicity and the cheap cost of greenhouses are the main features of Mediterranean Basin protected horticulture, many types of structures can be found in these regions, in dependence on local climate and economy. In this regard, two main cases can be discussed.

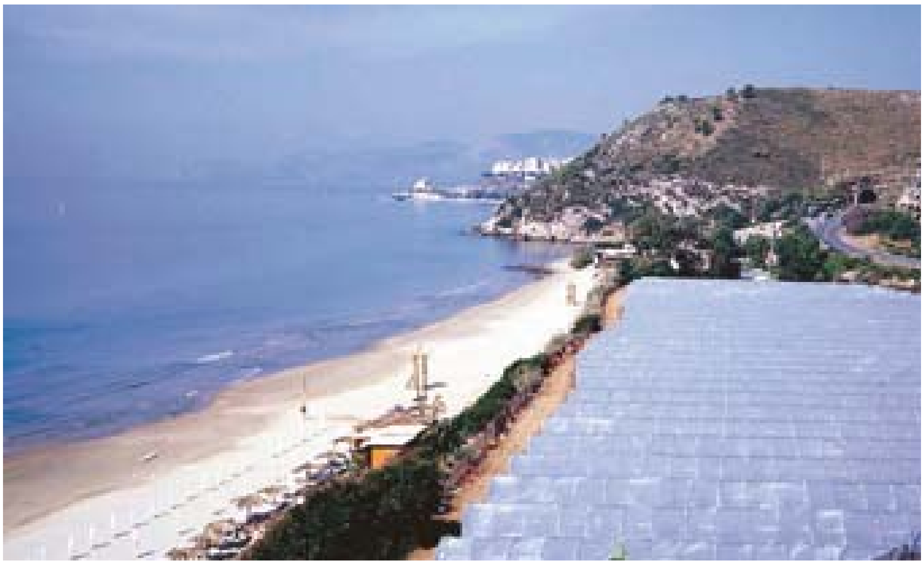
Almeria (Spain). The original Almeria greenhouse is the Parral, an adaptation of the traditional structure of wood and iron-wire used to support grape vines; it is characterised by a flat roof and perforated plastics (to drain the sporadic rain) and it does not have roof vents. Parral shelter has been largely replaced by symmetric greenhouses (Almeria type), which have small roof slopes and roof vents. The area set up with symmetric or asymmetric multi tunnels is rapidly increasing notwithstanding the investment is twice as high for the Almeria type. One typical feature of Almeria horticulture is the cultivation on *enarenado*. *Enarenado* is an artificial soil that is prepared as follows: on the original (poor) soil, growers apply, in sequence, a layer (30 cm) of clay soil, a 2-cm deposit of manure and a third layer of sand (10 cm). *Enarenado* has many advantages: little management, reduced water loss and salinity problems, and higher temperature during winter. However, *enarenado* requires periodical manure application, which is expensive; moreover, although it resembles artificial substrate culture, it does not allow recirculation of drain water.

Figure 6. Nitrogen use efficiency of some greenhouse crops in the Mediterranean countries (soil culture; mean value for Cyprus, Egypt, Greece, Israel, Italy, Spain) and in The Netherlands (soilless culture), in comparison with the physiological requirements (according to Tesi, 2001). Data were provided by different institutions in the selected countries.



Italy. Protected cultivation is quite wide spread in Italy on account of its mild climate in winter and the traditional Italian feeling for greenhouses, which appeared first in ancient Rome. Protected crops are scattered all over the country, but the most representative areas are located, moving from the North to the South, in Lombardia, Veneto, Liguria, Tuscany, Lazio, Campania, Sicily and Sardinia. Greenhouses are particularly widespread along the seacoast (Fig. 7). Different types of greenhouses and protection structures can be found ranging from wooden structures covered with plastic film to glasshouses fully equipped for automatic climate control and internal plant transportation. Most greenhouses are covered with plastic films with an emergency heating system, if any. Strawberry, vegetables and some flower crops (e.g. carnation) are usually cultivated in very simple greenhouses, whereas pot plants and propagation material are grown in more sophisticated glasshouses.

Figure 7. Plastic tunnels on the beach (Western Coast of Central Italy). Greenhouse industry often competes with tourism for land and water in the Mediterranean countries (By courtesy of Dr. J.P. Leymonie, New Ag International).



Opportunities

The strong point of Mediterranean Basin protected horticulture is undoubtedly the climate that is characterised by relatively high radiation during fall and winter thanks to the large number of clear days, the mild temperatures during winter and the seasonal stability of the temperature provided by the sea (Fig. 8). For instance, in Sicily more than about 500 hours of sunlight are available during winter, with a daily global radiation of 6-8 MJ m-2 and a mean air temperature of 10-13°C.

The availability and the cost of hand labour, often provided by immigrants from developing countries, also represent an important resource for the sector, which tends to invest more in growing technology (including fertigation) than in greenhouse structure and climatic control. As matter of fact, the adoption of more sophisticated technologies for energy saving, temperature control as well as plant transportation inside the greenhouse have been restricted to the cultivation of pot plants in regions with colder climate (France, Northern Italy).

Limits

Due to the prevalent climate and the current growing technology, the following problems are generally encountered in the Mediterranean Basin:

- lower light transmission (as a result of whitewashing as well) and poor ventilation, which often leads to CO_2 depletion, reduced photosynthesis and then crop growth and yield, with an important effect on produce quality as well;
- large fluctuation in temperature, a typical phenomenon in unheated greenhouses in clear-sky regions (sometimes, thermal inversion occurs in winter), is the main reason for variation in productivity during harvesting period and may result in physiological stress of the crop;
- high indoor temperatures typically occur from May to August; this makes almost impossible year-round cultivation, so that the production is generally seasonal with two peaks, in spring to early summer and in autumn (till the Christmas period, if climate is good enough);
- inadequate climate control often results also in high relative humidity which reduces crop transpiration; this may impair leaf cooling on warm days and promote the incidence of nutrient-related physiological disorders, like calcium deficiency (for instance, blossom-end rot of tomatoes and peppers);
- mild winter temperature, high internal humidity, the open structure of shelters, the lack of heating and, in many cases, the irrational management of crop residues facilitate

the proliferation of pests (white flies, thrips, leaf miners) and diseases (grey and black mold, root and stem rot, viruses), and make biological control quite difficult, thus resulting in a large amount of applied biocides;

- the harvest periods for open field and protected crops tend to overlap with consequent decrease of market prices;
- the use of soil, instead of soilless systems, renders the culture dependent on frequent soil disinfection (still based on methyl bromide, principally) and organic fertilisation; moreover, it does not allow the fine tuning of irrigation and fertigation nor the recirculation of drainage water, which are crucial for high crop performance and efficient use of both water and nutrients.

Growing Technologies in Relation to Water Scarcity and Salinisation

Drought and salinisation are the main constraints to the development of the Mediterranean Basin greenhouse industry. Thus the application of drip irrigation together with smart scheduling of water distribution is essential to improve crop water use efficiency.

Much experimental work has been done on the response of greenhouse crops to salinity. Although not all the physiological and biochemical mechanisms underlying the plant's tolerance or sensitivity to salt stress have been clarified, the response of many greenhouse crops to salinity is well established, in terms of both yield and produce quality. Indeed, some practices can be applied to alleviate the negative effects of salinity (Sanchez and Silvertooth, 1996). However, the effectiveness of these cultural practices depends on many factors, such as crop genotype, environmental and cultural conditions. In other words, these practices do not seem completely reliable and compatible with the need of standardised cultivation techniques and constant (predictable) crop yield and produce quality. Genetic manipulation, by means of recombinant DNA technology as well, may provide more salt resistant cultivars of the most important crops; however, the practical application of breeding seems still remote. Finally, poor irrigation water renders almost impossible the use of the recirculating water growing system that is the most effective technology to reduce the environmental impact of greenhouse crops.

Therefore, it seems that the use of treated wastewater and seawater (and rain water as well, where possible), coupled with the application of water-saving technologies (mulching, drip irrigation, smart scheduling of water supply, closed-loop hydroponics), might be an effective strategy to solve the problems related to water. Desalinised water, of course, costs much more than raw water; however, compared to other agricultural sectors, pro-

Figure 8. Monthly means of the relevant climatic factors in three different regions: Almeria (South-East Spain), Versilia (Tuscany, Central Italy) and Wageningen (Netherlands). The most important effects of external climate on indoor conditioning are shown (after Von Zabeltitz, 1999). [Source: Italy, ARSIA-Regione Toscana; Almeria and Netherlands, Costa and Heuvelink, 2000].

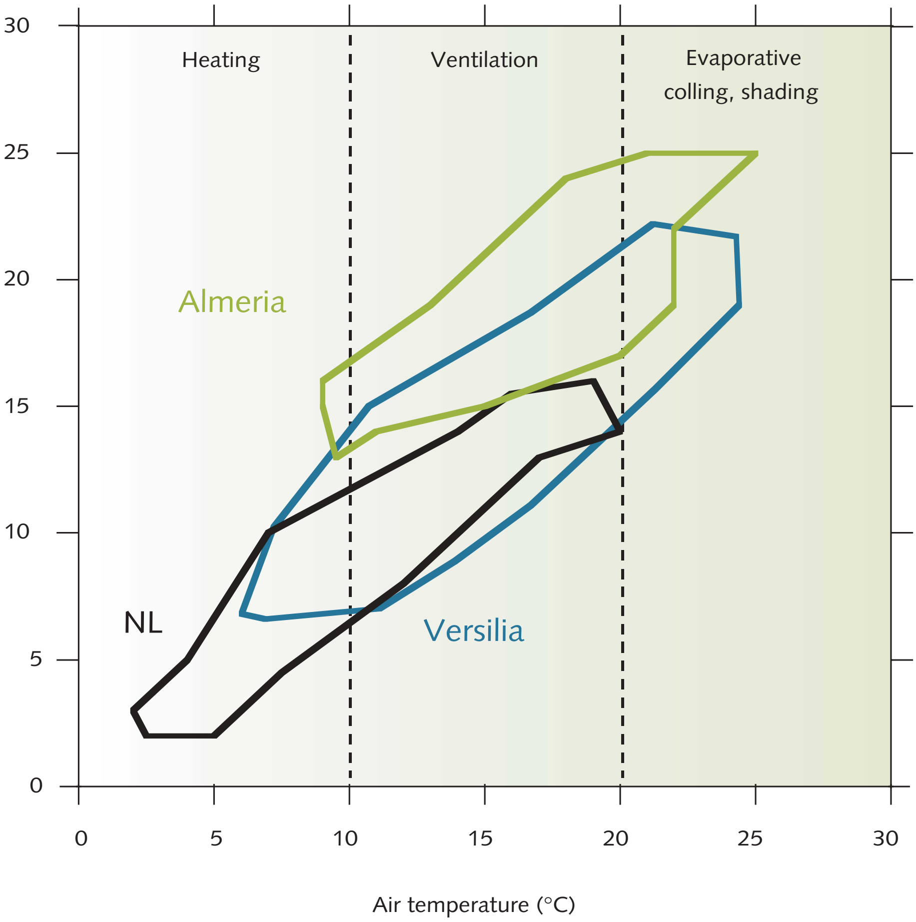


Figure 9. Seawater desalinisation plant in Carboneras, Almeria (Spain).

tected horticulture is much less affected by the cost of irrigation water due to high marginal price (Stanghellini et al., 2003). Undoubtedly, greenhouse growers fear the scarcity of water much more than its cost. Last but not least, the availability of high quality (i.e. low salinity) water may increase the production flexibility, in that growers do not have any limitation when crop and cultivar have to be selected for a production plan. And flexibility is crucial for the commercial competitiveness of the sector.

A seawater desalinisation plant has been recently established in Carboneras (Almeria) to exploit seawater for urban use and irrigation (Fig. 9). The potential of the plant, which is based on reverse osmosis, is about 120,000 cubic meters per day (nearly 44 million of cubic meters per year) of desalinised water, which may be distributed to about 5,000 hectares of horticultural crops at a price of around 0.8 /m3. Desaladora de Carboneras, the largest in Europe and second in the world, may provide data for policy makers in many Mediterranean Basin countries.

Marketing Policy

The future development and success of Mediterranean Basin protected horticulture does not hinge on growing technology only. A comprehensive marketing policy must be implemented in order to reduce transportation costs, supply the market, in particular the big supermarket chains that are now prevalent in the Western Europe, with labelled and quality-certified products, and stabilise their prices. It is becoming a common practice that big retail groups include in the contract with large producer organisations detailed growing protocols for the environmentally sound production of healthy commodities. Therefore, there is the need for grouping growers into large (co-operative) commercial organisations, in order to improve their ability to get a satisfactory commerce, including a remunerative price of their products. The commercialisation of innovative products may support the growth of the sector. For instance, fresh-cut (also named ready-to-use or minimally-processed) fruits and vegetables may represent a commercially valuable produce.

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Alberto Pardossi

Franco Tognoni

Luca Incrocci

About the Authors

The authors work at the Department of Crop Biology (Dipartimento di Biologia delle Piante Agrarie) in Pisa (Italy). Alberto Pardossi (left) and Franco Tognoni (middle) are, respectively Associate and Full Professor of Vegetable and Flowers Crops at University of Pisa; Luca Incrocci (right) is a research assistant. The authors' scientific interests are in the field of protected crops with particular emphasis on crop fertilisation and irrigation, including hydroponics. The paper is based on a study conducted in the framework of a research project funded by European Union on sustainable management of water resources in the Mediterranean protected horticulture (INCO-MED Hortimed).

Contact

A. Pardossi, L. Incrocci and F. Tognoni, Dipartimento di Biologia delle Piante Agrarie (http://www.agr.unipi.it/dbpa/), Università di Pisa, Viale delle Piagge, 23, 56124 Pisa, Italy, email Alberto Pardossi: alberto.pardossi@agr.unipi.it

Greenhouse Cultivation of Bananas

Víctor Galán Saúco, Ahmed Ait-Oubahou and Hanaf Abdelhaq

The idea of cultivating tropical fruits in greenhouses is certainly not new. The first European pineapples were produced during the reign of Louis 14th of France (Py, 1967) and its popularity as a greenhouse crop in Europe only waned towards the end of the 19th century when competitive fruits from the tropics became more readily available to consumers. Its cultivation under glass does however persist to this day on the Portuguese island of San Miguel, in the Azores Archipelago.

Morocco, with 4460 ha, and Spain, with 3000 ha in the Canary Islands, are the largest producers of banana under greenhouse worldwide. In Morocco greenhouse banana area reached its peak of 4650 ha in 1994 but decreased since due to import restrictions (Hanafi and Papasolomontos, 1999). The area of banana under greenhouse in Morocco is likely to decrease in the coming years because of competition from imported banana from South America.

The area of banana cultivation under cover in the Canary Islands have been in continuous increase but the future trend will depend on the changes to be implemented in the European banana market after the tariff-only system will be imposed, not later than 2006 or even perhaps in 2004.

Cultivation of banana under greenhouse is gaining importance in Israel, where some experimental plots were planted at the beginning of the 1990s and now about 100 ha is cultivated and there is a clear trend to increase the surface under protected cultivation (Y. Israeli, pers. commun., 2003). Small commercial plantings of banana under plastic are found in Crete (72 ha) (S. Lionakis, pers. commun., 2000), Cyprus (260 ha) (Papandreou, 1992), Lebanon (65 ha), (Marouni, pers. commun.) and Algarve region of Portugal (12 ha) (Louro, 1998). Smaller areas of banana under greenhouse are grown in Turkey, Korea, Tunisia, and Argentina (Galán Saúco, 2002). A few hectares of banana were planted under greenhouse during the 1990s in South Africa (Eckstein et al., 1998). In Iran, about 50 ha of banana are cultivated under greenhouse in the Northern part of the country adjacent to the Caspian sea (Ait-Oubahou, 2002). Attempts have also been made in Sicily and Sardinia with good production results, but doubtful economics (Pala, 1993), discouraging further plantings.

ADVANTAGES AND DISADVANTAGES OF BANANA GREENHOUSE CULTIVATION

The general advantages of greenhouse cultivation in the subtropics have been studied in depth in the Canary Islands (Galán Saúco et al., 1998) and include: (1) increase in the number of hours with a temperature above 20°C, considered the threshold below which growth and development cannot be improved by any cultural technique (Green and Kuhne, 1970); (2) protection against wind and other weather conditions (sunburn, hail); (3) reduction in water consumption, as evapotranspiration is reduced by up to 25%, this being the main reasons for the Israeli plantings; (4) increase in the leaf surface leading to higher photosynthetic capacity; (5) reducing the life cycle of the plant to less than 13 months from planting to harvest; and (6) to greater and heavier bunches in subtropical climate. Other additional advantages of greenhouse cultivation in subtropical areas include good size of banana fruit and theoretically the prevention of the dispersal of Sigatoka as the two inoculum types (conidia and ascospores) are spread mostly by wind (Carlier et al., 2000).

All of these points are of capital importance in reducing costs and increasing yields, to the extent that in some areas of the Canary Islands bunch weights have increased up to 61.7% (Galán Saúco et al., 1998), which translates into average yields of over 80 tonnes/ha (exceptionally 100 tonnes/ha per year) in comparison to averages of 60 tonnes/ha a year for well-managed open air plantations. Similar reports were reported under greenhouse cultivation in Morocco (Janick and Ait Oubahou, 1989). The reasons for this increase in yield lies in the fact that since vegetative growth precedes flowering and fruiting, there is no competition between both processes, and conditions that favor growth, such as those obtained in well managed greenhouses in the subtropics, also favor flowering and fruiting.

The greenhouses cost around 8 euros/m^2 in the Canaries as compared to 1.5 to 3 euros/m^2 in Morocco. In the Canaries where tourism is high, the structures have been thought to have a negative esthetic impact.

THE BANANA GREENHOUSES

The first type of greenhouse structure used for banana in Morocco was a 5-to-6-m-high structure covering 1 to 1.25 ha (Janick and Ait-Oubahou, 1989). Today, a structure developed in the Canaries made totally of wood or galvanized poles is frequently used. The size has remained relatively constant and is dictated by the dimensions of the plastic sheets (3 to 6 m wide by 120 to 140 m long). A single sheet of film is stretched over a wooden (usually eucalyptus) or metal frame, resulting in the basic

Banana greenhouse range in the Canary Islands.

Moroccan greenhouse measuring 100 m² 125 m, with a flat roof and curved ends. The sheeting usually used is 180 to 220 (m in thickness, which needs replacing every three years. Ventilation is usually achieved by opening/closing side sections, although in some areas the cladding is woven around the framework, leaving openings, that can cause excessive heat loss in the winter. Overexposed sides are often painted with lime to reduce excessive heat during the summer (Fig. 1).

The typical banana greenhouse in the Canary Islands (Galán Saúco, 1992; Galán Saúco et al., 1998), is a frame of galvanized steel pipes (5-to-10 cm in diameter and 6-to-7 m in length) embedded in concrete bases. Cladding is fine net, polyethylene film or a combination of the two sandwiched between a double-weave wire network. Net cladding is particularly recommended in the warmer areas of the Islands where the main goal is to protect the plants from wind damage. Banana structures last for more than 20 years but plastic covers should be replaced every 2-to-3 years while netting may last 5 years. Current trials are done by Instituto Canario de Investigaciones Agrarias (ICIA) to evaluate different types of greenhouse covers with current emphasis on long-lasting polyethylene types.

CULTIVARS

'Grande Naine' is the most widely planted greenhouse cultivar both in Israel (100%) and in Morocco with around 92% of the surface under cover (Ait-Oubahou, personal communication, 1999) and roughly 75% in the Canary Islands. 'Dwarf Cavendish' is the second in importance both in Morocco and the Canary Islands, with token plantings of 'Williams' and 'Poyo' in Morocco (M2%). Many new plantings in the Canaries, both under greenhouse and in the open air are being done with 'Gruesa', an interesting and highly productive locally selected 'Dwarf Cavendish' clone. Only 'Grande Naine' and 'Dwarf Cavendish' are planted under greenhouse in other countries.

CULTURAL TECHNIQUES

Cultural techniques for greenhouse banana cultivation in the Canaries include the use of micropropagated plants, with variable planting distances, with up to 3 plants/hole (1.0-2.5 m between groups) but always allowing aisles of 5-6 m. The grouping of 3 plants/hole allows easy aerial tying as well as more rational management, facilitating mechanization of different cultural techniques (such as desuckering, chemical treatments, and harvesting). In the first cycle densities can be very high, up to 4000 plants/ha, but should be reduced by around half for the 2nd and successive cycles. In the warmer, spring-type climate of the Canary Islands or the Souss Valley of Morocco, planting is generally done in the spring or at the beginning of the summer. Recent trials in the Canary Islands include spring planting in greenhouse at 10 _ 1 m (2 plants/hole) and again during the summer in the middle of the aisle (also at 2 plants/hole, spaced 1 m within the row), so that the initial spring planting can be automatically replaced during the summer of the following year and the summer planting is replaced in the spring of the second year, with a subsequent replanting of half of the population with micropropagated plants. Specialized machinery is needed for this type of practice, in order to shred and bury the unwanted plant material. No desuckering is required as the plantation is maintained permanently on a parent-crop cycle. 'Grand Naine' adapts better than 'Dwarf Cavendish' clones to plantings in groups of 2-3 plants per hole due to their upright leaves.

The excessive foliar surface under greenhouse requires leaf removal to avoid lack of light and consequently cycle delay. Leaf removal is carried out shortly after bunch emergence keeping a minimum of eight leaves/plant. The most recently emerged are retained. Each plant will produce a bunch/year in contrast with open-air plantings, where in many locations of the Canary Islands only 80% of the plants produce bunches in a given year. Desuckering, done similarly as in open air plantings, is easier under greenhouses as both sucker emission, growth and development is faster. This allows an easier control of cycle length, which permits the control of cycling to obtain the best prices.

Fertilization is also done similarly as in the open air plantings applying annually about 300 kg N, 40 kg P, and 500 kg K per hectare. A total of 12,000 m3 of water is applied annually per ha (Galán Saúco et al., 1998). Higher quantities of fertilizers are applied during the warmer months (April to November) when both water demand and photosynthetic activity are at a maximum. It is also common to apply organic matter (40-80 tonnes/ha) during winter to both soil temperature and photosynthetic activity (due to CO_2 increase caused by manure fermentation).

Water consumption can be reduced with drip irrigation by up to 25%. Daily greenhouse consumption is in the range of 10 L/plant in the winter and 20 L/plant in the summer, which is of capital importance due to the high cost of water in the Islands (averaging around 0.4 euros /m3). Greenhouse cultivation allows also the aerial tying of bunches to the internal pipes of the roof structure of the greenhouse eliminating the need to prop up plants.

Cultural techniques in Morocco are similar to those in the Canaries, although the comparatively cooler climate of Morocco makes it advisable to have two planting periods, February-May or September-October, to avoid flowering in winter. Because of extreme summer and winter temperatures, banana greenhouses are equipped with an overhead mist to reduce the risks of leaf burning and chilling in the winter.

High production of banana in Moroccan greenhouses.

Planting densities of banana in Morocco do not exceed 2000 to 2100 plants per ha. Double line is often preferred than the single row technique. The two rows are 1 to 1.2 m apart and plants are within the same distance on the row. Planting is done on triangular shape. Only one crop is produced per year and most of the suckers are removed systematically until flowering at which the plant follower is selected. The plant cycle is about 13 months from planting micropropagated plantlets of 5 to 6 leaves. Organic manure is applied at about 20 to 30 kg per plant. Fertilizers are applied either through irrigation or by hand around the plant. The main fertilizers are NPK, which are applied at rate of 400, 250, and 800 g/mat per cycle. Differences exist from one plantation to another due to differences in soil mineral content and technical know how. Large part of the fertilizers is applied from planting to flowering with about 1/4 of nitrogen and potassium used during the bunch development. Drip irrigation is most commonly used and a quantity of 10 to 12,000 m³ is required during the plant cycle.

In Iran, banana greenhouse is heated using a natural gas or fuel for at least 3 to 4 months period per year. The plastic is removed from June to late September (Ait-Oubahou, 2002).

PESTS AND DISEASES INCIDENCE AND CONTROL

The Canary Islands are blessed by not having many pests and diseases, being free of Sigatoka, *Radopholus similis* and with a reduced incidence of *Fusarium*. Phytopathological problems under greenhouse do not differ substantially from open air conditions, while exclusion measures, biological control, and integrated or even organic plot management are easy to apply.

Few pests and diseases colonize banana greenhouses in Morocco. Nematodes are by far the most important pests of banana requiring over 79% of pesticide input. The problem of nematodes is more severe in sandy than in heavy soil. At least 5 species of nematodes colonize banana under greenhouse in Morocco including: *Meloidogyne incognita*, *Meloidogyne javanica*, *Radopholus similis*, *Helicotylencus multicinctus* and *Pratylenchus* sp. All these species cause chlorosis, stunting and reduce leaf size and number. Infestation by nematodes prolongs the crop cycle, increase water stress sensitivity and reduce yield significantly. If *Meloidogyne* were the most abundant and important species on banana a decade ago, *Radopholus* sp. and *Helicotylencus* sp. are nowadays the species most frequent and most damaging (Lamine, 1999). *Radopholus* is found in other regions of the world but has not been reported in the Canary Islands, Cyprus, Israel, Lebanon or Greece (Sarah, 1989).

A number of insect and mite pests colonize banana in Morocco. These include, wireworms (*Agriotes* sp.); lepidopteran (*Opogona sacchari*), aphids (*Aphis gossypii*) and the mite (*Tetranychus urticae*). The two pests that cause economic damage are whitegrubs and mites, which require about 10% of total pesticide input in greenhouse banana in Morocco (Lamine, 1999). Disease control requires about 11% of chemical treatment that is directed mainly against cigar-end rot.

The major fungus disease, cigar-end rot, caused by *Verticillium theobromae*, is controlled by fungicides. Sigatoka has not been a problem. Virus diseases, including bunchy top, banana strip virus, and cucumber mosaic virus, have been a problem when locally field-grown stock has been planted.

CONCLUSIONS

Protected culture of bananas is technically feasible in the subtropics as both growth and flowering habit benefit from the climatic modifications achievable in the greenhouse. In the case of the banana, the tremendous increase in yield and the improvement in harvest planning can justify the investment in infrastructure. This has been amply illustrated in both the Canary Islands and Morocco. Despite high production and the know how developed during the last 22 years of banana production in Morocco, postharvest technologies including handling and ripening are still rudimentary, and require improvements.

Víctor Galán Saúco, Ahmed Ait-Oubahou and Hanaf Abdelhaq

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Víctor Galán Saúco

Ahmed Ait-Oubahou

Hanaf Abdelhaq

About the Authors

Víctor Galán Saúco, Chair of the ISHS Section Tropical and Subtropical fruits is the researcher leading the Department of Tropical Fruit, Instituto Canario de Investigaciones Agrarias, Apdo. 60, La Laguna 38200 Tenerife, Spain.
Ahmed Ait-Oubahou, is Professor in the Department of Horticulture, Institut Agronomique et Vétérinaire, Hassan II-Complexe Horticole d'Agadir, Morocco.
Hanaf Abdelhaq is Professor in the Department of Plant Protection, Institut Agronomique et Vétérinaire, Hassan II- Complexe Horticole d'Agadir, BP: 12042 Cite Balneaire, Agadir 80.000, Morocco.

Asia Pacific Theme at Horticultural Science Conference

September 1st - 3rd this year will see a major conference of horticultural and plant scientists from around the world at the Hyatt Regency Coolum on Queensland's Sunshine Coast. Under the auspices of the Australian and New Zealand Societies of Horticultural Science (AuSHS & NZSHS) and the New Zealand Society of Plant Physiologists (NZSPP), the conference has the theme of 'Harnessing the Potential of Horticulture in the Asian-Pacific Region'.

The programme includes sessions dealing with key issues and challenges for horticultural industries and scientists in the region, including:

- achievement of commercial potential,
- harvesting the genetic potential,
- reaching the potential for sustainable horticulture,
- building bridges for international collaboration,
- enhancing economic potential,
- education and training,
- harnessing the potential of sensory and postharvest technologies,
- regulation of plant metabolism, and
- stress physiology.

Keynote speakers from around the world will introduce the session topics, and include Professor Ian Warrington (Massey University, New Zealand), Professor Jules Janick (Purdue University, USA), Dr. Norm Looney - President of the International Society for Horticultural Science (ISHS) (Canada), Professor Robert Paull (University of Hawaii), Professor Geoff Dixon (Green Gene International), Professor Daryl Joyce (University of Queensland), Professor Ronnie Harding (University of New South Wales), and Peter Luxton (Zespri International, New Zealand).

Following the keynote presentations in each session, the majority of time has been allotted to submitted papers. The detailed conference program can be found on www.aushs.org.au/conference/index/htm and those wishing to present papers are required to submit abstracts by April 30th.

"This is the first time that Societies of Horticultural Science in Australian and New Zealand have joined together for a conference and we are delighted that the New Zealand Society of Plant Physiologists is also joining us at Coolum.

"Another highlight of the conference will be the NZSPP Annals of Botany address by an invited speaker," said Professor Richard Williams of the University of Queensland, conference program chairman.

Efforts are being made to attract delegates from countries throughout the Asia Pacific in an attempt to further enhance international collaboration.

Contact

Further details about the conference are available from:
Australia: Richard Williams, Phone: +61 (0)7.5460 1305, Russ Stephenson, Phone: +61 (0)7.5444 9649, Tony Biggs, Phone: +61 (0)2.4571 1321
New Zealand: Jill Stanley, Phone: +64 (0)3.528 9106, Julian Heyes, Phone: +64 (0)6.356 8300

Italian - National Academy of Agriculture

Jules Janick was inducted as a corresponding member of the National Academy of Agriculture of Italy and received his certificate during his seminar presentation on Horticulture and 10,000 Years of Change in Bologna, April 2, 2004.

New Books, Websites

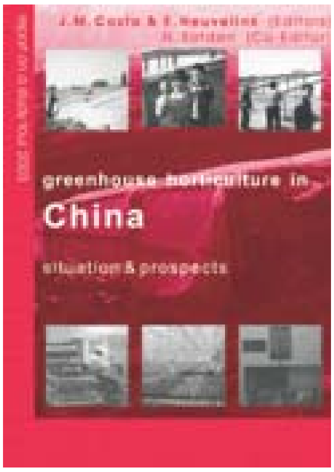
The books listed here are non-ISHS-publications. For ISHS publications covering these and other subjects, visit the Acta Horticulturae website www.actahort.org

BOOK REVIEWS

Alternative Agriculture: A History from the Black Death to the Present Day. Joan Thirsk. 1997. Oxford University Press. 365p. ISBN 0-19-820662-3

Joan Thirsk, an historian of agriculture, has put together an thoughtful book on the history of alternative agriculture in England. She defines Western mainstream agriculture as the production of cereals and meat and her point is that when food is scarce agriculture sticks to basic foodstuffs. But changed circumstances and major disjunctions oblige farmers to divert their energies from the primary pursuit of grain and meat to investigate other activities. These disrupting circumstances have come from declining populations as in the first half of the 14th century as a result of the plague or as is now the case from overproduction due to increased technology. There have been a number of solutions sought such as a search for new meat sources (pigeon, rabbit and chicken, for example) and particularly new crops (from industrial crops such as rapeseed, woad, mead, and saffron to a wide range of horticultural crops). Viewed in this context, organic agriculture appears to be a present solution to overproduction. Her conclusions are interesting and deserve quotation: *What of the lessons which farmers and policymakers may take to heart from the past? Judging by the experience of the three previous phases of alternative agriculture, the strong assumption of our age that omniscient governments will lead the way out of economic problems will not, in practice, serve. The solutions are more likely to come from below, from the initiatives of individuals, single or in groups, groping their way, after many trials and errors, toward fresh undertakings. They will follow their own hunches, ideals, inspirations, and obsessions, and along the way some will even be dismissed as harmless lunatics. The state may help indirectly, but it is unlikely to initiate, or select for support the best strategies, and, out of ignorance or lack of imagination, it may positively hinder.* This is an interesting book.

Greenhouse Horticulture in China: Situation & Prospects. J.M. Costa and E. Heuvelink (eds.), N. Botden (co-editor). 2004. Ponsen & Looijen BV, Wageningen, The Netherlands. 140p. + appendix. ISBN 90-6754-744-1.

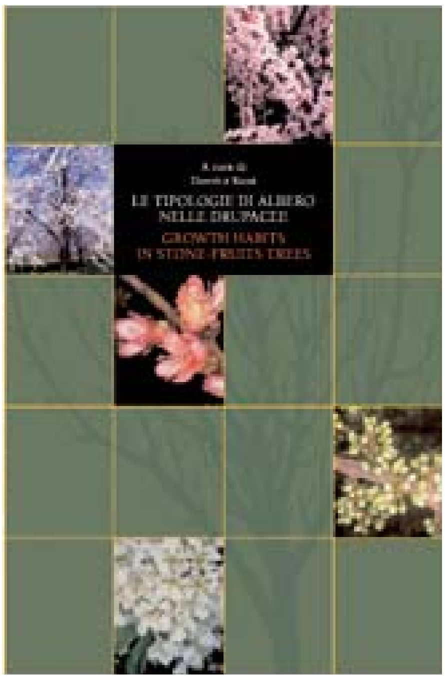


Greenhouse Horticulture in China: Situation & Prospects

This small book is a report of study group from the Horticultural Production Chains, Department of Plant Sciences, Wageningen University and Research Centre, that visited China in 2003 to study China's greenhouse industry. (A previous study tour by the Horticultural Production Chains Group investigated the greenhouse horticulture in Almeria, Spain.) Led by Miguel Costa, project leader and organizer, the trip included five other participants who visited a number of universities or institutes. The work begins with a brief introduction followed by an overview chapter on China's greenhouse horticulture. The importance of China's greenhouse industry is clearly shown in the first table; China has almost 55% of the total world's plastic greenhouse (including large tunnels) and over 75% of the world's small plastic tunnels. The next five chapters cover reports on the greenhouse industry in municipalities of Beijing and Shanghai, and the Provinces of Jiangsu, Shandong, and Yunnan. These chapters all include a "SWOT" analysis discussing industry strengths, weaknesses, opportunities, and threats. A final chapter presents an overview of China's horticultural sector. There is an extensive references section.

Growth Habits in Stone-Fruit Trees. D. Bassi (ed.). 2003. (Il Divulgatore, Bologna, Italy, October 2003. 173p.

This monograph focuses important points related to growth habits in stone fruit trees (apricot, peach plum, and sweet cherries) and represents a significant contribution to the field of breeding for improved fruit tree growth habit. A team of experts in the field (five working groups from the Universities of Bologna, Florence, Milan, and Pisa and from other research institutions) have produced an information platform based on an orderly and coordinated set of measured parameters. Each growth habit within a species is defined and discussed, terms are defined (glossary), objective tree growth data are presented, and reference cultivars are provided. Illustrations (hand drawing) represent a useful visual guide to each growth type. This book thus seeks to describe the main tree habits found in five important stone-fruit species and to identify the morphological keys unlocking their characterization and, in the process, provide some suggestions for their practical exploitation. The text is both in English and Italian.



Growth Habits in Stone-Fruit Trees

The book may be requested at mirella.dallavalle@unimi.it, or at icami.biblio@unimi.it (€ 50,00).

Above books were reviewed by Jules Janick

History of Horticulture - Horticulture 306 History 302 Class Notes. Jules Janick. 2003. Tippecanoe Press, West Lafayette, Indiana. 690p.

This publication is not a typical book - it does not even have an ISBN. Rather it is a multimedia publication of the class notes of the "History of Horticulture" course offered by Prof. Jules Janick at Purdue University. The entire publication is available at *www.hort.purdue.edu/newcrop/history* at no cost. The website version offers the information in 3 formats: 1) Each of the 42 lectures are available as text (with colour figures); 2) printer friendly pdf version (with black and white figures); and 3) a PowerPoint version of each lecture as shown in class (with colour figures). A paperback version (690p. with black and white figures) can be purchased by contacting Prof. Janick (janick@purdue.edu).

Prof. Janick's objectives were to provide an historical record of agriculture and horticulture from pre-history to the present, trace the origins and development of agriculture and horticulture and its relationship to modern civilization and culture, and provide an appreciation for how agricultural and horticultural developments have influenced modern science and technology.

Instead of chapters, the contents are arranged by course week. These include: 1) Origins of Agriculture, 2) Origins of Crop Plants, 3) Ancient Egyptian Agriculture, 4) Mesopotamia and the Fertile Crescent, 5) Agricultural Development in Asia, 6) Agricultural Development in Pre-Columbian America, 7) Greek and Roman Agriculture, 8) Medieval Agriculture in Europe, 9) Agriculture and Medicine, 10) The History of Spices, 11) Experimental Science, 12) Agricultural Scientific Revolution, 13) Horticulture, Politics, and World Affairs, 14 and 15) Horticulture in Literature and Art. Within each week there are individual lectures and associated readings. The readings are individual articles gleaned from scientific journals and books.

I am certain any horticulturist or non-horticulturist would enjoy this publication and it would make an excellent gift. Some of it may be familiar but since it is very broad in its content, every reader will be frequently thinking "I never realised that…." as they read his lectures and the associated readings. One can read all of it or, if they are short of time, select any topic that is particularly interesting without needing to refer to previous lectures. Prof. Janick is well-known for his erudite historical horticultural lectures and it is very generous of him to provide his notes for anyone to read and use. Readers may notice there that a few images are slightly fuzzy, there is some repetition between lectures and the associated readings, and other minor editorial errors. However, this is understandable as Prof. Janick is simply providing readers with his course notes, not an edited book. Perhaps it should be considered "Jules in the rough". My hope is that someday he will use his wealth of knowledge and these course notes to publish a full book version with colour figures.

Reviewed by Robert K. Prange

NEW TITLES

Acquaah, George. 2004. Horticulture principles and practice. 3rd ed. Prentice Hall, Upper Saddle River, New Jersey. ISBN 0-13-114412-X.

Evans, D.E., J.O.D. Coleman and A. Kearns (eds.). 2003. Plant Cell Culture. BIOS Scientific Publ. ISBN 185996320X. $47.95

Flora of North America Committee (eds.). 2003. Flora of North America. Vol 4. Oxford University Press. ISBN 0-19-517389-9.

Jackson, John E. 2003. Biology of Apples and Pears. Cambridge University Press. ISBN 0-521-38018-9. $130.00.

Jain, S. Mohan and R. Swennen (eds.). 2004. Banana Improvement: Cellular, Molecular biology, and Induced Mutations. Science Publishers, Inc, USA. ISBN 1-57808-340-0.

Nath, Prem, P.B. Gaddagimath and O.P. Dutta (eds.). 2004. Food Security and Vegetables: A Global Perspective. P.N. Agricultural Science Foundation, Bangalore. 412p. ISBN 81-901815-0-5. $50. www.pnasf.org

Robinson, Nick. 2004. The Planting Design Handbook. 2nd ed. Ashgate, Hampshire, UK. 336p. ISBN 0-7546-3035-8. £29.95. www.ashgate.com

Shrestha, Anil (ed.). 2004. Cropping Systems: Trends and Advances. Food Products Press, The Haworth Press, Inc., New York. 720p. ISBN 1-56022-107-0 (paperback). $59.95. ISBN 1-56022-106-2 (hardback). $89.95. www.haworthpress.com

Tijskens, Pol. 2004. Discovering the Future: Modelling Quality Matters. PhD thesis of Wageningen University. ISBN 90-8504-017-5. Info: Pol.Tijskens@wur.nl

WEBSITES

http://www.cast-science.org: Biotechnology-derived, Perennial Turf and Forage Grasses: Criteria for Evaluation

SPANISH JOURNAL OF AGRICULTURAL RESEARCH

The Spanish National Institute for Agricultural and Food Research and Technology (Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, INIA) publishes in English, since March 2003, the *Spanish Journal of Agricultural Research* (SJAR), with the aim of attending the need of new journals to publish international high quality research articles in agricultural sciences after a peer review process.

Last 20th February, Mr. Adolfo Cazorla, Director General of INIA, Mr. Fernando Riquelme, President of *Sociedad Española de Ciencias Agrarias* (SECH) and Mr. Carlos Gracia, President of *Sociedad Española de Agroingeniería* (SEA), signed an agreement of collaboration to facilitate the co-operation in the edition and diffusion of SJAR, which will be thenceforth the official journal of SECH and SEA.

We hope that SJAR will be soon included within the best international scientific journals databases and given that contributions of high quality and interesting content are published, the impact index will increase progressively, as well as its diffusion and popularity in the transfer of new knowledge within the agricultural sciences. We would like to take advantage of this opportunity to encourage ISHS members to send contributions to SJAR with results from your most interesting research.

SJAR edits four numbers per year and free subscriptions to an email alert service is available (through the following e-mail address: publinia@inia.es) which includes article title and abstracts of articles.

Courses and Meetings

The following are non-ISHS events. Make sure to check out the Calendar of ISHS Events for an extensive listing of all ISHS meetings: www.ishs.org/calendar

35th International Symposium on Essential Oils, 29 September - 2 October 2004, Giardini Naxon, Messina, Sicily, Italy. Info: Prof. Giovanni Dugo/Prof. Luigi Mondello, Dipartimento Farmaco-chimico, University of Messina, Viale Annunziata 98168, Messina, Italy, Phone: +39-090-676-6451/6536, Fax: +39-090-676-6532, email: iseo2004@pharma.unime.it and http://pharma.unime.it/foodchem/iseo2004

2nd Global Summit on Medicinal and Aromatic Plants, 25-29 October 2004, New Delhi, India. Info: Dr. V. Sivaram, Phone: 91-80-25244592, Fax: 91-80-23219295, email: cenfound@yahoo.co.uk and www.cenfound.org/global/global.html

12th Congress of Fruit Growers of Serbia and Montenegro, 29 November - 3 December 2004, Hotel Palisad, Ziatibor, Serbia. Info: Congress Secretariat, Phone: +381 11 624 626, Fax: +381 11 628 398, email: aiserbia@eunet.yu

Greenhouse Crop Production and Engineering Design Short Course, 16-19 January 2005, Tucson, AZ, USA. Info: Priscilla Files, Phone: 520/626-9566, Fax: 520/626-1700, email: pfiles@ag.arizona.edu and http://ag.arizona.edu/ceac/

17th International Botanical Congress, 18-23 July 2005, Vienna, Austria. Info: Dr. Josef Greimler, Phone: +43-1-4277-54123, Fax: +43-1-4277-9541, email: office@ibc2005.ac.at and http://www.ibc2005.ac.at/

FROM THE SECRETARIAT

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New ISHS Members

We are pleased to welcome the following new members:

NEW ORGANISATION MEMBERS:

Australia:Webster Horticulture

India:National Research Center For Onion and Garlic

Reunion:ARMEFLHOR

South Africa:SAPO Trust

United States of America:American Rose Society

NEW INDIVIDUAL MEMBERS:

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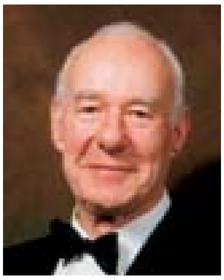
Schoorl, Dr. A.L. Bert Smit, Mr. Dilip Tambyrajah; **New Zealand:** Mr. Mark Apatu, Mr. Don Brash, Dr. David Brummell, Ms. Ingrid Ennis, Mr. Steno Flego, Mr. Myles King, Mr. Simon Lennard, Dr. Peter Meredith, Mr. Peter Mulligan, Tony Reeves; **Nigeria:** Mr. Opeyemi Agbaje, Mr. Lanre Rotimi; **Norway:** Prof. Per Steinar Davidsen, Morten Eirik Engelsjord, Dr. Cecilie Mathiesen, Mr. Frode Ringsevjen, Ms. Grethe Sylling; **Pakistan:** Dr. Saifullah Khan; **Peru:** Mr. Jose Gereda, Ms. Rosarella Isola, Ms. Francesca Silva-Rodriguez; **Philippines:** Mr. Neil Abejuela, Frederico Hernandes, Mr. Danny Panganiban; **Poland:** Monika Bieniasz, Ewa Dziedzic, Maciej Gastol, Jacek Glonek, Bogdan Kozinski, Jacek Lewko, Prof. Dr. Pawel Nowaczyk, Kazimierz Smolarz; **Portugal:** Vitor Costa Ferreira, Alexandre Furtado, Julio Marreiros, Ms. Maria Luísa Moura, Nuno Neves; **Romania:** Dr. Liana Melania Dumitru, Dr. Valentin Spita; **Saudi Arabia:** Ass. Prof. Abdullah Alhamdan, Mr. Eyad Kamel; **Slovenia:** Ziga Mazi; **South Africa:** Mr. Martin Botha, Anna Hartmann, Mr. Andre Jonker, Rui Krause, Mr. Andre Scholtz, Ms. Sally van Aardt; **Spain:** Luisa Andrade, Marise Borga, Olga Botella Miralles, Manuel F, Garcia-Legaz Vera, Maria del Rosario Haro Ramos, Mr. Frank Hilbert, Horacio López Córcoles, Mr. Víctor Martínez Guillén, Rosa Victoria Molina Romero, Mercedes Muzquiz Elorrieta, Dr. Lluis Palou, Antoni Payeras Urbina, Maria del Henar Prieto, Lourdes Pulido García, Manuel Romero de Avila, Juan Manuel Romero Garcia, Elisa Saez Cruz, Pedro Antonio Vazquez Martinez, Amaya Zalacain Aramburu; **Sweden:** Claes Anderson, Karin Blombäck, Ms. Lotta Nordmark, Dr. Marie Olsson, Maria Strandberg, Dr. Ibrahim Tahir, Timo Tarkiainen, Dr. Sandra Wright; **Switzerland:** Ms. Magaly Bergerioux, Pascal Engi, Mr. Jérôme Galli, Emiliano Medici, Jürgen Rohmeder, Mr. Matthias Zürcher; **Taiwan:** Jin-Hsing Huang, Weiping Hung, Dr. Fuh-Jyh Jan, Mr. Long-Wen Lai, ShuYen Lin, Dr. Thomas Lumpkin; **Tanzania:** Osman Maska, Hermangild Mayunga; **Thailand:** Dr. Montree Issarakraisila; **Tunisia:** Mr. Chihebeddine Slama, Dr. Jassem Tissaoui; **Turkey:** Ass. Prof. Esin Akcam Oluk, Mr. Fahre Karatac, Mr. Mustafa Kulcu, Prof. Dr. Fikrettin Sahin, Ms. Neslihan Taskin, Ömer Yamaner, Prof. Dr. Nesrin Ms. Yildiz; **United Arab Emirates:** Mr. Alphen D'Souza; **United Kingdom:** W.A. Adams, Mr. Colm Bowe, Mr. Peter Boyd, Ms. Grace Craddock, Jeremy Darby, Mr. Hani Hajj, Mr. Rupert Hargreaves, Dr. Peter Jaeger, I.T. James, Antonia Koutsidou, Mr. Andrew Macnish, Ruth Mann, Gordon McKillop, Chris Nicholl, Ms. Ebru Olgun, Mr. Digby Oliver, Ms. J.E. Patrick, Mr. Taylor Paul, Ms. Philippa Pickles, Ms. Claire Rawlinson, Mr. Daniel Sargent, Dr. Adrian Short, Dr. James Smith, Ms. Eva Tallentire, Mr. Nigel Watson, Mr. Chia-Hua Wu, Mr. Francis Zimuto; **United States of America:** Mr. Steve Ackerman, Mr. Jamal Al-Khasawneh, Jinhe Bai, David Barnard, Mr. Noel Barrera, Freeman Barsotti, Mark Battany, Richard Beeson, Maria Jose Berenguer, Phil Berger, P.K. Biswas, Mr. Steve Boos, Dr. William Brinton, Peter Brostrom, Dr. Bassett Brown, Art Bruneau, James Brusca, Johann Buck, Ms. Janette Builes, Melis Cakirer, Mr. Peter Carnwath, Louise Carpenter, Mr. Vincent Celeste, Audrey Charles, S.-K. Chong, Nick Christians, Mr. Stan Cutter, Dr. Michael Dobres, Mr. Henry Dotson, Ms. Rodelita Dumbrigue, Dr. Jon Dyer, Gennaro Fazio, Mr. John Fordham, Lanny Franklin, Wesley Friar, Jeff Gage, Mr. Bill Gerlach, Andrew Grant Grant, Steve Grattan, Jennifer Griffin, Jim Hansen, Blaine Hanson, Mr. Scott Hare, Ali Harivandi, Mr. Trace Harrell, Ms. Brooke Hart, Carol Heil, Ms. Kathy Hogan, Dr. Jiyoung Hong, Justin Howie, Orvis Hughes, Martha Hunt, Peter Ianniello, Dr. D. Richard Ishmael, Bill Ito, Brian Jackson, Jason Jandrew, Scott Johnson, Roger Kjelgren, Ms. Nicole LaGiudice, Peter Landschoot, Mr. Phillip Lee, Bernd Leinauer, Scott Levine, Ms. Susan Lewis, David Lillard, Dr. Kai-shu Ling, Michael Locke, Mr. Johnny Loff, Dr. John Lovell, John Lubisich, Dr. Mickael Malroy, Margaret J. McMahon, Andrew McNitt, Brian Mentz, Dr. Ronald Michaels, Stanley Michelini, Grady Miller, Prof. Dr. Harry Mills, Dave Minner, Sowmya Mitra, Mr. Thomas Molnar, Dr. Bruce Mowrey, Daniel Munk, Mr. Mark Murdoch, Bob Nagler, Ms. Vivian Nelson, John Nunes, Dr. Andrew Nyczepir, Dr. Michael Orzolek, Charles Peacock, Mr. Carl Pimentel, Dennis Pittenger, Belinda Platts, Phillip Pohl, Daniel Potter, Dr. Reza Pouremad, Dr. Lyle Ralston, James Reinert, M.D. Richardson, Brian Roethemeier, Stephanie Roueche, Mr. Timothee Sallin, Mr. Daryl Salm, Theodore Sammis, Blake Sanden, Dr. Joshua Schechtel, Christine Seale, David Shaw, Mr. Marshall Sherman, Dr. Paula Shrewsbury, Mr. David Shupert, Mr. Harry Simmons, Mr. J Robert Sirrine, Mr. John Slaughter, Mr. Mark Smith, George Snyder, Mr. Alan Stender, Laurencia Strauss, Dr. George Sundin, Himani Swami, Tom Trout, A.J. Turgeon, Ms. Janet Ms. Turner, Mr. Charles Vinz, Mr. Mike Wallen, Ms. Eileen Welch, Jeffrey Westendorp, Dr. Alan Wicks, Harold Wilkins, Allen Williford, Min Wu, Kolasin Yasin, Tom Yeager; **Vietnam:** Mr. Siebe van Wijk

In Memoriam

DAVID ROBINSON (1928 - 2004)



David Robinson

A great oak toppled in late March when David Willis Robinson died. The relative suddenness of his passing was a surprise to his family, many friends and colleagues. Charged with a zest for life, David somehow seemed destined to maintain his busy schedule for many years to come. One of the finest horticulturists of his era, his reputation as an inspiring influence was widely recognised.

The core of his career was spent as research director at the National Horticultural Research Centre, Kinsealy, Dublin. Mixing the practical with the theoretical, David stewarded an energetic and progressive research programme in the many facets of horticulture at Kinsealy and its sister top and soft fruit stations in Ballygagin and Clonroche, over many years. With great personal skills, he initiated new programmes and consolidated already established horticultural activities at these Centres during a period when the acquisition of essential funding for horticultural research was an ongoing struggle. David participated as an external examiner in all major universities, teaching horticulture in the UK and the Republic winning the respect of students for his knowledge and fairness.

Always reasonable, David was a formidable and logical debater. His questioning mind often laid bare accepted myth and consequently his progress in the field of weed control, his lifelong study, quickly gained international recognition. He was influential in transforming the approach to weed control in the commercial production of top fruit and soft fruit, not to mention his mastery in the sequential use of chemicals for the control of weeds in nursery stock and general ornamental plantations.

Appointments, honours and awards flowed in his direction. His early horticultural work, after very successful studies at Reading and Cornell Universities, found him in an Advisory capacity in South Down. A few years later, he was appointed as a research worker at the Horticultural Centre, Loughall, where much of his pioneering efforts in weed control were developed. In this time he gained a PhD in Weed Science at Queen's University, Belfast . After a dozen years here, during which time a burgeoning reputation was gaining momentum, he was appointed to his position at Kinsealy. Apart from his administrative and research programme duties, he found time to advise several overseas countries on the establishment of horticultural programmes during missions funded by the FAO and the Department of Foreign Affairs in Dublin. His great strength of logic, unbridled enthusiasm and skill in implementing agreed procedures was a great boon to horticultural personnel in the developing countries where he was advising. Since his retirement in 1988, he became well established as a broadcaster and branched out into hosting long-haul garden tours. Sojourns of six week intervals between 1993 to 1998 were spent at the Humboldt University in Berlin, where David lectured whilst developing a course in urban horticulture.

David joined the ISHS as a member in 1966. He was soon appointed Council member and became involved as Vice Chairman of the Commission Plant Substrates, Vice Chairman of the Commission Urban Horticulture to become Chairman of this group later on. He was one of the earliest to recognise the urban dimensions of horticulture as compared with its more traditional role in rural society. He was a key player in ISHS helping to steer it through troubled times and into the vigorous and robust organisation of today. David's internationalist approach was typified by the list of 60 countries with which he worked in an UN Food and Agriculture Organisation (FAO) programme. He received the Gold Veitch Memorial Medal of the Royal Horticultural Society, was made Fellow of the ASHS, and Honorary Member of the ISHS in recognition of his achievements in horticultural science and education. In addition he became a Fellow of countless other horticultural societies and organizations.

These honours, prestigious in their own right, can often obscure facets of the recipient which are just as worthy of elucidation. Despite all of the honours conferred upon him, David remained an essentially modest man. He had no difficulty finding time to help and encourage students and colleagues - in fact anyone seeking advice (especially horticultural advice!).

The loss of David will be keenly felt by his wife Muriel and daughter Karen, son Ivan and their children.

Jim Kelly with the assistance of Geoff Dixon and Michael J. Hennerty

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DALE EMMERT KESTER (1922 – 2003)

Dr. Dale Emmert Kester, Professor Emeritus for the University of California, Davis died on November 21, 2003. Dale was born July 28, 1922 on his family's farm in Ross, Iowa.

He was the third eldest of seven children. He was preceded by his wife Daphne, who died in 2000 after 54 years of marriage. He leaves behind his son William, daughter Nancy, and five grandchildren.

His lifelong interest in horticulture began along side his mother in her vegetable garden. This interest led Dale to enrol as a horticulture student at Iowa State University in Ames, Iowa in 1941. His college career was interrupted in 1943 when Dale joined the war effort as a U.S. Air Force pilot. He received his wings in 1944 after training in Texas before becoming a P-51 Mustang fighter pilot. As World War II pilot, Dale escorted bombers on 28 missions over Italy and Central Europe. Following the war, Dale returned to Iowa State University and completed his horticulture degree in 1947.

Dale met his future wife, Daphne Dougherty, while he was stationed in Baton Rouge, Louisiana. Daphne was a USO dancer at the time. They were married in July, 1946. Together they moved to Davis, California to accept a graduate research assistant position at the University. Dale was the first graduate student in the Pomology Department following the war. He received his M.S. (Horticulture) and Ph.D. (Plant Physiology) degrees from UC Davis. His Ph.D. dissertation concerned embryo culture of peaches. In 1951, he was offered an Assistant Professor position in the Department of Pomology at UC Davis where his work was to focus on almond production and breeding. This was the position he would hold until his retirement 40 years later in 1991.

Dale taught undergraduate plant propagation and pomology courses. Early in his career, he partnered with Dr. Hudson Hartmann to publish "Plant Propagation – Principles and

Practices". The first edition of this well known textbook was published in 1959 and is currently in its 7th edition. In recognition of their dedication to educating several generations of horticulture students, the book was renamed in 2002 as "Hartmann and Kester's Plant Propagation – Principles and Practices".

Dale published over 120 research papers in journals and conference proceedings. His efforts as an almond breeder led to numerous root stock introductions. Until his recent illness, he was still active in efforts to establish the cause for non-infectious bud failure in almond that he had pursued for over 25 years. Several co-authored papers on this subject will be published posthumously.

Along with Hudson Hartmann and others, Dale was a founding member of the Western Region of the International Plant Propagators' Society. He served that organization as Vice-President, program chair in 1996 and President in 1997. Dale received the Curtis J. Alley Award in 1999 for his lifetime service to the International Plant Propagators' Society. In 2002, shortly before his death, he received the society's highest award, the International Award of Honour. With this award, he was recognized for "his long-standing reputation as a dedicated teacher of students interested in plant propagation, his service to the International Plant Propagators' Society and especially, for his seminal textbook on plant propagation used the world over".

Dale was a long-time member of the International Society for Horticultural Science and of the American Society for Horticultural Science and was recognized as a AHSH Fellow in 1977. He served as the first chair of the Propagation Working Group and received the Stark Award in 1980. In 1998, he was the Spenser Ambrose Beach Lecturer at Iowa State University.

Dale Kester was one of the most internationally recognized horticulturists of his generation, but remained a very unpretentious man. He was easy-going, good humored and appeared more impressed with his colleagues' achievements than his own. Dale was a mentor, role model and a friend. He will be missed by the horticultural community.

R. Geneve, F. Davies, Jr., and R. Zimmerman

PASSED AWAY

H.D. Stiles (USA), ISHS member, passed away on February 21st, 2004.

Calendar of ISHS Events

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

YEAR 2004

- July 5-9, 2004, Bologna (Italy): **X International Workshop on Fire Blight.** Info: Prof. Carlo Bazzi, University of Bologna, Via Filoppo Re 8, 40126 Bologna, Italy. Phone: (39)0512091446, Fax: (39)0512091446, email: cbazzi@agrsci.unibo.it web: www.agrsci.unibo.it/fireblight
- August 1-8, 2004, Corvallis, OR (USA): **I International Symposium on Humulus.** Info: Dr. Kim Hummer, USDA ARS NCGR, 33447 Peoria Road, Corvallis, OR 97333-2521, USA. Phone: (1)541.738.4201, Fax: (1)541.738.4205, email: khummer@ars-grin.gov and Prof. Dr. Lyle Craker, Dept. of Plant & Soil Science, University of Massachusetts, Stockbridge Hall, Amherst, MA 01003-7245, USA. Phone: (1)413-545-2347, Fax: (1)413-545-3958, email: craker@pssci.umass.edu web: www.ars-grin.gov/cor/hopsymposium.htm
- August 2-7, 2004, Chapingo (Mexico): **V International Symposium on Cactus Pear and Cochineal.** Info: Dr. Candelario Mondragon-Jacobo, Nogal 259, Arboledas, Queretaro, Qro. 76140, Mexico. Phone: (52)442122546 and (52)461611029413, Fax: (52)461611029413, email: jacobo77@hotmail.com or rebe27_10@yahoo.com and Prof. Dr. Paolo Inglese, University of Palermo, Dipt. colture Arboree, Viale delle Scienze, 90128 Palermo, Italy. email: pinglese@unipa.it
- August 18-21, 2004, Perth (Australia): **International Symposium on Horticultural Education Extension and Training. Recent Advances in Horticultural Education.** Info: Dr. Peter J. Batt and Ass. Prof. Zora Singh, ISHS Education Symposium, Horticulture Curtin University of Technology, GPO Box U1987, Perth 6845, WA, Australia. Phone: (61)892667596 or 892663138, Fax: (61)892663063, email: ishs@curtin.edu.au web: www.muresk.curtin.edu.au/ishs/ download the first announcement here.
- August 25-26, 2004, Maroochy (Australia): **ISHS Board Meeting**
- August 27, 2004, Maroochy (Australia): **ISHS Executive Committee Meeting**
- August 28-31, 2004, Maroochy (Australia): **Joint ISHS Executive Committee and Council meeting**
- August 29-September 3, 2004, Berlin (Germany): **International Symposium on Horticultural Economics and Management. Creating Value in a Changing Society.** Info: Prof. Dr. Wolfgang Bokelmann, Humboldt University, Faculty of Agriculture and Horticulture, Inst. of Economics and Social Science in Agriculture, Luisenstrasse 56, 10099 Berlin, Germany. Phone: (49)3020936136, Fax: (49)3020936236, email: w.bokelmann@agrar.hu-berlin.de web: www.agrar.hu-berlin.de/wisola/ishs
- September 1-3, 2004, Coolum (Australia): **Regional Conference: Harnessing the Potential of Horticulture in the Asian Pacific Region.** Info: Prof. Richard Williams, University of Queensland Gatton Campus, School of Agronomy and Horticulture, Gatton Qld 4343, Australia. Phone: (61)754601305, Fax: (61)754601283, Email: richard.williams@uq.edu.au web: www.aushs.org.au
- September 5-10, 2004, Brisbane (Australia): **V International Strawberry Symposium**. Info: Dr. Neil Greer, QLD Dept Primary Industries, PO Box 5083, Sunshine Coast Mail Centre, Nambour, QLD 4560, Australia. Phone: (61)754449605, Fax: (61)754412235, email: greern@dpi.qld.gov.au web: http://www.qsga.org/symposium/
- September 6-9, 2004, Lofthus (Norway): **VIII International Symposium on Plum and Prune Genetics, Breeding and Technology.** Info: Dr. Lars Sekse, Plante Forsk - Norwegian Crops Research Institute, Ullensvang Research Centre, 5781 Lofthus, Norway. Phone: (47)53671200, Fax: (47)53671201, email: lars.sekse@planteforsk.no web: http://www.planteforsk.no/
- September 6-10, 2004, Bursa (Turkey): **III Balkan Symposium on Vegetables and Potatoes.** Info: Dr. H. Özkan Sivritepe, Department of Horticulture, Faculty of Agriculture, Uludag University, 16059 Bursa,

Turkey. Phone: (90)2244428970, Fax: (90)2244429098, email: ozkan@uludag.edu.tr web: http://www.3bsvp.org/

- September 7-10, 2004, Gumushane (Turkey): **I International Rose Hip Conference.** Info: Dr. Sezai Ercisli, Ataturk University, Agricultural Faculty, Department of Horticulture, 2540 Erzurum, Turkey. Phone: (90)4422312599, Fax: (90)4422360958, email: sercisli@atauni.edu.tr web: www.atauni.edu.tr/rosehip or http://fenbilimleri.atauni.edu.tr/rosehip
- September 12-16, 2004, Leuven (Belgium): **International Symposium GREENSYS 2004 - Sustainable Greenhouse Systems: Co-operation of Engineering and Crop Science .** Info: Prof. G.P.A. Bot, Wageningen-UR, PO Box 43, NL-6700 AA Wageningen, Netherlands. Phone: (31)317476442, Fax: (31)317425670, email: info@greensys.nl, and Dr. Leo F. M. Marcelis, Plant Research International, Bornsesteeg 65, PO Box 16, 6700 AA Wageningen, Netherlands. Phone: (31)317475802, Fax: (31)317423110, email: l.f.m.marcelis@plant.wag-ur.nl web: www.greensys2004.nl
- September 12-17, 2004, Debrecen (Hungary): **V International Symposium on In Vitro Culture and Horticultural Breeding.** Info: Dr. Miklós Fári, Böszörményi ut 138, 4032 Debrecen, Hungary. Phone: (36)52316947, Fax: (36)524183332, email: silvercentrum@axelero.hu or fari@helios.date.hu web: www.ivchb2004.org
- September 12-17, 2004, Fortaleza (Brazil): **III International Symposium on Tropical and Subtropical Fruit.** Info: Dr. Osvaldo Kiyoshi Yamanishi, University of Brasilia, Faculty of Agriculture and Veterinary, Fruit Section, Caixa Postal 04508 - Asa Norte, 70910-970 Brasilia, DF Brazil. Phone: (55)613072858, Fax: (55)613071161, email: kiyoshi@unb.br web: http://www.3istsf.cjb.net
- September 27 - October 2, 2004, (Turkey): **V International Symposium on Olive Growing.** Info: Dr. Mucahit Taha Ozkaya, University of Ankara, Faculty of Agriculture, Department of Horticulture, 06100 Ankara, Turkey. Phone: (90)5355264860, Fax: (90)3123179119, email: ozkaya@agri.ankara.edu.tr web: www.olive2004turkiye.com
- October 4-8, 2004, Corfu (Greece): **VI International Symposium on Chemical and Non-Chemical Soil and Substrate Desinfestation.** Info: Prof. Dr. Eris Tjamos, Agricultural University of Athens, Department of Plant Pathology, Iera Odos 75, 11855 Votanikos-Athens, Greece. Phone: (30)2105294505, Fax: (30)2105294513, email: ect@aua.gr web: http://www.aua.gr/SD2004/
- October 5-9, 2004, Jinju (Korea): **III International Symposium on Persimmon.** Info: Dr. Seong-Mo Kang, Department of Horticulture, Gyeongsang National University, Jinju 660-701, Korea. Phone: (82)557515486, Fax: (82)557515483, email: smk@nongae.gsnu.ac.kr web: www.persimmon3.org
- October 20-23, 2004, Chaves (Portugal): **III International Chestnut Symposium.** Info: Dr. Carlos Abreu, Universidade de Tras-Os-Montes e Alto Douro, Apartado 202, 5000-911 Vila Real . Phone (351)259350508 Fax: (351)259350480, email: cgabreu@utad.pt web: www.utad.pt/eventos/chestnutcongress
- October 24-28, 2004, Daejon (Korea): **IV ISHS Symposium on Brassica and XIV Crucifer Genetics Workshop.** Info: Prof. Dr. Yong Pyo Lim, Dept. of Horticulture, Chungnam National University, Kung-Dong 220, Yusong-Gu, Taejon 305-764, South Korea. Phone: (82)428215739, Fax: (82)428231382, email: yplim@cnu.ac.kr web: www.brassica2004.org
- November 7-14, 2004, Sorrento, Naples (Italy): **V International Walnut Symposium.** Info: Dr. Damiano Avanzato, MiPAF, Istituto Sperimentale per la Frutticoltura di Roma, Via di Fioranello 52, 00134 Roma, Italy. Phone: (39)0679348186, Fax: (39)0679340158 , email: davanzato@mclink.it or Dr. Maria-Emilia Malvolti, CNR, Istituto per la Biologia Agroambientale e Forestale, Viale Marconi, 2 05010 Porano (Terni), Italy. Phone: (39)0763374913, fax: (39)0763374980, email: mimi@ibaf.cnr.it or walnut2004@sistemacongressi.com web: (active March 2004) www.walnut2004.sistemacongressi.com
- November 10-12, 2004, Sydney (Australia): **Postharvest Unlimited Downunder Conference 2004**. Info: Dr. David Tanner, Manager Supply Chain Innovation, Food Science Australia, PO Box 52, North Ryde, NSW 1670, Sydney, Australia. Phone: (61)294908472, Fax: (61)294908593, email: david.tanner@csiro.au or Carolyn Moorshead, AIRAH, Level 7, 1 Elizabeth Street, Melbourne, VIC 3000, Australia. Phone: (61)396148868, Fax: (61)396148949, email: carolyn@airah.org.au web: www.airah.org.au/postharvest2004
- November 14-19, 2004, Almería (Spain): I**X International Symposium on Growing Media and Hydroponics.** Info: Dr. Miguel Urrestarazu Gavilán, Dpto. Producción Vegetal, Universidad de Almería, Lan Cañada de San Urbano, 04120 Almería, Spain. Phone: (34)950015929, Fax: (34)950015939, email: mgavilan@ual.es
- November 15-18, 2004, Melbourne (Australia): **International Symposium on Processing Tomatoes.** Info: Mr. Bill Ashcroft, Institute for Sustainable Irrigated Agriculture, Ferguson Road, Tatura, VIC 3616, Australia. Phone: (61)358335253, Fax: (61)358335299, email: bill.ashcroft@dpi.vic.gov.au web: http://www.worldtomatocongress.com.au/
- November 22-26, 2004, Cancun (Mexico): **II International Symposium on Acclimatization and Establishment of Micropropagated Plants.** Info: Dr. Jorge Santamaria, Centro de Investigación Cientifica de Yucatán, Dept. Biotecnología, Calle 43 No. 130 Col. Chuburna de Hidalgo, 97200 Mérida, Yucatán, Mexico. Phone: (52)999813923, Fax: (52)999813900, email: jorgesm@cicy.mx web: http://www.cicy.mx/eventos/simp2004/simposium.htm

YEAR 2005

- January 9-13, 2005, Santiago (Chile): **VI International Symposium on Peach.** Info: Prof. Dr. Rodrigo Infante, Santa Rosa 11.315, Departamento de Produccion Agricola, Universidad de Chile, Santiago, Chile. Phone: (56)26785813, Fax: (56)26785626, email: rinfante@uchile.cl web: www.peach2005.cl
- January 16-21, 2005, Talca (Chile): **V International Symposium on Mineral Nutrition of Deciduous Fruit Crops.** Info: Dr. Jorge Benjamin Retamales, University of Talca, Escuela de Agronomía, Casilla 747, Talca, Chile. Phone: (56)71200214, Fax: (56)71200212, email: jretamal@utalca.cl web: www.fruitmineralnutrition.cl
- March 13-17, 2005, Bonn (Germany): **X International Symposium on Timing of Field Production in Vegetable Crops.** Info: Dr. Felix Lippert, Institut für Obstbau und Gemüsebau, Universität Bonn, Auf dem Hügel 6, 53121 Bonn, Germany. Phone: (49)228735139, Fax: (49)228735764, email: lippertf@uni-bonn.de web: www.gartenbauwissenschaft.uni-bonn.de/vegcrop2005
- April 11-15, 2005, East London (South Africa): **IV International Pineapple Symposium.** Info: Mr. Allen Graham Duncan, Managing Director, Summerpride Foods Ltd., PO Box 507, East London, 5200, South Africa. Phone: (27)2743-7311770, Fax: (27)2743-7311544, email: allen@sumpride.co.za web: www.pinesymp05.org
- May 16-20, 2005, Faro (Portugal): **III International Symposium on Figs.** Info: Prof. Dr. José Leitao, FERN, University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal. Phone: (351)289800939, Fax: (351)289818419, email: jleitao@ualg.pt
- May 20-26, 2005, Tehran (Iran): **IV International Symposium on Pistachio and Almond.** Info: Dr. A. Javanshah, Iran Pistachio Research Institute, PO Box 77175/435 Rafsanjan, Iran. Phone: (98)3914225202, Fax: (98)3914225208, email: javanshah@pri.ir web: http://www.pri.ir
- May 29 – June 2, 2005, Leuven, (Belgium): MODEL-IT 2005. **Applications of Modelling as an Innovative Technology in the Agri-Food Chain.** Info: Prof. Bart Nicolai, Lab. Of Postharvest Technology, KULeuven, W. Decroylaan 42, 3001 Leuven, Belgium. Phone: (32)16322375, Fax: (32)16322955, email: bart.nicolai@agr.kuleuven.ac.be
- June 6-10, 2005, Bursa (Turkey): **V International Cherry Symposium.** Info: Prof. Dr. Atilla Eris, Uludag Universitesi, Ziraat Fakültesi, Bahce Bitkileri Bolumu Baskani, 16059 Bursa, Turkey. Phone: (90)2244428001,

Fax: (90)2244428120, email: atillaer@uludag.edu.tr or Co-convener Dr. Masum Burak, Ataturk Central Horticultural Research Institute, 77102 Yalova, Turkey. Phone: (90)2268142520, Fax: (90)2268141146, email: masum_burak@yalova.tagem.gov.tr

- June 13-17, 2005, Murcia (Spain): **XIII International Symposium on Apricot Breeding and Culture.** Info: Dr. Felix Romojaro and Dr. Federico Dicenta, CEBAS-CSIC, PO Box 164, 30100 Espinardo (Murcia), Spain. Phone: (34)968396328 or (34)968396309, Fax: (34)968396213, email: apricot@cebas.csic.es Symposium Secretariat: Viajes CajaMurcia, Gran Via Escultor Salzillo 5. Entlo. Dcha., 30004 Murcia, Spain. Phone: (34)968225476, Fax: (34)968223101, email: congresos@viajescajamurcia.com

- NEW June 14-17, 2005, Kuala Lumpur (Malaysia): **II International Symposium on Sweetpotato and Cassava - 2ISSC.** Info: Dr. Tan Swee Lian, MARDI, Rice & Industrial Crops Research Centre, PO Box 12301, 50774 Kuala Lumpur, Malaysia. Phone: (60)389437516, Fax: (60)389425786, email: sltan@mardi.my web: http://www.mardi.my

- June 21-24, 2005, Aas (Norway): **V International Symposium on Artificial Lighting.** Info: Prof. Dr. Hans R. Gislerod, Dept. of Plant and Environmental Sciences, Agricultural University of Norway, PO Box 5022, 1432 Aas, Norway. Phone: (47)64947800 or (47)64947824, Fax: (47)64947802, email: hans.gislerod@ipf.nlh.no or lightsym2005@nlh.no web: www.lightsym2005.no

- June 26-30, 2005, Saltillo Coahuila (Mexico): **X International Symposium on Plant Bioregulators in Fruit Production.** Info: Dr. Homero Ramirez, Salazar 1081, Zona Centro, Saltillo Coahuila 25000, Mexico. Phone: (52)84174167, email: homeror@terra.com.mx web: www.saltillo2005.org

- NEW July 5-10, 2005, East Lansing, MI (USA): **IX International Controlled Atmosphere Research Conference.** Info: Dr. Randolph M. Beaudry, Michigan State University, Department of Horticulture, A22 Plant& Soil Sci. Building, East Lansing, MI 48824-1325, USA. Phone: (1)517 355 5191 x303 or x339, Fax: (1)517 353 0890, email: beaudry@msu.edu or allens@msu.edu

- July 6-9, 2005, Columbus, Ohio (USA): **International Symposium on Herbaceous Ornamental Plant Germplasm Conservation and Utilization.** Info: Dr. David Tay, Director, Ornamental Plant Germplasm Center (OPGC), Ohio State University, 670 Tharp Street, Columbus, OH 43210-1086, USA. Phone: (1)614-292-1941, Fax: (1)614-292-3768, email: opgc@osu.edu web: http://opgc.osu.edu

- NEW July 10-15, 2005, Chiang Mai (Thailand): **International Symposium on Improving the Performance of Supply Chains in the Transitional Economies.** Info: Dr. Peter J. Batt, ISHS Supply Chain Management Symposium, Horticulture, Curtin University of Technology, GPO Box U1987, Perth 6845, WA, Australia. Phone: (61)892667596, Fax: (61)892663063, email: p.batt@curtin.edu.au web: www.muresk.curtin.edu.au/ishscm

- July 13-15, 2005, Columbus, Ohio (USA): **International Symposium on Greenhouse Systems and Energy Conservation.** Info: Prof. T. Short, Dept. Agric. Engineering, OARDC, Ohio State University, Wooster, OH 44691, USA. Phone: (1)330-263-3855, Fax: (1)330-263-3670, email: short.2@osu.edu

- NEW September 1-4, 2005, **Singapore (Singapore): International Conference & Exhibition on Soilless Culture - Singapore 2005 (ICESC2005), Fort Canning Gallery.** Info: Dr. Mallick F. Rahman (Chair), Secretariat: Block 461 #13-75 Crawford Lane, Singapore - 190461. Phone: (65)62918153, Fax: (65)62987978, email: ICESC2005@singaporehydropnonics.com web: www.singaporehydroponics.com

- September 4-10, 2005, Angers (France): **International Symposium on Growing Media.** Info: Dr. Jean-Charles Michel, National Institute of Horticulture, INH, Research Unit A-462, SAGAH, 2 rue Le Notre, 49045 Angers Cedex 01, France. Phone: (33)241225422, Fax: (33)241225553, email: jean-charles.michel@inh.fr, web: http://ishs-angers.agrena.org/

- NEW September 12-16, 2005, Townsville, North QLD (Australia): **III International Symposium on Cucurbits.** Info: Dr. Gordon Rogers, Horticultural Research and Development, PO Box 552 Sutherland NSW 2232, Australia. Phone: (61)295270826, Fax: (61)295443782, email: gordon@ahr.com.au

- NEW September 2005, Potenza (Italy): **International Symposium on Advances in Grape and Wine Research.** Info: Dr. Vitale Nuzzo, Universita' degli Studi della Basilicata, Dipartimento di Produzione Vegetale, Via N. Sauro 85, 85100 Potenza, Italy. Phone: (39)0971205636 or (39)3293606254, Fax: (39)0971202269, email: nuzzo@unibas.it or vnuzzo@tiscalinet.it

- October 20-28, 2005, Lilongwe, Malawi: **International Symposium on High Value Indigenous Fruit Trees in the Tropics and Subtropics: Production, Utilisation and Marketing.** Info: Dr. Festus K. Akinnifesi, SADC-ICRAF Agroforestry Programme, Makoka Agricultural Research Station, PO Box 134, Zomba, Malawi. Phone (265)01534203, Fax: (265)01534283, email: f.akinnifesi@cgiar.org

- November 2005, Kuala Lumpur, Malaysia: **First International Symposium on Papaya.** Info: Dr. Abd Shukor Abd Rahman, Horticulture Research Center, MARDI, GPO Box. 12301, 50774, Kuala Lumpur, Malaysia. Phone: (603)89437263, Fax: (603)89487590, e-mail: arshukor@mardi.my

- December 5-7, 2005, Santiago (Chile): **IX International Rubus and Ribes Symposium.** Info: Dr. Maria Pilar Banados, Universita Catolica de Chile, Departamento de Fruticultura y Enologia, Casilla 306-22, Vicuna Mackenna 4860, Santiago, Chile. Phone: (56)26864305, Fax: (56)25534130. email: pbanados@puc.cl

- 2005, Kearneysville, WV (USA): **I International Symposium on Transgenic Fruit Crops.** Info: Dr. Ralph Scorza, USDA-ARS, Appalachian Fruit Research Station, 45 Wiltshire Rd., Kearneysville, WV 25430, USA. Fax: (1)3047282340, email: rscorza@afrs.ars.usda.gov

- 2005, Florida (USA): **International Symposium on Biotechnology of Tropical and Subtropical Species.** Info: Dr. R. Litz

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