Chronica Horticulturae

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Horticultural Highlights

Bioactive Compounds and Designer Plant Foods • Vitamin-A Partnership for Africa • Plastic Greenhouse Industry of Spain • Horticulture in Eritrea

Symposia and Workshops

Natural Preservatives in Food Systems • Olive Growing • Cactus Pear and Cochineal • Mineral Nutrition of Fruit Plants • Cherry • Tropical and Subtropical Fruits • Model-IT

ISHS

CHRONICA HORTICULTURAE

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

Cover photograph: Pigmented vegetables supply phytonutrients that are beneficial to human health, see article p. 6

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

ISHS

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Horticulture, Health and Society

Robert J. Bogers, Treasurer

Robert J. Bogers

About a year ago I wrote in "News from the Board" that the ISHS was enjoying good financial health. Since then, our financial situation has further evolved towards our goal of having a strategic reserve of one-year's budget. This allows me to be brief about finances and elaborate a bit on other aspects of societal health. But let us first look at the ISHS.

A HEALTHY HORTICULTURAL SOCIETY

In 2004 the regular membership revenues increased by more than 8% to € 263,651 (7.6% above budget), mainly due to an increase in the number of individual members. Sales of publications also increased by more than 8%, to € 670,942 (5.6% above budget), mainly due to increased sales of *Acta Horticulturae* (32 volumes published) and online articles. The staff at our headquarters in Leuven has worked very hard to achieve this result.

The year 2004 closed with a net result of revenues over expenses of € 80,635, after an amount of € 60,608 of unused provisions for the financial year 2003 had been added to the result of 2004 and new provisions amounting to € 97,729 had been charged to the profit-and-loss account of the year 2004. Thus, the available provisions for the years 2005 and 2006 have increased by an amount of € 37,121 as compared to the provisions that had been taken in 2003 for the years 2004 and 2005. All provisions were taken with the aim of covering various future expenses, such as the online publication Horticulture Research International and Horticultural Reviews, publications in relation to the International Horticultural Congress, management meetings during the next IHC and outreach initiatives.

The year 2004 ended with a total in cash, short-term deposits and investments of € 933,597, an increase of 71,086 in comparison with 2003. During the year 2004 an amount of € 250,000 was transferred from cash (bank account) to our (conservative) investment portfolio; the value of the investment portfolio at the end of the year (€ 484,364) was € 274,103 higher than at the beginning of that year, whereas cash was € 203,017 lower. The increase in the investment portfolio has recouped losses from past downturns in the financial markets.

	2002	2003	2004
REVENUES			
Contribution members (dues)	245,873	242,159	263,651
Sales	633,131	620,242	670,942
Other Income	12,358	20,585	25,962
Total	**891,362**	**882,986**	**960,555**
EXPENSES			
Costs books	209,604	259,422	207,844
Personnel costs	308,093	324,584	363,400
Office costs	110,656	122,086	126,136
Depreciation	4,998	4,528	6,406
General management costs	136,919	137,357	139,013
Changes in provisions	121,092	0	37,121
Total	**891,362**	**847,977**	**879,920**
RESULT: Revenues over expenses	**0**	**35,009**	**80,635**

	2002	2003	2004
ASSETS			
Current assets			
Cash and deposits	657,309	862,511	933,597
Accounts receivable/prepayments	128,798	68,319	52,619
Inventories	89,399	55,911	51,636
Total	875,506	986,741	1,037,852
Long-term assets			
Long-term receivables	13,504	2,408	11,408
Property, plant and equipment	5,853	3,736	5,229
Intangible fixed assets	0	4,430	3,323
Total	19,357	10,574	19,960
TOTAL ASSETS	**894,863**	**997,315**	**1,057,812**
LIABILITIES AND EQUITY			
Current liabilities			
Accounts payable & accrued charges	301,073	368,516	348,377
Equity	593,790	628,799	709,435
TOTAL LIABILITIES AND EQUITY	**894,863**	**997,315**	**1,057,812**

A HEALTHY HUMAN SOCIETY

Recently the contribution horticulture can give to human health and well-being has received a lot of attention. The beneficial influence of fruits and vegetables on human health is becoming increasingly clear, and the possibilities of strengthening food security and improving diet quality in developing countries by growing fruits and vegetables in small gardens in or near

urban areas are getting more and more attention. Also, medicinal plants are the subject of regular international symposia.

In my daily work as director of Frontis (a part of Wageningen University and Research Centre that aims at stimulating scientific debate by bringing together top scientists from all over the world) I recently co-organized and attended a workshop on "Farming for Health", which, in addition to animal farming, includes possibilities for "Green Care" farming, horticultural therapy, therapeutic horticulture, healing gardens and healing landscapes: plants, horticulture farms, gardens and landscapes are used in therapy to improve human well-being or to reach predefined goals.

In their conclusion to this workshop, which was co-sponsored by the European Science Foundation, Jan Hassink and Majken van Dijk noted that in many European countries an increasing number of commercial family farms initiate "Green Care" activities. These activities can offer a welcome opportunity to broaden the financial basis of, in particular, small-scale farming. In Germany, health institutions have often been the main driving force. In the US, farm-based programmes are usually started by non-profit organizations. In many countries allotment gardens, community gardens and city farms are more and more recognized as green sites that can be beneficial for human well-being in a curative and preventive way. Target groups can be vulnerable children, psychiatric patients, people with mental problems, people with an addiction history, elderly people with dementia, autistic persons, long-term unemployed, people with burn-out and prisoners.

There is, however, limited scientific knowledge on the possible beneficial influence of specific Farming-for-Health activities on human health and well-being. The participants in the workshop agreed that research should be performed by interdisciplinary teams of scientists with a background in health care, horticulture/agriculture and nature management. A common conceptual framework for Farming-for-Health activities should be developed, as well as a multidisciplinary scientific network that coordinates a joint programme and develops projects. It is my opinion that the ISHS and its members could play a major role in this new and promising field.

Building Capacity for Horticultural Science in Africa: Report of the ISHS Board and CRC Meetings Held in Arusha, Tanzania

Norman E. Looney

Norman E. Looney, ISHS President

In late January of 2005, and for the first time ever, the ISHS Board of Directors met in East Africa to conduct the business of managing our Society. In addition to two full days of reports and deliberations on Society affairs, the Board met with its Committee for Research Cooperation (CRC) to formulate plans for bringing the products and services of ISHS to the African horticultural science community. It is no coincidence that this meeting was held near the site of the AVRDC (World Vegetable Center) Regional Center for Africa (RCA) and the Director General of AVRDC, Dr. Thomas Lumpkin, serves on the CRC. The Board was pleased and honoured by the contributions that Dr. Lumpkin and his RCA staff, in particular Drs. M.L. Chadha and Mel Oluoch, made to the success of these meetings.

The CRC has been very supportive of the Board ambition to have more international symposia on topics of specific interest to, and conveniently located for, our colleagues in Africa and elsewhere in the developing world. Of several such symposia proposals discussed at Arusha, the following are the most advanced in their development:

ISHS Board and CRC. From left to right: Jozef Van Assche, Rodomiro Ortiz, Norman E. Looney, Charles Crissman, André de Jager, Jacky Ganry, Ian Warrington, Jules Janick, Alison Hodder, Robert Bogers, Uygun Aksoy, Alfons Werrij, Jung Myung Lee.

- The First International Symposium on Smallholder Fruit Production in the Tropics will be held in Nairobi, Kenya in November 2005.
- October 2006 will see the First International Symposium on the Contributions of African Botanica to Humanity - an event that will be held in N'Zérékoré, Guinea.
- The First International Symposium on Indigenous African and Asian Vegetables, originally envisaged for RCA Arusha, is now planned for India in October of 2006.

Reception committee at Ngorongoro National Park greets Board in Tanzania.

Following the Board and CRC meetings Norman Looney and Jules Janick and the entire CRC joined a 3-day USAID-supported Global Needs Assessment Workshop, also held in Arusha. This event attracted more than 100 sub-Saharan Africa horticultural science and industry professionals. The task was to identify and rank the full range of constraints to the further development of horticulture industry, including production by smallholder farmers, across this immense and very diverse region.

Nancy Karanja (International Potato Center CIP, Nairobi), Ian Warrington (ISHS Vice-President), Stephen Agong (Jomo Kenyatta University, Nairobi) and Jules Janick (ISHS Board Member).

Regional Center for Africa (RCA) of the Asian Vegetable Research and Development Center (AVRDC).

This workshop and subsequent versions of the same held in Honduras (for Latin America and the Caribbean) and Egypt (for the Middle East and Asia) was organized by staff of the AVRDC (main campus in Taiwan) and by a number of USA university-based scientists led by Dr. Patrick Brown and others at the University of California at Davis. A full report of these workshops is nearing completion and will be highlighted in a subsequent issue of *Chronica*. It is sufficient to say here that the Board has fully supported these assessments and envisages the Society being a partner in several "capacity building" initiatives that will arise from this effort.

Aside from the potential outcomes of this Global Needs Assessment, the Board discussed and further developed the following Society initiatives that specifically address the need to reach and better serve horticultural science and industry in the developing world:

- The Board confirmed a new fee structure for ISHS Country/State Membership that should provide a voice on Council for more of our colleagues in poor countries. The new schedule includes a one year Category IV membership for countries with low per capita incomes and stipulates that a fee will not be collected until after the first representation at Council.
- There was (and continues to be) serious discussion about revamping the category of Organizational Membership in the Society with the aim of providing access to ISHS products and services to more scientists in Africa, Asia and Latin America. The approach will be to recognize certain organizations and agencies that conduct or serve horticultural science around the world as *ISHS Partners* - a no-fee category of membership. These are organizations or agencies with which ISHS has a clearly defined business relationship - FAO, CIRAD, CIP, and the AVRDC are good examples. In turn, the small to large research centers around the world where these Partners conduct or support research would become *Institutional Members* of the Society with a prescribed menu of services and privileges. The concept is that the Institutional Membership fee would, in many cases, be paid by the appropriate ISHS Partner.
- The Board considered and acknowledged the great importance of urban and peri-urban horticulture to the well being of many millions of people living in cities in the develo-

Mel O. Oluoch, Training Specialist of the Regional Center for Africa (RCA), with an African eggplant.

Indigenous African vegetable garden.

ping world. It heard a presentation from Dr. Nancy Karanja about the Urban Harvest initiative of the International Potato Center (CIP; a CGIAR center with headquarters in Lima, Peru). Dr. Karanga is part of a growing cohort of professionals recognizing that urban and peri-urban food production is deserving of greater attention from the scientific community. This topic will be featured as an IHC2006 symposium and the Society hopes to move quickly to find a Working Group and/or Commission home for researchers working in this important subject area.

- The Board formally welcomed the International Society of Citriculture (ISC) as a partner in establishing a new ISHS Section on Citrus. It learned that the ISC selected Dr. Gene Albrigo (University of Florida) to be the first Section Chair and discussed the opportunities that this Section will provide for better serving the needs of horticultural science and industry in the tropical and subtropical world.

Clearly, many opportunities are available to our Society for greater participation in the global (and very noble!) effort to reduce poverty and improve human nutrition through agricultural/horticultural research and education. As a society of and for horticultural science, our key strengths are in our diverse array of international symposia, our publications, and our periodic Congresses. Through good leadership, sound management of Society resources, and strategic partnerships with other organizations involved in international development we can provide meaningful support to our colleagues in the developing world as they endeavour to conduct better research and be more effective educators. This is what your Board means when it talks about "capacity building" for international development.

Issues

Bioactive Compounds and Designer Plant Foods: The Need for Clear Guidelines to Evaluate Potential Benefits to Human Health

John W. Finley [1]

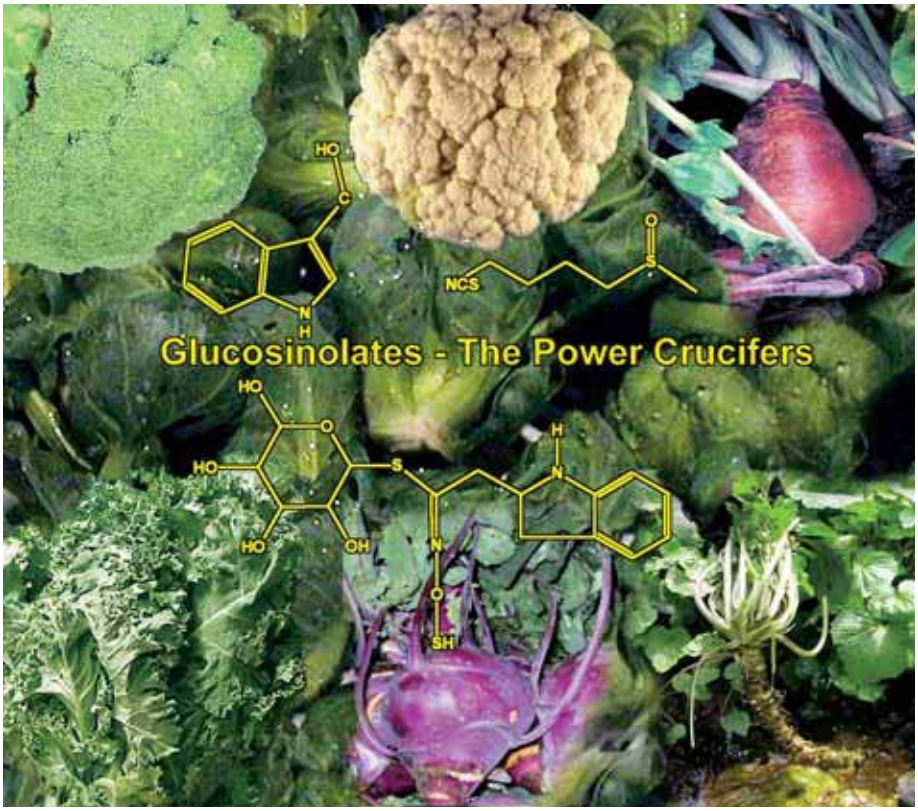
Advances in molecular biological techniques have made it increasingly easy for scientists to manipulate genes involved in plant growth and development. Today many researchers are attempting to manipulate accumulation of so-called 'bioactive compounds', i.e. compounds that cause a specific biological response in animals that consume them, and so create foods from 'super plants' that can be marketed as functional foods. However, the ability of plant scientists to manipulate these compounds often exceeds the ability of medical scientists to understand what benefits, if any, they provide to the consumer. Consequently the plant/food industry needs to establish their own set of criteria that will allow them to determine whether a specific compound is beneficial to human health when supplied as a chemical component of a plant food. Evaluation of scientific evidence for the biological benefits of supplemental ß-carotene, lycopene, polyphenols, glucosinolates and selenocompounds by a proposed set of criteria finds major problems and deficiencies in all. The state of the knowledge should stimulate cooperation between plant scientists and human nutritionists that will allow development of plant foods that provide a real benefit to human health.

THE NEED TO ESTABLISH CRITERIA

These are exciting times for the plant science community. Development and refinement of molecular biological techniques has proceeded simultaneously with an increased awareness of the role of diet in the development of chronic disease. These events have been the impetus for many botanical laboratories initiating projects with the objective of manipulating plant genes that control the accumulation of essential nutrients or potentially beneficial phytochemicals. The scientific and popular media have reported (and often sensationalized) how lycopene-enhanced tomatoes prevent prostate cancer, how anthocyanin-filled blueberries prevent aging, and how glucosinolate-enhanced broccoli helps remove carcinogens from the body. Other reports tell how the phytochemicals of tomorrow will prevent cancer, reduce cholesterol, improve memory, control blood sugar levels, promote weight loss, and keep the edge on our immune system. The public is literally buying the message, as "functional foods," i.e. foods that contain compounds that promote health

[1] The views expressed are those of the author, and do not represent any official positions or policies of the USDA, Agricultural Research Service

Figure 1. Cruciferous vegetables as a group may contribute more cancer-inhibiting phytochemicals to the diet than any other group of vegetables. The most powerful of these may be the glucosinolates, chemicals that are not bioactive by themselves, but must be hydrolyzed to an active form by enzymes within the plant or within bacteria in an animal's gut. The total amount, as well as the abundance of specific glucosinolate compounds is extremely variable between cruciferous species and also within the different germ-lines of a single species. This variation must be considered when making claims about the benefits of consuming specific cruciferous foods.



beyond basic nutrition, are among the fastest growing segments of the food industry with sales of more than $10 billion worldwide in 2002. To some it may seem to be a second "Green Revolution," in which plants are being altered not only to be more productive and disease resistant, but also to increase "health" to the consumer. As in the first green revolution, plant scientists are in the forefront of the battle.

However, this second green revolution is very different from the first where the enemy was clearly visible, and the objectives clearly defined. The enemy was typified by the protruding bellies and emaciated limbs of young children in Africa and Asia suffering from kwashiorkor, or protein/calorie malnutrition. The objective was simple - develop crops with increased yield to fill the stomachs of starving children. Plant scientists responded with breeding programs, and in a relatively short period the images began to disappear from newspapers, television, and magazines. This battle was won, and plant scientists got much of the credit.

Like many other conflicts in the world today, however, the objectives of the new revolution are ambiguous. This time the pictures in the media are typified by beautiful and handsome, athletic and financially secure Westerners who are concerned about their health and quality of life. To ensure that they will never develop prostate cancer they consume lycopene-enriched foods, and to ensure cardiovascular health they eat 25 g of soy a day. While there is evidence that perhaps lycopene and certainly soy consumption do improve health, the work of many plant scientists is directed toward enhancing the plant content of other phytochemicals for which there is little understanding of function and even fewer objective measures of a benefit to health. Also, the news media covered much of the first green revolution but in the present revolution there are few follow-up stories and even less evidence that progress is being made. Therefore to keep consumer confidence - as well as to keep the ethical integrity of the science - scientists need to agree to governance by an objective set of criteria that evaluate whether the changes made to plant composition actually do improve health.

Plant scientists need first to agree to the purpose of their actions; is the purpose to improve human health or is it to produce a product that the public perceives as healthful? If the purpose is truly to improve human health, then compounds in plants selected as targets for manipulation in plants should be backed by evidence of efficacy that satisfies rigid criteria. The food health claim procedure developed by the U.S. Food and Drug Administration (FDA) was designed for just this purpose, but the procedure for approval is long, rigid and potentially costly, and may not be applicable in all cases. Consequently, the plant science community must develop their own qualitative criteria and standards to determine whether there is evidence that a specified compound improves health. Apart from demonstrating that a particular compound improves health, additional criteria are needed to prove that consumption of a plant food containing enhanced quantities of the compound will provide the same benefit. For example, if there is evidence that lycopene reduces the risk of prostate cancer, additional criteria must be established to demonstrate that consumption of lycopene-enhanced tomatoes will also decrease the risk of prostate cancer.

There are virtually an unlimited number of plant-based compounds that potentially benefit human health; therefore criteria are needed to limit the number of compounds that are given even an initial assessment of health benefits. The FDA Health Claim procedure requires of all candidate compounds (a) that the compound of interest be chemically identifiable, and (b) the proposed health benefit have discrete and measurable endpoints. For example, if an "antioxidant" is promoted as beneficial, the antioxidant activity should be attributable to discrete compounds and not to the activity of unidentified "factors." Additionally endpoints used to justify a benefit to health should not be based on in vitro procedures such as the ability to reduce an oxidized substrate (e.g. many of the common antioxidant assays such as the Oxygen Radical Absorbance Capacity (ORAC) or Ferric Reducing Ability of Plasma (FRAP) assays). Only compounds that meet these criteria should be further evaluated for efficacy.

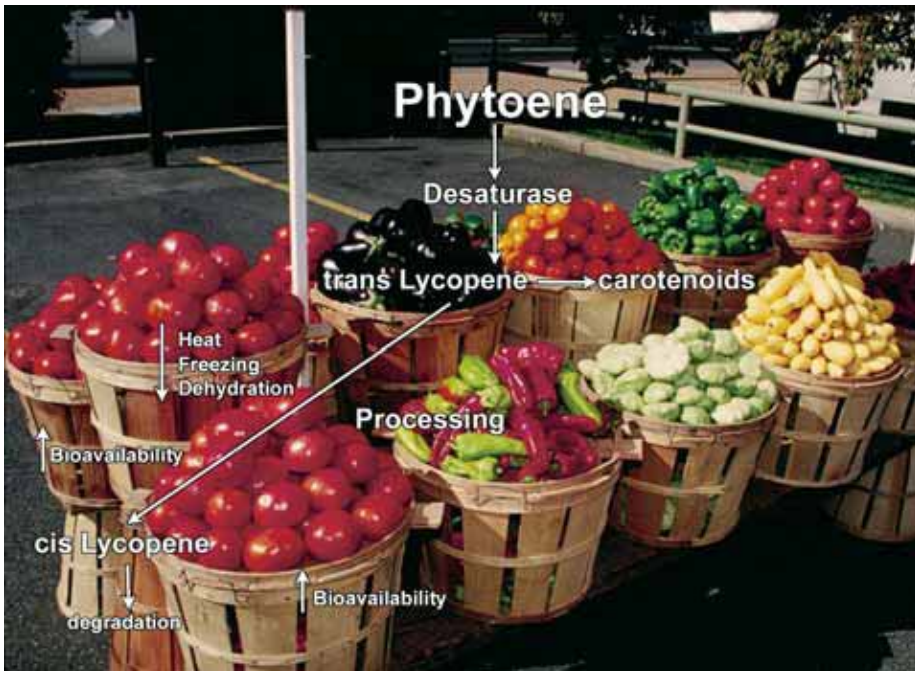
CAREFULLY CONSIDER THE STRENGTH OF SUPPORTING RESEARCH

The process of evaluating the efficacy of a candidate compound must consider the strengths and limitations of the various types of supporting evidence. Studies that used animal and cell culture models are important for describing *potential* effects. However cultured cells and laboratory animals are not humans and the scientific literature has numerous examples of physiologic processes described in such models that did not extend to humans. While epidemiologic research is considered stronger than investigational studies with non-human models, there is an increasing awareness that epidemiologic research is subject to biases that can change the interpretation of reported findings; such biases include ill-defined varia-

bles, inadequate attention to confounding interactions, inadequate sample size, and inadequate means of dietary assessment (Dennis et al., 2004). Interventional studies are the strongest evidence of efficacy, but all are not without limitations. The "gold standard" is the randomized, double blinded (blinded to the participant and the investigator), placebo-controlled study that examines the actual health end-point. Unfortunately such studies are very expensive and the literature is full of studies with much less scope and control. Evaluation criteria should address the limitations of intervention studies, especially in regards to using information from limited studies to make universal conclusions regarding human health in general.

Evidence that a particular chemically pure compound is bioactive (i.e. able to induce a biological response in the animal that consumes it) cannot be used to infer that the same compound is bioactive when consumed as a component of *a plant food enriched in the same substance*. Unfortunately, this often is assumed and the scientific literature has many examples of where the two measures of bioactivity were different (see discussion of ß-carotene below). Therefore additional criteria are needed to judge whether consumption of a bioactive compound *as a component of a plant food* also results in a benefit to human health. First, criteria should be established to judge whether the compound of interest is present in the food in an amount and chemical form that will result in bioactivity (given consumption of a reasonable amount of the food). The scientific literature contains reports of bioactivity that have been induced by feeding graded levels of a compound until a dose-threshold was reached; however such studies often do not take into account that such intakes would be impossible or even dangerous on a regular basis. Additional criteria also should evaluate whether enhancement of one phytochemical in a plant results in unintended negative interactions in the plant or in the animal that consumes it. Finally, the efficacy of the bioactive compound must be evaluated in the context of the food matrix, and the compound must be demonstrated to be *bioavailable* (i.e. able to move from the food matrix in the gut to the target tissue; this is a function of absorption and intermediary metabolism). The following examples summarize research concerning the bioactivity of several compounds of popular interest and the relevant research is used to illustrate misleading assumptions or knowledge gaps.

Figure 2. Colored vegetables contain carotenoids; one of the most studied of these is lycopene, a phytochemical found in high concentrations in tomatoes. Emerging evidence is suggesting that carotenoids in tomatoes, especially lycopene, may help reduce the risk of prostate cancer. However, almost every step involved in tomato production and processing affects the ultimate accumulation and chemical form of lycopene. All of these influences must be taken into consideration when promoting the benefits of lycopene from tomatoes.



Determination of Bioactivity, ß-Carotene and Cancer: The Need for Critical Examination of All Data

Carotenoids are pigmented phytochemicals found in almost all colored vegetables. One of the most common carotenoids, β-carotene, has been extensively studied for its purported ability to suppress cancer. Studies of β-carotene illustrate the importance of testing a compound within the context of the food matrix, and of critically examining all data, especially with regard to the strength of the models used.

Epidemiologic studies conducted before 1995, as well as some studies in animals and cell culture, seemed supportive of the hypothesis that β-carotene was the primary bioactive compound in fruit that reduced lung cancer risk (Willett, 1990). This idea was consistent with a hypothesis that explained β-carotene's function as an antioxidant that protected against oxidation-induced cellular damage and prevented DNA damage that could lead to mutations. To some, the evidence seemed sufficiently consistent to justify human intervention trials, but there was an important flaw in this conclusion in that the epidemiologic data were from studies of fruit and vegetable intake and not from studies of β-carotene *per se*. Thus in retrospect, perhaps it is not so surprising that a large randomized and blinded clinical trial found that supplementing 20 mg/day of chemically pure β-carotene to Finnish male smokers resulted in a slight, but statistically significant, increase in the incidence of lung cancer (The Alpha-Tocopherol, β-Carotene Study Group, 1994). These results were later confirmed by a second intervention trial conducted in the United States (Omenn et al., 1996).

A primary lesson to be learned from the β-carotene experience is that extrapolation beyond the limits of data, or interpretation of data outside of the context of the experiment, may not only give erroneous results, but in fact may lead to dangerous conclusions. Epidemiologic data relating fruit and vegetable consumption to cancer cannot possibly ascribe an effect to a single compound, and it is in fact impossible to differentiate between the effects of a single compound and the synergy of multiple phytochemicals present in the plant. Despite these limitations many researchers focused exclusively on β-carotene and did not consider the complexity of the food matrix. In retrospect, it also appears that animal and cell culture studies may not have been nearly as supportive as claimed. Few cell culture studies were done in models of lung cancer, and much of the 'antioxidant' theory is based on emerging evidence. Certainly a lack of rigorous examination and questioning of the evidence may have at best impeded science, and at worst actually may have been a risk to public health.

Determination of Bioactivity, Polyphenols and Cancer: The Need for Valid Endpoints

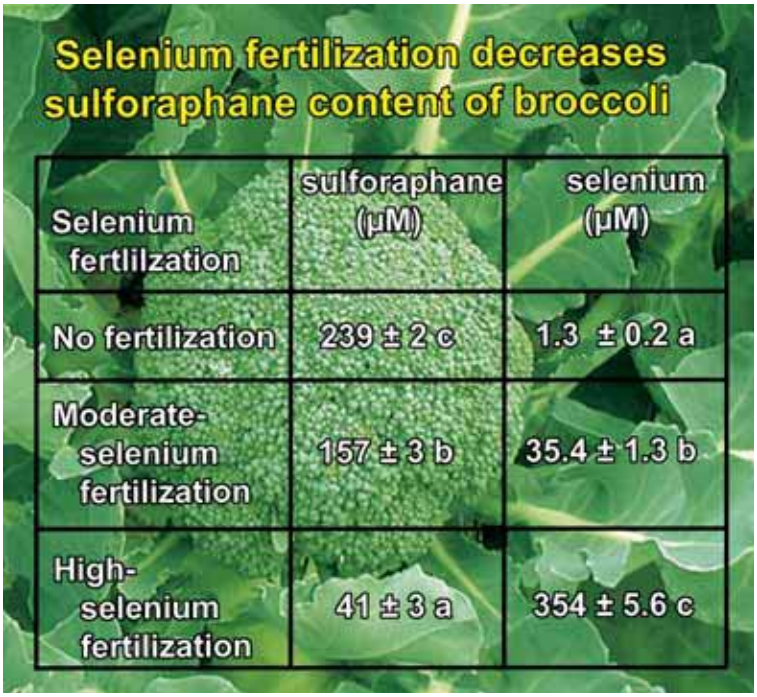
"Antioxidant" is a ubiquitous term in food/nutrition science and industry, and many products claim to "improve antioxidant status" or "decrease oxidative stress." Yet, for many antioxidants, there is disagreement as to the in vivo functional importance of the compound(s), as well as to the optimum level of intake or expo-

sure. Despite these limitations, some researchers continue to promote supra-nutritional intakes of their favorite antioxidant compound. Polyphenols are an enormous general class of chemicals (more than 8000 described compounds), and many polyphenols are reported to have antioxidant ability; work with polyphenols illustrates some of the above problems.

The scientific literature published between 2001 and the present contains approximately 700 reports of the antioxidant potential of phenolic compounds in plants (excluding the reports of antioxidants associated with oils or oilseeds). Most of these reports have reported "antioxidant potential" based on in vitro methodology. For example it has been reported that in vitro antioxidant activity is well correlated to phenolic content of berries, tomatoes, nectarines, peaches and plums, grapefruit juice, and apple and yucca extracts. Although such reports may add to our understanding of the chemical properties of such foods, they do not tell us anything definitive about their potential to promote health in humans; this is because many of the tests used to determine "antioxidant potential" have little or no relevance to human health. For example more than 200 studies reported the results of a common type of test that includes the Trolox Equivalence Assay or TEAC, the diphenyl-1-picrylhydrazyly, or DPPH assay, and the 2,2'anziobis-(3-ethylbenzothiazoline-6-sulphonic acid (ABTS) assay. All of these tests measure in vitro ability of the plant extract to destroy a spontaneously formed radical (Aruoma, 2003). There are multiple reasons why these tests do not give information relevant to human health. First, because the test is done in vitro there is no assessment of whether the compounds in the plant actually make it into the cell (or are even absorbed), and second the tests measure only the disappearance of a spontaneously formed radical and thus are only an indirect measure of ability to reduce the damage caused by oxidative stress. Thus the primary reason for the prevalence of such tests is their simplicity and not their relevance; such reports should be treated as preliminary information and not as evidence of a health benefit to humans.

These problems were summarized in a review in *Mutation Research*, which stated *"... it is clear that not a single method can give a comprehensive prediction of antioxidant efficiency"* and suggested that *"the question of bioavailability and fate of metabolites of antioxidant components must be addressed,"* and concluded that *"we have to agree (to) governance on in vitro antioxidant methods based on an understanding of the mechanisms involved"* (Aruoma, 2003).

Figure 3. It may not be possible to develop a "super plant" that contains high concentrations of many bioactive chemicals and has "super-potency" for improving health and reducing disease. An example is broccoli, a plant that can accumulate large amounts of the cancer-inhibiting chemicals selenium and sulforaphane. However, accumulation of high amounts of selenium results in a substantial decrease in the amount of sulforaphane in broccoli. The interaction of sulforaphane and selenium is not confined to plants; both chemicals work together to regulate an enzyme that is important in the cancer process. Thus when attempting to enhance a specific biochemical in a plant, one must ensure that other health-promoting components are not decreased or made less available to the consumer. One also must ensure that multiple chemicals do not elicit unexpected biological responses in the person that consumes the food.



A Plant Must Contain a Bioactive Compound in an Effective Concentration and Chemical Form: The Examples of Glucosinolates, Lycopene, and Cancer

To prove bioactivity of a compound *when consumed through a plant food*, one must first demonstrate that the compound is found in the plant food in an amount and chemical form that provides bioactivity. Examples from two types of vegetables, cruciferous vegetables containing glucosinolates and tomatoes containing lycopene, illustrate the extent of the variation possible from genetic and environmental sources. They further illustrate that variation may be of a magnitude that makes it difficult to ascribe a health benefit to a particular compound in a plant.

Cruciferous vegetables such as broccoli, parsnip, Brussels sprouts, Chinese cabbage, radish, horseradish, wasabi, white mustard, watercress, and cauliflowers are a dietary source of glucosinolates, compounds that may reduce the risk of several cancers. Glucosinolates in plants are chemically converted by bacteria in the gut or enzymes in the plant tissue to isothiocyanates, and it is the isothiocyanate that causes a biological response (Keck and Finley, 2004). One of the most important reactions is the conversion of the glucosinolate glucoraphanin to the isothiocyanate sulforaphane. In an animal, sulforaphane has several important biological actions including activation of cell signals that upregulate detoxification enzymes and thus rid the body of potential carcinogens, and regulation of cell division and cell death in irreparably damaged cells. There is limited epidemiologic evidence that glucosinolates reduce the risk of cancer, and although very few human feeding studies have been conducted, the animal, cell culture, and epidemiologic evidence has been used as the basis for production of glucosinolate-enhanced plant foods.

The primary problem with marketing foods based on glucosinolate content is that we are just beginning to understand the factors that affect the amount and form of glucosinolates in cruciferous foods. Plants are not produced under the same rigorous conditions as pharmaceuticals, and variations in production and post-harvest processing conditions may induce substantial variation. In fact the variation in the glucosinolate content of crucifers can be so great as to cast doubt on whether the cancer inhibitory effects of crucifers really can be ascribed to glucosinolate intake. A recent study used a modeling procedure to introduce estimated variation in the glucosinolate content of crucifers reported in cancer studies (Dekker and Verkerk, 2003). When glucosinolate intake was assumed to be a constant function of crucifer intake, high crucifer consumption cut the relative risk of cancer by as much as half.

However when estimates of glucosinolate variation resulting from cultivation, processing and domestic cooking were introduced into the model, glucosinolate consumption did not significantly reduce cancer risk.

The chemical form of the predominant glucosinolate varies between different cruciferous species. For example glucobrassicin and glucoraphanin may account for as much as 95% of the total glucosinolate concentration in broccoli, whereas Brussels sprouts, cabbage and cauliflower contain little or no glucoraphanin. Crucifers other than broccoli generally contain high concentrations of sinigrin, and gluconasturtin is abundant in Chinese cabbage, radishes, and watercress. Researchers of the University of Illinois have studied the variation of glucosinolates in cruciferous vegetables and have reported that the concentration of total glucosinolates in a plant is not predictive of a specific glucosinolate compound as Brussels sprouts contained twice the total glucosinolates but only ~ 15% of the glucoraphanin content of broccoli (Kushad et al., 1999). The same researchers also reported that the glucoraphanin content of different broccoli varieties varied more than 25-fold. Thus one cannot ignore the variation inherent in the production system or inherent in genetic diversity. In fact the variation may be so substantial as to call into question whether a compound in a plant actually does benefit health.

Lycopene and tomatoes illustrate that substantial variation in the form and concentration of a bioactive compound can be introduced by post-harvest and processing conditions. The media has given much attention to the benefits of lycopene and many people assume it to be essential especially for protection against prostate cancer in men (this perception has been enhanced by the inclusion of lycopene in several brand name vitamins). Tomatoes are the richest plant food source of lycopene, and those seeking to market the benefits of lycopene-containing tomatoes need to ensure that they contain adequate lycopene in a bioavailable form. Similar to cruciferous vegetables, genetic variation greatly affects the lycopene content of tomatoes (lycopene content of deep red varieties is much greater than in yellow varieties). However, harvest, post-harvest and processing conditions may have an even greater effect on lycopene concentrations. Tomatoes become enriched in lycopene as the fruit ripens, and vine-ripened tomatoes contain more lycopene than tomatoes picked green and ripened in storage; likewise tomatoes produced outdoors in the summer contain more lycopene than tomatoes produced in a greenhouse. Post-harvest processing also affects lycopene bioavailability, and cooking in general causes physio-chemical changes that increase the bioavailability of lycopene (Shi and Le Maguer, 2000; Bramley, 2002). Consequently marketing tomatoes on the basis of lycopene requires that production conditions are carefully monitored and standardized, otherwise one consumer may receive a product with an effective dose, whereas another consumer may receive a product with a much lower dose and/or perhaps in a less bioavailable form.

Enhancing the Content of One Phytochemical in a Plant May Result in Unforeseen Interactions with Other Bioactive Compounds: The Example of Selenium in Broccoli

Selenium (Se) is an essential trace element that is used by animals as a component of various selenium-containing enzymes. However, Se also may suppress cancer by mechanisms completely unrelated to its role as a nutrient. Nutritional requirements for selenium are satisfied by an intake of 55 micrograms/day, but a study conducted in the eastern US demonstrated that supplementation of 200 micrograms of selenium/day dramatically reduced overall cancer incidence and mortality and specifically reduced prostate and colorectal cancer (and there was some indication of reduced lung cancer incidence) (Clark et al., 1996). Because the results of the human intervention study are supported by a multitude of epidemiologic studies and mechanistic studies with animals and cultured cells, a strong argument may be made for enhancing foods with selenium.

Broccoli is easily enhanced with selenium and may accumulate selenium in an especially beneficial chemical form. Selenium-enriched broccoli has been reported to inhibit development of several types of cancer in laboratory animals (Finley, 2003). However, studies with high-selenium broccoli illustrate another potential problem with the production of plants enhanced with a specific bioactive compound - enhancement of one bioactive compound (selenium) interferes with production of another important phytochemical (sulforaphane). Further, the interaction between selenium and sulforaphane also causes unexpected changes in the animal that consumes selenium-enhanced broccoli.

Selenium-enriched broccoli is easily produced by fertilization with selenium during maturation of the plant inflorescence. However, compared to unfertilized broccoli, selenium fertilization may decrease the total content of sulforaphane by as much as 75% (there also is evidence that it may decrease specific phenolic acids by as much as 50%) (Finley et al., 2005). The interaction of selenium and sulforaphane extends to the animal that consumes broccoli. Thioredoxin reductase is a protein that needs selenium for activity, and thioredoxin reductase activity is controlled in part by the availability of dietary selenium. However studies in cultured cells have demonstrated that sulforaphane and/or broccoli induces transcription of thioredoxin reductase mRNA and increases the activity of thioredoxin reductase enzyme activity beyond the maximum normally induced by Se alone (Hintze et al., 2003). The functional consequences of such a change in thioredoxin reductase regulation are unclear since the enzyme is both a powerful antioxidant (potentially protective against cancer) as well as a potent inducer of many growth genes (potential induction of cancer). But regardless of the overall impact on cancer, these studies demonstrate a completely unforeseen interaction by two phytochemicals with very different metabolic pathways. Such interactions must be characterized and the impact on health determined in order to assess the overall value of the food.

SUMMARY

Advances in molecular biology have opened the door to the development of "super plants" that contain greatly enhanced concentrations of presumed beneficial compounds and can be marketed as Functional Foods. The health and welfare of the consumer, as well as the future of the industry, depend on development of strict standards and criteria that will ensure such foods are safe and efficacious for the desired health benefit. A multi-step evaluation process has been proposed and may be summarized as follows:

1. Determine whether the compound of interest is chemically defined and whether the proposed health benefits have measurable endpoints. If either of these criteria are lacking, then the compound should not be considered until the basic science is more complete.
2. Carefully consider the totality of evidence (especially human interventional and epidemiologic studies) relating a compound to a proposed health outcome - collaborations with departments of nutrition and/or medical schools will greatly facilitate this step. Compounds with proven efficacy become candidates for manipulation in plant systems.
3. When a plant food is developed, determine whether production and/or processing systems introduce unacceptable variation in the final product. This may take considerable experimentation and refinement of techniques.
4. Determine whether consumption of the plant food results in the same biological outcome as consumption of the chemically pure compound. For many compounds, this may have been already accomplished in step 2, however for other products, this may require additional human studies.
5. Finally, carefully consider interactions induced by the manipulation of the plant. Some interactions may affect the function of the plant, whereas other interactions may occur in the human that consumes the plant food. A product that improves one functional measure of health but decreases another may be at best a waste of the consumer's

resource, and at worst a potential risk to health.

The examples given in this report illustrate multiple deficiencies and flaws in our understanding of potential health-inducing compounds in plants; these problems certainly should give pause to the rush to manipulate the compound *du jour* and market whatever the consumer will accept. But it should not end the interest in improving health through improvement of plant foods; rather it should stimulate further research to resolve these inadequacies. Improvement of health care has become a national political debate and priority. Our top three problems are heart disease, cancer and the host of problems associated with obesity, all of which have nutritional problems at their core. Thus by logical extension the solution to these problems must have nutrition at its core. Plants hold great promise for becoming 'designer' or 'super' foods that can be targeted at specific health problems, but the development of plant foods that make a real difference will depend on extensive cooperation between plant scientists and medical researchers to ensure that marketed products actually do provide the purported health benefits.

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Vitamin-A Partnership for Africa: A Food Based Approach to Combat Vitamin A Deficiency in Sub-Saharan Africa through Increased Utilization of Orange-fleshed Sweetpotato

Regina Kapinga, Pamela Anderson, Charles Crissman, Dapeng Zhang, Berga Lemaga and Fina Opio

The Vitamin A for Africa (VITAA) partnership is promoting the increased production and use of orange-fleshed sweetpotato (OFSP) to combat vitamin A deficiency in sub-Saharan Africa. This deficiency is one of the leading causes of early childhood death, and a major risk factor for pregnant women in Africa. Vitamin A is essential for a child's normal mental and physical development and for keeping everyone healthy and strong - especially pregnant and lactating mothers. The lack of it can be a death sentence, in some cases directly but more often via a weakened immune system, which exposes victims to diseases such as measles, pneumonia and malaria. Vitamin A deficiency also reduces the ability to see clearly in poor light and can lead to night blindness. The VITAA partnership therefore targets young children and their mothers, who are the most vulnerable to vitamin A deficiency. In sub-Saharan Africa, more than 3 million children under the age of five suffer from vitamin A-related blindness. OFSPs are rich in beta-carotenes that the body converts easily into vitamin A, they are easy to grow and the average consumer can afford them. Efficacy studies have proved that the daily addition of 100 g of the sweetpotato to the diet can prevent vitamin A deficiency in children and dramatically reduce maternal mortality. An ex-ante impact assessment (pilot study) has indicated that introducing the new high beta-carotene cultivars will benefit 50 million African children under the age of six. Pioneered and led by the International Potato Center (CIP), the VITAA partnership includes more than 50 organizations from the health, nutrition and agriculture, non-government organizations, community-based organizations, root crops sub-regional research networks, and private business sectors, working together to extend the impact of OFSP in more than ten partner countries in the region. About 15 new starchy OFSP cultivars with moderate resistance to viruses and weevils have been accepted by the farmers and consumers in Tanzania, Uganda, Kenya, Mozambique and South Africa. OFSP cultivars currently occupy 1-2% of the planted area in the lake zone of Tanzania, 5-10% in Central Uganda and 10-15% in Western Kenya. Adoption is higher if there is a ready market for the cultivars, both as fresh roots and vines and as processed foods. Farmers in western Kenya, eastern and central Uganda are increasing their incomes by selling planting material. In Uganda, a single farmer can earn up to US$ 400 per month. OFSPs are contributing to the welfare of households disrupted by HIV/AIDS, as well as other crises. In northern Uganda, where persistent violence has forced many farmers to live in protected camps and in Mozambique during the 2000-2001 drought and floods, OFSPs contributed to food security, income generation and improved nutrition for the displaced people. To encourage adoption, VITAA has developed a social marketing strategy and action plan. Awareness campaigns and nutrition education are creating a demand for more planting materials and information. Mothers and school-age children are targeted with messages that create demand for the new varieties and associated food products. The work is also encouraging governments, non-government organizations, and community-based organizations to take responsibility for the distribution of the high beta-carotene materials. The initial VITAA activities were supported by contributions from the Canadian International Development Association (CIDA), CIP and its donors that contribute with unrestricted contributions, United Kingdom Department for International Development (DFID), the OPEC Fund for International Development, the Senior Family Fund, The Micronutrient Initiative, United States Agency for International Development (USAID)-Africa Bureau, the Regional Network for Improvement of Potatoes and Sweetpotato in East and Central Africa (PRAPACE) and the Southern Africa Root Crops Research Network (SARRNET). Future plans include expanding the VITAA partnership to more countries and sectors, with large-scale dissemination of the varieties to all major sweetpotato producing and consuming countries in Africa. These efforts will be combined with institutional and capacity building and

Orange-fleshed sweetpotato.

studies of traditional processing to improve beta-carotene retention. Work will continue on developing nutritional and agricultural training programmes for household decision-makers, community leaders, local educators and children.

BACKGROUND

VITAA is promoting a simple change - consumption of orange-fleshed sweetpotato instead of traditional African white ones - to make a difference in the lives of millions of children and mothers, the people most at risk from vitamin A deficiency. The VITAA partnership, a CGIAR 2003 award-winning project, offers prospective donors an opportunity to support a novel initiative that has achieved major impact in sub-Saharan Africa. On 9 May 2001, an international group of 70 agriculturists, health experts and nutritionists launched what is believed to be the first crop-based initiative to attack the tragic consequences of vitamin A deficiency in sub-Saharan Africa. Working under the VITAA umbrella, more than 50 partner agencies from the health, nutrition and agricultural sectors have agreed to work together to extend the impact of orange-fleshed sweetpotato in more than ten partner countries in sub-Saharan Africa. Original VITAA countries include: Ethiopia, Kenya, South Africa, Tanzania, Uganda, Mozambique and Ghana. CIP and partnership scientists are working in this region, and for the larger global community, to address this nutritional deficiency, which is one of the leading causes of early childhood death, and a major risk factor for pregnant women in Africa. The CIP-led and pioneered VITAA project recognizes that this devastating condition is completely preventable, and supports research that seeks a breakthrough food-based solution - the substitution of vitamin rich orange-fleshed sweetpotatoes for the white-fleshed sweetpotatoes that comprise an important part of the sub-Saharan African diet. VITAA funding agencies include: CIP, DFID, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), the OPEC Fund for International Development, the Senior Family Fund, The Micronutrient Initiative, the USAID-Africa Bureau, PRAPACE, and SARRNET.

THE PROMISE OF ORANGE-FLESHED SWEETPOTATO IN COMBATING VITAMIN A DEFICIENCY

A recent ex-ante impact case study conducted by economists from CIP and Michigan State University strongly suggests that 50 million African children under the age of six could benefit from the new orange-fleshed varieties. Complementary field studies conducted by CIP in collaboration with several VITAA partner agencies, have shown that orange-fleshed sweetpotato and sweetpotato-based food products are not only acceptable to both producers and consumers in terms of appearance, taste, and texture, but also have contributed to the alleviation of vitamin A deficiency. The new sweetpotato cultivars also performed well with respect to yields, and pest resistance and also had high beta-carotene content. One of the principal findings from the studies is that African mothers would readily accept the new cultivars, dispelling the myth that African taste preferences precluded the use of orange-fleshed sweetpotatoes. The bio-efficacy study recently completed in South Africa has demonstrated that the daily addition of as little as 100 g of OFSP to the diet could prevent vitamin A deficiency in children. A micro-enterprise component using OFSP also has the potential to increase rural incomes for the people who need it most in rural communities. Now the partnership is capitalizing on the opportunity revealed by these findings. Adaptive research activities are being advanced in Kenya, Mozambique, Ghana, Tanzania, South Africa, Ethiopia, Madagascar, DR. Congo, Rwanda, Zambia, Malawi, Burundi and Uganda, where the National Agricultural Research Institutions scientists are working with CIP's regional staff to screen several orange-fleshed cultivars in order to access their suitability to different environments.

VITAA Goal

Healthy, rural populations through food-based approaches to nutrition, focused on vitamin A.

VITAA Purpose

Children and adults consume orange-fleshed sweetpotato (OFSP) in levels that lead to reduced vitamin A deficiency.

VITAA Agenda

The agenda consists of a coordinated set of activities in the major sweetpotato-producing countries of Eastern and Southern Africa. Its principal objective is to promote wide-scale production and use of orange-fleshed sweetpotato. The partnership program focuses on Uganda, Kenya, Ghana, Tanzania, South Africa, Mozambique and Ethiopia. Close linkages are also maintained with partner institutions in other countries through two regional root and tuber crops research networks: PRAPACE and SARRNET. Project activities include: impact assessment before the interventions (ex-ante), participatory testing of varieties for adaptation and acceptability, community-based multiplication of planting materials, nutrition education, post-harvest processing for market and for home consumption, promotion through social marketing, monitoring of impact on nutrition and health, and capacity building. Principal beneficiaries are young children and their mothers, the two groups most at risk for vitamin A deficiency. Implementation strategies concentrate on women because of their central role in the production and marketing of sweetpotato and other food crops used in the family diet.

Mrs. Joweria Sekiyanja harvests by piecemeal orange-fleshed sweetpotato roots for her family's meal.

PRINCIPLES OF THE VITAA WORK PLAN

As a result of these highly promising results, VITAA engagement is mainly community-based and focused on women decision makers. It also emphasizes nutrition education and micro-enterprise development. The partnership operates according to the following principles:

- That orange-fleshed sweetpotato is now acceptable by African consumers and ready for full-scale development, and will also prove effective as an entry point for other food-based strategies aimed at reducing vitamin A deficiency in sub-Saharan Africa.
- That VITAA cultivars can empower local communities to help mothers and young children prevent vitamin A deficiency through their own labour and industry but also increase their incomes through value addition.
- That VITAA provides a highly effective tool to address vitamin A deficiency among rural poor communities, more especially: children, pregnant women and lactating mothers.
- That evidence exists that the VITAA cultivars may also help reducing the impact of anemia, measles, and malaria.

VITAA PROGRESS AND MAJOR ACHIEVEMENTS TO DATE

Impact Assessments, Monitoring and Evaluation

An ex-ante impact assessment study done jointly by the International Food Policy Research Institute (IFPRI) and CIP, which was completed in 2001, revealed that in many parts of SSA, there is sufficient per capita production of sweetpotato to warrant optimism about positive nutritional consequences for vitamin A deficient populations with the introduction and diffusion of OFSP cultivars. The study estimates that up to 50 million children in the region could benefit significantly from the new OFSP cultivars.

Planning and Constituency Building

Working from the results of the ex-ante assessment, project leaders have embarked on a program of constituency building. The objective is to garner support for the use of high vitamin A sweetpotatoes among national policy makers, as well as NGOs and development agencies working in agriculture, human health, and nutrition.

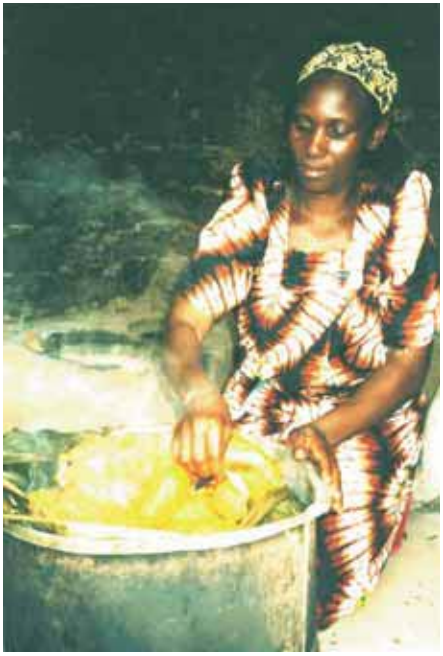
Adaptive Research

New technologies exist on: the utilization of new noble varieties in the family diets, processing techniques of nutri-products including the enrichment of local weaning foods. To date ten to twenty OFSP cultivars with high dry matter have been accepted by consumers in the region.

Training

To the greatest extent possible, training programs have been and continue to be conducted in all major project areas, including impact assessment, seed multiplication, post harvest processing and marketing, micro-enterprise and micro-credit. Priority has always been given to the concept of training of trainers. The training of experts who can move skills and expertise to rural areas and help to empower local people including extension workers, NGOs and community leaders, has been given increasingly higher priority.

A child in rural Rwanda eating and enjoying cooked orange-fleshed sweetpotato root.



Mrs. Joweria Sekiyanja preparing to serve her family with cooked orange-fleshed sweetpotato.

Social Marketing

To encourage adoption of new technologies, VITAA has also developed a social marketing strategy and action plan. Targeting has focused on mothers and school-age children with messages that create demand for the new varieties and associated food products. The social marketing component has also encouraged the country governments, non-government organizations, and community-based organizations to take responsibility for the distribution of the high beta-carotene materials and for micro-enterprise development.

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The Plastic Greenhouse Industry of Spain

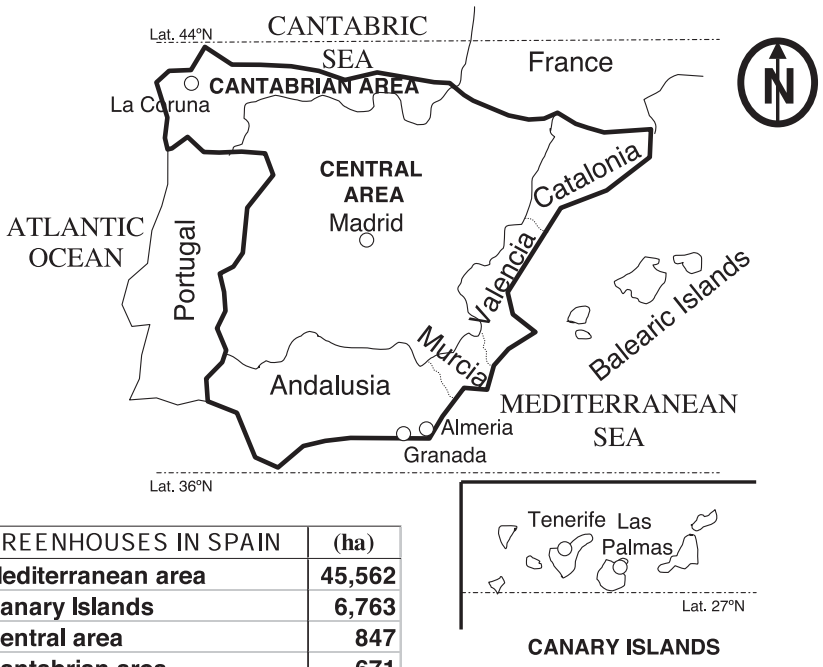
Nicolas Castilla and Joaquin Hernandez

INTRODUCTION

In the last few decades, the protected culture industry in Spain has expanded, based on the use of low-cost plastic greenhouses. The energy crisis in the 1970s and the introduction of plastic film were major contributing factors to the shift in European greenhouse production to southern regions, such as Spain, where inexpensive plastic greenhouses and the development of simple technologies enabled the production of low-cost, out-of-season commodities (Castilla, 1994). Improved long-distance transportation and efficient international marketing facilitated a wide supply of produce to the increasing export and domestic markets, resulting from economic development. The climatic advantages of the Mediterranean area, main greenhouse zone in Spain (Fig. 1), are related to the high radiation conditions in the autumn and winter (associated with a predominance of direct solar radiation over diffuse radiation in the large number of clear days), the mild winter temperatures and the climatic stability influenced by the proximity of the sea.

The Spanish greenhouse industry is a good example of the "Mediterranean greenhouse agrosystem," characterised by low technological and energy inputs (Baille, 2001). In most cases, the use of simple structures, a generally low level of technology, and the lack of equipment for climate control create a very strong dependence of the greenhouse microclimate on external conditions (Castilla, 1994; La Malfa and Leonardi, 2001).

Figure 1. Schematic situation of the greenhouses in Spain. Mediterranean area includes the Andalusian, Murcia, Valencia and Catalonia regions as well as the Balearic Islands.



GREENHOUSES IN SPAIN	(ha)
Mediterranean area	45,562
Canary Islands	6,763
Central area	847
Cantabrian area	671
TOTAL	53,843

HISTORICAL

The absence of reliable statistical data of greenhouses in Spain has frequently led to overestimate the area under greenhouse cultivation (MAPA, 2004). The evolution of the protected area (23,850 ha in 1989; 47,700 ha in 1999) shows stabilization at the end of the 20th century. Recent estimates of the Spanish greenhouse area, including walk-in tunnels, reached slightly over 53,800 ha (data adapted from FIAPA, 2001; MAPA, 2004; Sanjuan, 2004; and personal communication sources). These figures do not include fruit tree net-shelters (over 6,500 ha) mainly used for hail protection of table grapes, loquat, and citrus in the southeastern Spain. The adjacent coastal provinces of Almería (26,958 ha), Murcia (6,050 ha) and Granada (4,499 ha), in the southeast of the Iberian Peninsula, constitute 69.7% of the total greenhouse area (Fig. 1), influenced by their dry subtropical Mediterranean climate (Fig. 2). In this area, the progressive increase in the level of protection for vegetable growing began using very simple windbreaks in the early 1900s, complemented later by the use of sand-mulch (*enarenado*) and followed in the 1960s by the introduction of the flat roofed *parral* type greenhouse, an adaptation of the wire and wood structure locally used to support vines for growing table grapes (similar to the Italian *pergolato*). This greenhouse structure of low height (1.9-2.5 m), named *parral* type, fixes and supports the plastic film between two grids of wire. The roof geometry developed later, for easier shedding of the infrequent rain and for improving solar-radiation transmission (Castilla and Lopez-Galvez, 1994; Soriano et al., 2004), and raising the roof height (2.4-3.5 m to the eaves).

The wire and wood structure used to support the vines for growing table grapes (named *parral)* was adapted for the construction of the low-cost *parral* type greenhouse. Photo by courtesy of O. Lescure.

The *enarenado* method, locally extended in southeastern Spain, modifies the soil profile by

placing a layer of silty clay soil over the original rocky sandy soil after levelling the ground, and spreading manure on top (up to 10 kg per m^2, lightly tilled to about 20%), under a siliceous sand mulch of about 8 cm thick (Castilla et al., 1986). In this soil profile, roots concentrate in the sand-manure-soil interface. Water evaporation from the soil is reduced and low-quality (salty) irrigation waters can be used without costly yield reductions.

The coastal Mediterranean regions of Spain (Andalusia, Murcia, Valencia, Catalonia, and Balearic Islands) contain 84.6% of the total greenhouse area (Fig. 1). The Canary Islands (in the Atlantic Ocean, between 27 and 29°N latitudes) concentrate greenhouses in the dry tropical Mediterranean climate areas of Las Palmas and Tenerife provinces (12.6% of the total area).

CROPS

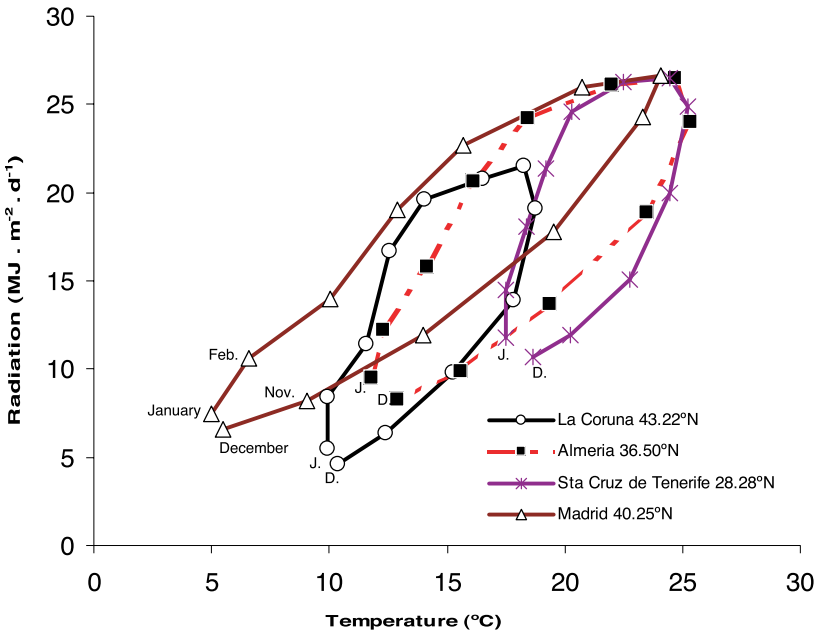
In Spain, 88% of the total greenhouse area is devoted to vegetable crops (tomato, sweet pepper, cucumber, green beans, strawberry, melon, watermelon, eggplant, squash, lettuce, in descending order). Production of flowers (mainly carnation and rose) and ornamentals constitute only around 5% of the greenhouse area. Banana is the major tree crop in plastic greenhouses. Table 1 presents the average yields of the most common greenhouse vegetable crops in the Almería area.

Table 1. Average commercial yields of the most common vegetable crops in the Almería area, in the prevailing growing calendars of the most common greenhouse vegetable crops.

Crop	Yield (kg m^2)	Calendar
Tomato (long cycle)	14.0	Sept-May
(short cycle)	10.5	Jan-May
Sweet pepper	5.7	Aug-Jan
Cucumber	7.6	Sept-Jan
Green bean (dwarf)	1.1	Oct-Dec
Melon	3.5	Feb-June
Watermelon	6.8	Feb-June
Squash	5.2	Sept-Jan
Eggplant	6.7	Sept-May

***Parral* type greenhouses in the Almería area.**

Figure 2. Average daily solar radiation and temperature over the year in several Spanish locations: La Coruna (Cantabrian area), Madrid (Central area), Almería (Mediterranean area) and Santa Cruz de Tenerife (Canary Islands).



GREENHOUSE TECHNOLOGY

The different climatic conditions between the Spanish regions, the species chosen, and the growing calendar, basically determine the technological level of the greenhouse and equipment. In the coastal Mediterranean areas of the Spanish Peninsula, for example, it is normally possible to grow vegetables in unheated low-cost greenhouses throughout most of the winter season (Fig. 2). In the non-coastal areas, due to their colder climates, heating is a necessity during the winter.

Greenhouse Types

Two major greenhouse groups can be differentiated: artisan and industrial. The artisan group is the prevalent in the Spanish industry, basically represented by the *parral* greenhouse, made by a vertical structure of rigid pillars (of wood, iron, or steel) on which a double grid of wire is placed, to attach the plastic film. As in other Mediterranean zones, the availability and price of local materials as well as installation expertise have been fundamental in the greenhouse expansion.

The arch-shaped multispan (multitunnel) system prevails among the industrial types, mostly covered with plastic film or, in some cases, with rigid or semirigid materials (preferentially polycarbonate). These arc-shaped multitunnels are normally of galvanised steel and are preferred by the ornamental growers and nurseries. Multitunnels are more airtight than the *parral* type greenhouses and easier to equip. The glasshouse area is scarce, below 1% of the total greenhouse area (far from high figures attributed by Jouët, 2001).

In the Almería area, flat roof *parral* plastichouses (around 33% of the area) are decreasing. The saddle roof *parral* type structure is expanding, currently representing around 63%, while multitunnels and others are 4% (Fernández and Pérez-Parra, 2004). Collecting rainwater from the greenhouse roof is a widely expanding practice.

Long life (UV-ultraviolet) polyethylene (PE) is the prevailing greenhouse covering material in the country, followed by the long-life infrared (thermal) PE film and the multilayer (PE-EVA-PE) film, where EVA = ethylene vinyl acetate. In the Canary Islands, the very mild winter minimum temperatures allow the use of high-radiation transmission nets as greenhouse covers (mostly for banana and tomato growing). These net-greenhouses are also used in the non-coastal highland areas of the Iberian Peninsula for spring-summer growing of fruit vegetable crops.

Greenhouse Equipment and Management

1. Equipment. Choice of greenhouse equipment is determined, by local climate, the crop, growing cycle, and greenhouse type. The technology packages (greenhouse and equipment) are numerous and their management is oriented to achieve optimal crop performance, technically as well as economically.

In the Almería province, less than 1% of the greenhouses are heated (FIAPA, 2001), reflecting that its use is more an economic than a technical problem. Heating is installed mostly in

An example of the industrial greenhouses used in Spain (arc-shaped plastic multitunnel).

high-technological-level greenhouses (multitunnels) or for frost protection in inexpensive structures by way of pulsed hot air heating systems. Relevant night/day temperature variations occur in unheated plastichouses. Low-temperature (40-50°C) water-heating systems that use plastic tubes for heat distribution are preferred to high-temperature systems that require steel tubes. If the latter are installed, the heating tubes provide the rails for mechanisation. The use of movable thermal screens is not common, as they are difficult to install in low-cost greenhouses, where double covers during the winter are preferred. Inflated double covers are rare.

Poor ventilation is typical of Spanish greenhouses. The limited venting area (12% as an average in the Almería area), covered with insect-proof nets (over 90% in Almería) is far from optimal. The trends of constructing taller greenhouses and increasing roof vents area are enhancing ventilation.

For greenhouse cooling, whitewashing is prevalent (96.5% in Almería) during the high-radiation season. This solar radiation reduction restricts photosynthesis and limits potential production. In a similar way, dirt deposition on the plastic cover and plastic aging reduce light and potential yields. Low pressure, inexpensive air fogging systems are preferred to high pressure systems, due to clogging. In the province of Almería, fogging is used in around 2% of the greenhouses. Shading screens are not common.

Poor ventilation generates carbon dioxide (CO_2) depletion. Only high-technological-level greenhouses are equipped for CO_2 enrichment (0.2% in the Almería area). The use of fans for air removing and mixing the greenhouse air, in order to increase the photosynthesis efficiency, is spreading.

The use of computerised climate control systems is very scarce and most well equipped greenhouses are operated by simple automation systems. In poorly equipped greenhouses climate control is inadequate.

2. Crop Techniques and Practices. In the past, greenhouses normally produced two crops per year (autumn to mid-winter and late winter to spring cycles), but single cropping is increasing, particularly in heated greenhouses, with indeterminate *solanaceous* species. The use of hybrids is widespread. The wide demand for high-quality disease-free vegetable transplants and the use of grafting are increasing the use of specialized seedlings. The sub-optimal microclimate conditions make it necessary to improve fruit-setting in some periods, using insects (honeybees and bumblebees).

3. Plant Protection. Greenhouses represent a unique environment for the development of pests and diseases, encouraged by a mild microclimate and plenty of food. Major pests include leaf miners, whiteflies, and mites, which are more common in the older growing areas. Virus and soil-borne diseases appear to be more important than aerial diseases. During the last decade netting of vents were rapidly and widely adopted to prevent pest and insect-transmitted viruses.

Integrated pest management (IPM) is widely used in the Spanish greenhouse industry. Effective IPP (integrated production and protection) management programs are extending. These programs include general plant-hygiene measures inside and outside the greenhouse, removing and recycling crop residues and plastics, use of bees for pollination, proper irrigation and fertilization scheduling, and grafting on resistant rootstocks. In most greenhouse zones, the mild temperatures in the open air during winter allow the survival of pests and ease later invasions, as compared with winter freezing areas.

4. Irrigation and Soilless Culture. Localised high-frequency irrigation systems (mostly drip) are used in 99% of the greenhouse area, increasing the high water use efficiency in greenhouses. There is a clear trend to improve the control centers of the fertigation systems.

Soil-borne diseases, influenced by monoculture, are encouraging the adoption of soilless culture. In newly constructed greenhouses, soilless systems are adopted in over 35% of the area, as compared to less than 10% in old greenhouses. The most common substrate is perlite, followed by rockwool and coconut fibre. The limited and variable quality of irrigation water restricts the use of recirculation in soilless systems.

5. Residues and Wastes. The greenhouse industry generates internal residues, as other agricultural activities, that affect soil and water and external wastes, such as plastics and plant debris. Practically all the plastic waste from the greenhouses is recycled. Plant debris is composted, landfilled, burned (under control) or used in biofumigation. The environmental impact of leaching water from irrigation appears as a basic point to improve. Relevant studies and efforts on that subject are being conducted.

6. Other Aspects. Labour availability and cost are key aspects for the greenhouse industry, with increasing numbers of immigrants providing labour in the Spanish industry. Other technical and socio-economic aspects such as communications, electricity supply, and marketing facilities have also been most relevant for the greenhouses development.

MARKETING

The challenge to supply seasonal perishable products of high quality year round has favoured the exports from Spain to the rest of Europe. In the Spanish greenhouse industry, both domestic and export market-focused pro-

A well-equipped plastic greenhouse in Spain.

duction coexist, in different degrees of importance, depending on the product. Frequently, the export market requirements prevail when determining the cultivars to be grown. As the trade statistics combine both greenhouse and open-air grown crops, no reliable information is available. Estimates of the export volume situate it over 50% of the produce, mostly to other European countries. Harvesting periods sometimes overlap with open-air produce, thereby influencing market prices.

In the middle of the 1990s, the increasing competition of Mediterranean countries producing vegetables sometimes almost saturated the European markets. At the same time, new marketing structures appeared, avoiding the auction system, and the growers groups started selling their produce directly to the supermarket chains, in an active marketing approach (van Uffelen et al., 2000). These new marketing channels were effectively used by the associated Spanish growers to supply the European markets with greenhouse vegetables.

The diversification of greenhouse production is characterised by new presentations of established products rather than by new crops that require research and promotion in the market. New presentations of established crops include variations of the colour, shape or size of crops already cultivated, as well as quality labels. Relevant examples of diversification are the cherry and cluster tomatoes as well as "baby" vegetables (Castilla, 2002).

Traceability of the produce is becoming a necessary must for production. Thus this technology is spreading quickly, in order to provide the consumer with security concerning production (high-quality products cultivated in environment-conscious, labour-safe, and hygienic ways).

In the Spanish greenhouse industry the setting up of integral quality management systems appears as a clear priority, in order to emphasize the quality and differentiation strategies. The image of clean production will be increasingly used in future marketing strategies. For the sustainable production of safe and high-quality vegetables in Spain, growers provide production details, as a common practice in supplies to supermarket chains. Labelled and quality certified products are winning the confidence and sustaining consumer fidelity.

An important greenhouse vegetable-packing industry has developed in the southeastern Spain.

ECONOMICS

Greenhouse Produce Costs

In most cases, the use of simple structures and the scarce climate control in some periods limit potential yield, product quality, and timing of production, but allow a low-cost production compared with the Northern European greenhouse agrosystem, which is based on sophisticated structures having high technological and energy inputs, requiring major investments, and achieving higher crop yield.

There is an enormous variability of production costs in the Spanish greenhouse industry due to the variety of cycles and technological level. To examine the general overview of competitiveness, Table 2 summarizes variable production costs for tomato in two greenhouse ecosystems: low cost Spanish vs. high cost Belgium. Salaries appear as the most important cost in both cases. Fertilizers and pest-control costs are lower in the Spanish industry. The variable cost of water is low in the Spanish greenhouses, relative to the total production costs of greenhouse vegetables, but non-existent in the Northern greenhouse agrosystem, as stored rainwater in those countries covers the irrigation requirements. However, the greatest difference in the comparison is the 35% cost of natural gas, for heating and carbon dioxide injection in the Northern greenhouse agrosystem (Table 2). The annual fixed costs of the *parral* type greenhouse (lower technological level) are around 1.3 euros per m^2 but increasing in better-equipped greenhouses. However, the higher transport costs in the Spanish produce, when exporting to the European market, compensate for these lower production costs in Spain (Verhaegh, 1988; Castilla et al., 2004). In the Almería area (in 2004), the average gross income of the greenhouse grower was around 4.5 euros per m^2.

Recent data, comparing the sustainability of the greenhouse produce in Spain and the Netherlands, show that primary fuel consumption, for cultivation and transport purposes, per kg of tomato, sweet pepper and cucumber is estimated to be 13, 14-17 and 9 times greater, respectively, in the Netherlands (Van der Velden et al., 2004). In the past the primary objective of research has been to increase yields in order to reduce unitary costs. At present, the major objectives have been directed to increase quality and improve marketing strategies.

Table 2. Composition of the variable costs of greenhouse conventional tomato in Almería (adapted from Calatrava-Requena et al., 2001) and of beef tomato in Belgium (adapted from Benoit, 1990; 2002, personal communication). Yields of 14 kg m^{-2} (Spain, unheated plastic greenhouse) and 55 kg m^{-2} (Belgium, climatized glasshouse). (Castilla et al., 2004).

	Spain		Belgium	
Costs	**Euros m^{-2}**	**%**	**Euros m^{-2}**	**%**
Natural gas (heating + CO_2)	-		8.80	35.0
Salaries	0.92	46.0	10.91	43.4
Plant material	0.17	8.5	2.00	8.0
Fertilizers + Pests control	0.65	32.5	1.37	5.4
Water	0.13	6.5	-	
Others	0.13	6.5	2.06	8.2
Total	**2.00**	**100.0**	**25.14**	**100.0**

Technological Packages

There are diverse options available for the Spanish greenhouse industry. In the various "technological packages" there is a need for knowledge of crop response, not just technically but economically, to improve climate control (Baille, 2001) under the diverse growing conditions. As an example of the diverse options in the Spanish greenhouse industry, Table 3 presents the greenhouse structure construction costs in the south of Spain. The old *parral* type structure, with motorised lateral and roof vents and no other climate control, costs around 7.8 euros m^{-2}. The improved *parral* type greenhouse (higher roof slopes, motorised lateral and

Table 3. Average greenhouse structure construction costs in the south of Spain (taxes and price of the land are not included). Costs are calculated for 1 ha minimum area. Plastic film cladding is included (Castilla, 2005).

Greenhouse type (motorised lateral and roof ventilation included)	Euros m^{-2}
Low roof slope structure (old *parral* type)	7.8
High roof slope structure (new *parral* type, multispan)	10.2
Arched shaped multispan (multitunnel)	15.6

roof vents) construction cost is around 10.2 euros m^{-2} and the arched-roofed multispan reaches 15.6 euros m^{-2}.

As those structures are progressively equipped for better climate control, the total construction costs for the improved high roof slope (*parral* type) greenhouse is between 10.2 and 16.2 euros m^{-2} (Table 4). The arched shaped multispan greenhouse total construction cost varies from 15.6 to 38.1 euros m^{-2} (Table 5). The average extra investments for greenhouse growing (including soil clearing, levelling and preparation, the drip and soilless systems as well as the proportional parts for the water reservoir, building and electric costs) are around 9.8 euros m^{-2} (Castilla, 2005). Clearly, the technological level of the equipment should be chosen according to the greenhouse structure type.

Table 4. Structure and equipment costs for the high roof slope greenhouse (new *parral* type, motorised vents, Table 3) in southern Spain. (taxes and price of the land are not included). Costs are calculated for 1 ha minimum area. Computerised climate and fertigation controls are not included. (Castilla, 2005).

Costs	Euros m^{-2}
Structure	10.2
Fans (only mixing and removing)	1.2
Fogging system (low pressure)	1.8
Heating system (hot air)	3.0
Total	**16.2**

Table 5. Structure and equipment costs for the arched shaped multispan greenhouse (with motorised vents, Table 3) in southern Spain. Costs are calculated for 1 ha minimum area. Computerised climate and fertigation controls are not included (Castilla, 2005).

Costs	Euros m^{-2}
Structure	15.6
Fans (only mixing and removing)	1.2
Fogging system (high pressure)	5.0
Heating (steel tube and CO_2 injection)	11.3
Shading-thermal screen	5.0
Total	**38.1**

CONCLUSIONS

The strongest factor in the Spanish greenhouse industry is the conducive climate in its Mediterranean and Southern coastal area of the Peninsula and the Canary Islands. In addition, proximity to the European markets (as compared with other African Mediterranean countries), costs of production, and proper socio-economic conditions represent important opportunities for the Spanish greenhouse industry.

There are a number of production problems. In Almería, 76% of the growers consider plant protection the main problem, followed by the excessive humidity and temperature and poor ventilation. Growers appear to be more intent on increasing and mechanising the vent area than on installing heating and fogging systems (FIAPA, 2001). Low temperatures are considered a minor problem. The recent and very harmful frosts in 2005 will probably increase the grower interests on installing emergency heating systems. The limited resources and poor quality of irrigation water is another vexing problem. Production costs, product quality and environmental impact, as in other mild winter climate areas (La Malfa and Leonardi, 2001), appear to be the prevalent problems to solve in the Spanish greenhouse industry.

The globalisation of the markets has increased the competitiveness, highlighting the need for increased quality of the greenhouse produce, through better climate control. An economic compromise between the higher investment costs of better-equipped greenhouses and their agricultural performances is needed, in order to produce commodities of good quality at competitive levels (Castilla et al., 2004). The transportation costs to distant export markets limit the competitiveness of the produce with nearer production areas.

Grower education and training appear as a basic point, since the cultural level of the growers can be a limiting factor to improving the technological level of the greenhouses (Baille, 2001). Great effort is required to attain technical and economical knowledge concerning crop response in greenhouse technology. The demands of the market for healthy, safe and high quality products will be increasingly important in determining production strategies in the future. Quality and differentiation strategies are a clear priority for competitiveness.

Net-covered greenhouses can be of interest in areas or periods of low rainfall and very mild minimum temperatures. High-radiation-transmission nets are used.

The proximity of the sea contributes to the climatic stability of temperatures (Carchuna area, Granada). Photo by courtesy of Maldonado.

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Borlaug Leadership Enhancement Fellowships

The Borlaug Leadership Enhancement in Agriculture Program (LEAP) has been announced. This program, funded by the United States Agency for International Development (USAID), is designed to enhance the quality of thesis research of graduate students from developing countries who show strong promise as leaders in the field of agriculture and related disciplines. A secondary goal is to increase the interaction between US scientists and their CGIAR collaborators.

Awards will be made on a competitive basis to students from USAID eligible countries in sub-Saharan Africa who show strong scientific and leadership potential, have a well coordinated proposal between their home university, a US university mentor, and the CGIAR mentor, and whose research is related to a strong research and support project within the host country. Emphasis will be placed on work that has relevance to the national development of the student's home country. Details of the program are found on the LEAP website (http://leap.ucdavis.edu).

Horticulture in Eritrea[1]

Brhan Khiar Saleh

Eritrea, a new country which gained its independence from Ethiopia in 1991 after a bitter 30 year struggle, is situated in the horn of Africa, bordering the Red Sea to the East, Sudan to the West and North, Djibouti and Ethiopia to the South. The country covers an area of 124,000 km^2 and has a population of 3.56 million. Eritrea has a coastline of over 1000 km and is home to some of the world's finest marine life. The country is divided into six administrative zones.

In spite of its small size, Eritrea is divided into six main agro-climatic zones. Generally Eritrea has an arid and semi-arid climate. The altitude ranges from less than 100 m in the coastal plains up to 2400 m in the central highlands with small areas above that. In the Highlands, Western Escarpment and South Western Lowlands rainfall usually occurs during summer (June-September). Average annual rainfall in these areas ranges from 400 to 700 mm. In the Coastal Plains rainfall occurs during the winter months with an average of less than 200 mm per year. The Green Belt Zone is an exceptional area that enjoys high rainfall occurrence during the period November-March. Average annual rainfall in this zone exceeds 1000 mm.

AGRICULTURE

Almost 70-80% of the Eritrean population live in the rural areas and practice agricultural or related activities. Agricultural contribution to the gross domestic product (GDP) accounts for only about 16% and for about 20 to 30% of current exports. The agricultural sector has been hampered by the 30 year war for independence and recurrent drought. The predominant agricultural system is traditional subsistence farming, characterized by low input/output; poor water and soil conservation and management practices; low levels of technology; very low productivity; high rates of deforestation; and environmental degradation. From 1992 through 2002 the average area cultivated varied from 217,299 ha to 500,161 ha. Farming systems vary depending on the different agro-ecological zones. The systems are rain fed cereal/pulses, small scale irrigated horticulture, semi commercial preurban livestock, agro-pastoralist, nomadic pastoralist and irrigated commercial farming systems.

Rain Fed

The majority of the population is involved in rain fed crop and livestock systems. This system is the main source of stable crops such as cereals and pulses, and contributes relatively high-value animal foods. But over the past years, this system has been gradually losing diversity in most areas, particularly the highlands, leading to the threat of food insecurity. The average farms are less than 1 ha in the highlands and 2 ha in the lowlands. Traditional rain fed agriculture accounts for more than 90% of the crop land. Cereals cover some 80% of the rain fed areas. Sorghum is the most important crop followed by barley, wheat, tef, maize, and millets. Sesame is the main oil crop and chickpea is the leading pulse. Some horticultural crops such as potato and tomato are also produced under rain fed production system.

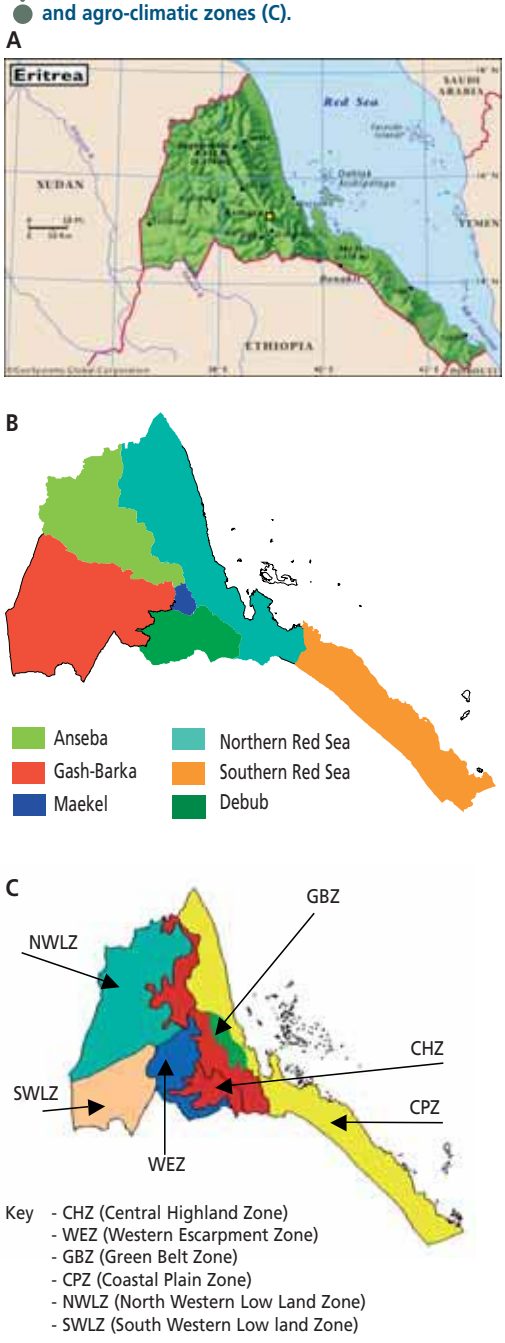
Irrigated

Irrigated systems are based on the seasonal rivers and underground aquifer reserves. Seasonal river water is either stored in small dams and ponds for irrigation or flooded into the fields by different flood diversion techniques. Underground aquifers reserves (borehole or surface wells) are the main source of water for perennial fruit crops and vegetable production. Commercial farms use surface and drip irrigation for high value crops, mainly banana, citrus, mango, papaya, onion, tomato, pepper, eggplant and okra. Because of the high local demand the subsector does not generate much marketable surplus. Imports are high, even in good crop years, and supply from one quarter to one half of demand.

Pastoral

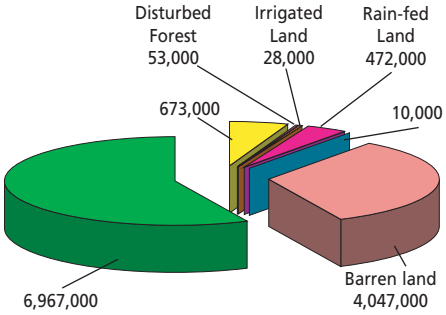
Pastoral systems thrive in the lowlands and ruminants represent cash assets through sale of male animals, while providing food in the form of milk and meat. The system has been under stress due to the shrinkage of grazing land and disease. Hand labor and oxen are the main source of power in Eritrea although there is an increasing use of tractors. Traditional animal production remains a major occupation in Eritrea. Livestock tend to be concentrated in the lowlands (60%). Animal resources serve as an important part of the national diet and provide raw materials to tanneries, dairies, and meat processing plants.

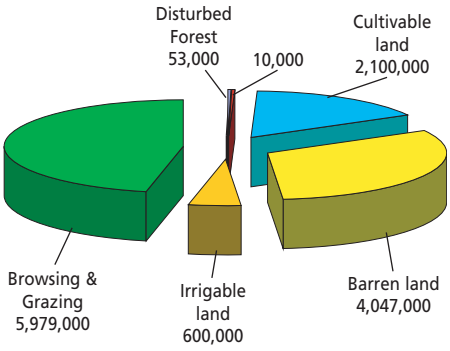
Map of Eritrea (A); administrative zones (B) and agro-climatic zones (C).



[1] Source: Nonpublished reports of Planning and Statistics Division, Ministry of Agriculture
National Agricultural Research Institute

Current (above) and potential (below) land use categories (ha).





Seasonal river that flows through the potential horticultural lands.

Drip irrigation unit with submersible pump at Afhimbol Farm, one of the newly established large scale horticultural farms.

Water storage in micro-dams for irrigation. (A) Elabered Farm, one of the most famous old horticulture and dairy large scale farms established by Italian investors. (B) Sawa Farm, one of the recently established large scale farms.

Different citrus species and cultivars at Halhale Research Station.

Williams banana from different farms in the Gash-Barka region.

Lettuce production for export at Elabered Farm. (A) Field covered with plastic mulch and (B) seedling production under plastic tunnel.

HORTICULTURE

Eritrean farmers have long practiced horticulture. However modern horticultural production was introduced during the Italian colonial period (1891-1941). From 1954 to 1960, immense lands were developed for horticultural production and many large commercial orchards and vegetable farms were established. Horticulture reached a peak in the 1960s and 1970s consisting of banana, citrus, sweet pepper, cucumber production for export to markets in the Middle East and to Europe. However, this sector was devastated by the 30 year conflict with Ethiopia (1961-1991), and is still affected by continued border conflicts.

After independence was achieved in 1991, horticultural development programs were launched including construction of dams and roads, establishment of irrigation schemes, support for farm equipment and inputs, and human resource development. The Ministry of Agriculture has been focused on training programs to improve human capacity-building. At present horticulture is divided between small holders but a number of large-scale farms have been established in recent years. In 2003 there were about 12,500 ha devoted to vegetables and 1000 ha to fruit trees. Production was estimated at 114 thousand tonnes for vegetables and 14 thousand tonnes for fruit with a value of US$ 20 million.

The horticultural sector is hampered by low capital and technology inputs; non-improved cultivars; poor cultural practices including land preparation, fertilization, weed control, irrigation, and pest and disease control; problems in postharvest handling and marketing; poor management practices; and recurring drought. Thus, production of most horticultural crops is below regional and world averages. Although Eritrea enjoys a range of climate zones that would permit the cultivation of a wide range of fruits, vegetables, flowers, herbs and medicinal plants, production has not yet satisfied the domestic markets. Yet with more than 600,000 ha of land with a potential for irrigation there is a huge potential for increased production and export to outside markets. At present only 28,000 ha are irrigated. With the importance of horticulture in increasing the health and welfare of the population and its potential for economic development, the horticultural subsector is considered as a priority area in the Eritrea development program.

Some of the fruit crop species that have potential in Eritrea. (A) Grape, (B) Avocado, (C) Annona, (D) Strawberry.

Seed potato field at Adi-Mengoti and harvest day at Maedo, Debub region.

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Maritsa Vegetable Crops Research Institute: 75 Years of Service

Stoika Masheva, Miroslav Michov, Galina Pevicharova and Dimitrina Kostova

Scientia Cum Praxis

Scientific Studies with Practical Application

Maritsa Institute, founded in 1930, has developed over the years as a leading center for vegetable research in Bulgaria. Combining scientific studies with practical application, the Institute has yielded remarkable successes in different fields including the development of vegetable hybrids, improvement and stabilizing of local forms and accessions to high-yielded and high-quality cultivars, and amelioration of vegetable growing technologies. Prominent researchers from Maritsa Institute have created close links to agricultural universities and educational institutions to transfer modern horticultural methods and knowledge. Looking forward to Bulgarian membership in the European Union, Maritsa Institute has developed fruitful collaborations with related institutions in member countries. The Institute will join the European Research Area focusing on transferring European knowledge and technology and to further develop the Maritsa Institute as a leader and promoter of Vegetable Crops Improvement Linkage for Bulgaria and the Balkans.

Maritsa Main Entrance House, built in 1960. It is surrounded by rare and valuable dendro species and comprises mainly administrative and library premises, some labs, and offices of researchers. The other Units are scattered in an Arboretrum, in smaller buildings.

INTRODUCTION

Historical Background

Bulgaria is a country with a long tradition in vegetable growing, due to favorable climatic conditions, as well as to the great diversity of vegetable forms and accessions with unique and desirable properties. For centuries, Bulgarian gardeners were well known in Europe, especially in the Danube regions of the Austrian Empire. Even today, fine restaurants in Vienna buy their fresh vegetables from the Bulgarian vegetable market. Together with other agricultural branches, vegetable growing made considerable progress in Bulgaria at the end of the 19th century, enriching local traditions with modern methods. However, it was realized that advances in modern agriculture could not be developed without science. As a result an Experimental Agricultural Station, mainly devoted to vegetables, was established in Plovdiv on 1st April 1930. The nucleus of the Station was built on the ground of a large private farm with excellent fertile soil. Later the Institute was named the Maritsa Vegetable Crops Research Institute, after the famous Maritsa river, the ancient Hebros, which rises from Rila Mountain, transverses the town of Plovdiv, and irrigates the province of Tracia, until it reaches the Aegean Sea. The first successes came soon. In 1932, Professor Hristo Daskalov and his research team carried out profound theoretical investigations on heterosis and released the first F1 tomato hybrids the same year. Due to its excellent quality, this hybrid remained in production for more than 30 years. Several years later heterosis breeding was applied successfully to eggplant, pepper, and cucumber. The Institute also played a significant role in elaborating the theoretical basis for hybrid seed production and its application into practice. At that time Bulgaria became a world leader in yield and total production of hybrid seeds. In 1950, total production was 10,000-12,000 kg of tomato hybrid seeds, with yields of 200-250 kg/ha. During this early stage, laboratories for quality control and technological analysis were established, striving to evaluate unique local germplasm collected from all over the country and preserved in the Institute.

In a period of 75 years more than 300 cultivars and F1 hybrids were created and widely spread throughout the country. Some of them, because of their valuable characteristics, were exploited in foreign breeding programs. Maritsa Institute also became famous as a pioneer of new technologies in vegetable production. The unique and traditional Bulgarian method for vegetable growing on "phytarion" (flat level areas surrounded by low dikes), was mechanized and adapted for bean, pea and later for processing tomato, red pepper, and potato. The Institute was also a pioneer in greenhouse vegetable production and constructed the first greenhouses for tomato and cucumber. Furthermore, the Institute developed the first plant tissue culture laboratory for potato and flower crops, established an international station for potato breeding and cultivar maintenance with German participation, elaborated technology for biological pest control, and utilized hydroponics systems for vegetable growing.

For years the Institute has been a coordinator of scientific research from several local experimental stations established on different climatic zones and soil types: in Negovan (on flowers and leaf vegetables), in Samokov and in Smolian (on potato), in Gorna Oriahovotsa (on onion and cucumber). Many leading scientists from Maritsa Institute are invited by the Agricultural University of Plovdiv as prominent lecturers and teachers to a new generations of horticulturists and agonomists in the fields of genetics, breeding, and agrotechnology. The research groups of the Institute are involved in international collaborations with corresponding institutions in The Netherlands, Italy, France, England, Spain, Germany, Hungary, Poland,

Czech Republic, countries of the former Yugoslavia, Russia, and Moldova.

Structure of the Institute

Maritsa Vegetable Crop Research Institute is a legal entity in Bulgaria, and a Member of the National Center for Agrarian Science (NCAN) under the Ministry of Agriculture and Forestry. It comprises two main Departments: (1) Breeding, Variety Maintenance, and Introduction and (2) Technology-for-Growing.

The people playing major roles in the Breeding Department are the breeders of the most important Bulgarian vegetables including tomato, pepper, cabbage, cucumber, potato, onion and garlic, bean and pea. Their research is supported by investigations carried out at seven laboratories that are included as separate units in the department and have long experience in different aspects of vegetables technology: Vegetable Fruit Quality, Virus Immunity, Plant Tissue Culture, Cyto-genetics, Molecular Investigation, Physiology, and Vegetable Processing.

For 75 years the Breeding Department has been a coordinator and executor in the creation and implementation of a large number of cultivars and F1 hybrids of the principal vegetable crops of Bulgaria. A great diversity of local and introduced forms and cultivars, breeding lines, and populations of wild species have been developed. Most of the local cultivars (Bulgaria is a secondary centre of origin for pepper, head cabbage, bean, and onion), have been stabilized and improved through the breeding programme of the Institute, distinguished by high nutritional value and organoleptic characteristics that make them competitive in the marketplace. The Department works with a rich gene pool from these crops, variable in their morphological and biological characters. There are 14 PhD scientific officers, including 6 senior members. In addition, there are 6 professors as associate members. The scientific staff of the Department has a long-standing experience in vegetable breeding, and has acquired considerable practice in managing projects, supported by the Bulgarian Ministry of Science and Education, and Ministry of Agriculture and Forestry. An international project on red pepper quality, developed by INCO-COPERNICUS 94, was successfully completed with participation of the pepper breeding team and Vegetable Fruit Quality Laboratory. There is an ongoing project, funded by the International Atomic Energy Agency (IAEA) in Vienna, on the induction and study of tomato and pepper mutants with high nutritive quality. The Breeding Department is also responsible for cultivar maintenance and seed preservation (gene bank).

The Technology-for-Growing Department comprises the following units: Agrotechnology, Plant Protection, Plant Nutrition, and Mechanization. The scientific staff includes 10 PhD officers, 6 of whom are senior, and an additional 3 professors as associate members. Great emphasis on investigations in the Plant Protection Unit is now being given to the development of sustainable control systems and crop protection strategies. The team of Plant Nutrition directs its efforts towards investigations on bio-products as alternative solutions to improve nutrient regime and plant growth. The team of Agrotechnology deals with the influence of the main environment factors on yield. The current research on mechanized technologies concerns analysis on input-output energy for growing vegetables in open and protected fields, in order to decrease the energy ratio. There is an on-going project on improvement of greenhouse crops production technology and efficiency, funded by FAO [TCP/BUL/3002(A)]. The Institute is also involved in organization of training and extension activities in the Vegetable Sector, part of the joint project, entitled *"Strengthening of fresh fruit and vegetable marketing quality standards control system"* (PPA/04/BG/9/1), funded by the Netherlands Ministry of Economy. A significant part of Maritsa research programs integrates the efforts of scientists from different structural Units of the Institute.

RESEARCH TOPICS

The priority investigations of the Institute comprise a number of topics as follows:

- Enhancement of vegetable quality by improving biological value (increasing the components with antioxidant effect), sensory characteristics, pest and disease resistance, high temperature and drought tolerance by the use of conventional and biotechnological breeding methods.
- Evaluation and exploitation of various vegetable germplasm, comprising local and introduced accessions, breeding lines, and cultivars.
- Improvement of integrating systems for pest control (pests, diseases, and weeds) in vegetables.
- Investigations on bio-products as alternative solutions to improve nutrient regime, plant growth and plant quality.
- The effect of environment factors on quality and quantity of the yield in protected and open field.

Tomato Program

The tomato breeding program is directed towards the creation of cultivars for early production and mid-season production for fresh consumption and for processing. As a result of a long lasting breeding program, the team works with valuable genetic materials, derived from interspecific hybridisation between *Lycopersicon esculentum* and wild species such as *L. pimpinellifolium*, *L. chilense*, *L. pennellii*, and *L. peruvianum*. These species possess complex resistance to pathogens such as

Promising tomato breeding line for fresh consumption.

Cladosporium fulvum, *Fusarium oxysporum* f.sp. *lycopersici*, *Leveillula taurica*, *Corynebacterium michiganense*, and *Verticillium dahliae*. A major emphasis is to create gene resources, combining high biological value with disease resistance to new races of economically important pathogens. As a result of crosses between *L. esculentum* and *L. chilense* indeterminate tomato lines were created by the joint efforts of tomato breeders and the Vegetable Fruit Quality Lab teams. Lines were divided into three types according to the concentration of β-carotene based on total pigmentation in the fruits: 80-90%, 50-60%, and about 30%. The fruits also possess comparatively high Vitamin C content reaching up to 57 mg per 100 g fresh tissue. A number of gene sources with high level of lycopene (over 10 mg per 100 g) were created at the Tissue Culture Laboratory as a result of in vitro callus treatment with sublethal doses of gamma rays Co^{60}. In the same laboratory effective procedures were developed for micropropagation, callusogenesis, organogenesis, and regeneration of valuable breeding lines, cultivars, and F1 tomato hybrids. Tomato hybrid forms and stable lines between *L. esculentum* and *L. peruvianum* and *L. pennellii* were created, as a result of embryo rescue technology. A system was developed for in vitro selection of tomato forms tolerant to the fungal pathogen *Alternaria solani* using its culture filtrates. In the last two years a successful method was developed for genetic transformation by *Agro-*

bacterium tumefaciens that resulted in the creation of transformed tomato lines with heavy metal tolerance. At the Virus Immunity Laboratory, the most promising lines with high biological value are tested for *Tomato mosaic virus (ToMV)* and *Cucumber mosaic virus (CMV)* resistance. A large part of the tomato breeding materials for fresh consumption and processing are assessed for their chemico-technological and sensory properties at the Vegetable Fruit Quality and Processing Laboratories. The genetic diversity of the exploited materials of tomato is characterized and identified at the Molecular Genetics Lab using molecular markers.

The aims of a joint program with the Cytogenetics Laboratory are to incorporate a male-sterile gene in valuable breeding lines and cultivars as well as to investigate the expression of dominance and recessiveness responsible for fertility and sterility in hybrids and backcross progenies. Incomplete dominance and lethality were expressed in some of the homozygous genotypes. To prevent flower abortion in winter and early spring, some substances that influence earliness and yield were licensed from the Physiology Laboratory.

A comprehensive system of soil and substrate analysis was elaborated at the Plant Nutrition Laboratory in order to diagnose soil and substrates nutrient status. Monitoring nutrient needs of tomato grown as soil and soil-less culture is carried out in order to recommend the optimal norms for fertilization. Relationships are established between the nutrient levels and the quality of the production. In collaboration with the Plant Protection Unit the impact of vesicular mycorrhizae (VAM) fungi is being investigated on the growth, development, and productivity of tomato as well as the use of biological agents against soil-borne pathogens and root-knot nematodes as an alternative to methyl bromide as a treatment for soil disinfection in greenhouses.

Biomethods are being improved by searching for new biological agents. Several entomopathogenic fungi (*Aschersonia* sp., *Verticillium lecanii*), parasites (*Encarsia formosa*, *Aphidius matricariae*, *A. ervi*) and predators (*Phytoseiulus persimilis*, *Macrolophus costalis*, *M. nubilis*, and *Amblyseius* sp., *Orius niger*) are used as bioregulators to ameliorate the density of economically important pests on tomato: *Trialeurodes vaporariorum*, *Myzus persicae*, *Aphis nasturtii*, *A. gossypii*, *Thrips tabaci*, and *Frankliniella occidentalis*. The antagonistic activity of *Trichoderma* sp., *Gliocladium* and *Enterobacter cloaceae* is investigated. Procedures are elaborated for control of soil-borne and aerogenic fungal pathogens.

Pepper Program

In the course of over 70 years, a great diversity of genetic materials has been created and maintained, mainly based on unique local forms, typical for the region of Bulgaria. They were improved by the methods of conventional breeding. Some of these local cultivars, due to their valuable characteristics, are still in production and are also initial materials for creation of new cultivars, responding to contemporary requirements. At present, the pepper breeding team disposes with a valuable collection of over 500 local and introduced accessions.

Pepper seed production.

Contemporary breeding program is focused on the creation of green and red fruited types as well as pepper for grinding (paprika). The breeding program for "green pepper" and "red pepper" emphasizes the creation of lines and cultivars with high biological value (mainly on ascorbic acid content, over 120 mg per 100 g for green and over 200 mg for red) as well as on good sensory properties. The desired characteristics for fresh consumption are crispness, succulence, freshness and non-pungency and for processing (for baked, canned, and for juices) are easy peeling, fleshy pericarp and intensive red color. Attention is paid also to variable nuances of green (light yellow to dark green) and red (light orange to dark red) colors and to various shapes: oblate, edged, bell, blocky, conical tapered, kapia, and slender type.

The objectives of the paprika breeding program is earliness and uniformity in ripeness as well as enhancement of quality and quantity of total pigments and their long storage. Red pepper lines with over 300 ASTA units are now established. One of the breeding directions is to search or create forms with stable pigment content after frost.

At the Plant Tissue Culture Laboratory, procedures are optimised for obtaining haploids in anther culture, derived from local cultivars of *Capsicum annuum*. These procedures will be used for species conservation, maintenance, and creation of homozygous lines. Also effective procedures for micropropagation, callusogenesis, organogenesis, and regeneration of valuable forms, lines, cultivars and F1 hybrids are developed.

The investigations at the Virus Immunity Laboratory are focused on strain variability of the most spread viruses on pepper in Bulgaria: *Tobacco mosaic virus (TMV)* and *Cucumber mosaic virus (CMV)*. Recently *Pepper mild mottle virus (PMMV)* and *Eggplant mottle dwarf virus (EMDV)* were discovered in greenhouse pepper during a collaborative programme with the Plant Virology Institute in Torino, Italy. One of the aims of the team is to introduce TMV resistance in several traditional pepper cultivars. Breeding lines and hybrids have been created, resistant to *Verticillium dahliae* and *Phytophthora capsici*, thanks to a joint programme with Plant Protection Unit. An important aim of the breeding team is to create male sterile analogues of the most spread commercial pepper cultivars in order to be used in a hybrid programme. The requirements of new pepper cultivars to environmental factors are investigated with the Agrotechnology Unit in order to assess their suitability for different growing regions.

Cucumber Program

The cucumber breeding program deals with all types of cucumber species such as long European type, American slicers, mini and pickling cucumbers. A great number of F1 hybrids of top performance have been created,

Green pepper variety for fresh consumption.

most of them with predominantly gynoecious flowering habit, parthenocarpic fruits with dark green to green color, smooth to slightly rubbed surface, tolerant to *Sphaerotheca fuliginea*. Several slicer F1 hybrid types used as the seed parent combine CMV tolerance and predominantly gynoecious flowering habit combined with the excellent taste and flavor of wide spread monoecious cultivars, used as the pollen parent.

As a result of collaboration between the Virus Immunity Laboratory and Plant Virology Torino, a cucumber virus was identified as a new putative tombusvirus species provisionally named *Cucumber Bulgarian latent virus (CBLV)*. Also, *EMDV* on cucumbers is announced for the first time in Bulgaria.

For the creation of breeding materials with complete homozygosis in respect to some valuable characters, haploid cucumber plants were produced with the joint efforts of Department of Plant Genetics, Breeding and Biotechnology at Warsaw Agricultural University, Poland and the Cytogenetics Laboratory. Embryos were induced by gynogenesis and cultured in vitro. The subsequent cytological analysis determined them as monohaploids. Several doubled haploids and genome chimeras were obtained by colchicine treatment. Interspecific hybrids were created in vivo between *C. sativus* and *C. melo* var. *agrestis* subsp. *sikimensis* to increase genetic diversity. The Physiology Laboratory licenses several complex substances that induce male flowers in gynoecious lines, necessary for their reproduction as parents in hybrid programmes.

The intensive breeding program matches up with continuous new demands in term of disease resistances. A new trend of the current plan is to combine the CMV resistance with resistance to *Sphaerotheca fuliginea* and *Pseudoperonospora cubensis*. The team disposes with lines, possessing complex resistance to these three pathogens.

Cabbage Program

Bulgaria appears to be a second center of origin for *Brassica oleraceae* var. *capitata* (heading cabbage). Cultivars developed at the Institute possess unique taste characteristics, appropriate for fresh consumption and processing. Two cultivars, 'Kiose' and 'Balkan', derived from a local accession, were widely used for years for fresh use and for kraut. 'Besapara' is the only cultivar in Bulgaria for early spring production by autumn planting.

The objectives of the breeding program are to release early white cabbage cultivars for spring sowing and broccoli with high ascorbic acid content and resistant to hollow stem. Collaboration programmes with the Plant Tissue Culture and Cytogenetics Laboratories strives to increase the genetic diversity in heading cabbage using in vivo and in vitro mutagenesis mainly to separate male sterile forms. Also procedures are optimised for obtaining haploids in anther culture.

As a result of several years screening of valuable gene sources from *Brassica oleracea* var. *capitata*, var. *sabauda* and var. *italica*, the breeding team has created several breeding lines resistant to *Peronospora parasitica*. Current investigations are dealing with complex resistance towards three pathogens: *P. parasitica*, *Alternaria brassicicola*, and *Xanthomonas campestris* pv. *campestris*. Tests conducted with entomologists from the Plant Protection Unit revealed resistance to *Breyicorine brassicae* in white cabbage. Search for resistance to *Mamestra brassicae*, *Pieris brassicae* and *Pieris rapae* is an aim of the team. A project with the Agrotechnology Unit deals with the introduction of organic farming systems appropriate for Bulgarian cultivars of white cabbages.

Bean Program

Phaseolus bean cultivars of the Maritsa Institute carry the genetic background of valuable local forms and accessions. They are oriented mainly for two directions: fresh consumption and processing. Most of the cultivars are bush type, with oval or cylindrical, stringless, straight and smooth skinned pods, with dark green, light medium green or yellow color, resistant to *Pseudomonas phaseolicola* and bean common mosaic virus (BCMV). Recently, some cultivars were released for home gardeners with runner growth habit, flat pods and superb bean flavor.

Serious obstacles for bean production are virus diseases. A breeding programme for virus resistance is carried out together with the Virus Immunity Laboratory to investigate virus variability and create resistant gene resources. The team develops breeding lines and cultivars resistant to CMV, temperature dependent necrotic strains of *Bean common mosaic virus (BCMV)* as well as to *Bean common mosaic necrosis virus (BCMNV)*. A collaboration program with the Vegetable Fruit Quality Laboratory is to release breeding lines, combining viral and bacterial resistance with good sensory characteristics.

The Cytogenetics and Physiology Laboratories developed a procedure, based on gamete selection, for obtaining high temperature-tolerant genotypes in bean. Polyploids were induced in *P. vulgaris*, *P. coccineus*, and *P. acutifolius* to obtain fertile amphidiploids from interspecific hybrids in *Phaseolus*.

The collaboration program between the bean breeder and the entomologists from the Plant Protection Unit aims to investigate the level of susceptibility toward *Acanthoscelides obtectus* in different accessions and cultivars of *P. vulgaris*. A number of lines have been identified that possess pest tolerance. The effectiveness of various phytopesticides applied against bean weevil in open field is under investigation.

Pea Program

Pea cultivars of *Pisum sativum* created at Maritsa Institute are wide spread in Bulgaria. They satisfied the needs for early, mid-early and late production of peas mainly for canning and freezing. Most of the cultivars are wrinkle-seeded, The new tendencies at the breeding programme concern the development of super early cultivars, uniform ripeness, multipoded, with increased number of peas; resistance to the most spread viruses; and tolerance to high temperature and drought. Models for sensory evaluation of various breeding materials, adapted to various uses, are carried out at the Vegetable Fruit Quality Laboratory.

Onion Program

Since Bulgaria is considered a secondary center of origin for onion, most of the cultivars created in the Institute possess valuable characters from local accessions and forms. They are distinguished by good keeping quality due to firm, tightly adhering skin and thin neck; by attractive yellow-brown to light brown color; by varibility in shape from globular to slightly flattened globe; for growing by direct seeding or by sets.

The Institute has significant achievements in hybrid breeding and hybrid seed production in onion. The present breeding program is focused on creating male-sterile lines and their maintainers, with strong pungent to sweet taste. Attention is paid on lines with white colored

Onion seed production.

bulbs and high dry matter content, suitable for dried onion production, as well as on gene resources, resistant to *Botrytis* sp.

Potato Program

Bulgaria is at the border area of optimal conditions for potato growing. The most important limiting factor for potato production is aphids as virus vectors causing degeneration of seed potatoes. In this respect the Institute is a pioneer in elaborating a strategic breeding program in the 1960s for the creation of virus-resistant cultivars and technology for virus-free seed production.

Genes for virus resistance were transferred from different wild species such as *Solanum acaule*, *S. demissum*, *S. sisimbrifolium*, *S. chacoense*, *S. stoloniferum* to *S. tuberosum* materials. Valuable breeding lines and cultivars ('Iverze' and 'Nadejda 25') were created with high productivity, earliness and good organoleptic properties. In order to increase the genetic diversity and to create initial materials with complex immunity to virus diseases and late blight (*Phytophthora infestans*) an International Station was founded in Rodopa Mountain with Bulgarian and German collaboration. A network for virus-free seed production was elaborated and consisted of a tissue culture laboratory for virus free initial materials, insect-proof greenhouses and high land farms with low aphid infestation.

Regeneration in callus culture of potato.

The current potato program places special emphasis upon introducing resistance to cyst nematodes (*Globodera rostochiensis*) in valuable and widely used cultivars. The Plant Tissue Culture Labatory uses experimental mutagenesis to increase genetic diversity, mainly to separate early forms. Serious damage to potato production due to climate changes impose a new trend in the breeding program: creation of breeding lines and cultivars tolerant to high temperature and drought. This program is a collaboration of the Physiology and Cytogenetics Laboratories. The potato team is currently working on the creation of specialized cultivars for boiled potatoes and puree, French fries and chips, in order to respond to the new requirements of the processing industry in Bulgaria. To ameliorate and to increase the quality and quantity of yield from early potatoes, the Agrotechnology Unit is researching the application of nonwoven plant covers.

PROSPECTS FOR FUTURE RESEARCH

Because of the forthcoming membership of Bulgaria in the European Union there are several important research objectives for future research.

- Transfer the recent achievements of European knowledge in the field of plant genetics, fruit quality, integrated pest management (IPM) to Bulgaria. This will be achieved by courses, conducted by prominent European lecturers and by short-term visits of young PhD students and researchers of the Institute to European Institutes.
- Develop Maritsa Institute as a promoter of Vegetable Crops Improvement Linkage (VCI Inner Linkage and VCI Balkan Linkage) in order to integrate research and researchers in Bulgaria and in the Balkan region.
- Create motivated young researchers, disseminate the scientific information and results, and facilitate communication and collaboration between Balkan countries with similar scientific interests in the field of vegetable science.

One of the contributions of the VCI Inner Linkage will be the elaboration of strategy for Bulgarian vegetable science that will be relevant to Europe. The Inner Linkage will also be exploited as a social instrument for elaboration and diffusion of technology and knowledge transfer programme for farmers, seed producers, and processors. The most important achievement of VCI Balkan Linkage will be to bring in contact scientists from the Balkan region in order to join their research efforts for creation of high quality vegetable technology, based on existing germplasm. Wide range of local germplasm, possessed by Institutes in this region, will be exchanged offering new qualities and traits for investigations.

CONTACT

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New Books, Websites

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

BOOK REVIEWS

Litchi and Longan: Botany, Cultivation and Uses. C. Menzel and G.K. Waite (eds.). 2005. CABI Publishing, Wallingford, UK. 336p. ISBN 0-85199-696-5 (hardback). £75.00 / $140.00. www.cabi-publishing.org

This book fills a gap in providing a comprehensive review of two important sapindaceous fruits. Each of the 14 chapters is written by individuals who are well-known for their lichi and longan research. The editors themselves have made significant contributions to our knowledge of these two crops.

The first chapter provides an excellent introduction on the origin, history, production and processing. It may have been preferable if there had been a separate chapter on processing. The introduction is followed by chapters on Taxonomy, Botany and Plant Development; Propagation; Biotechnology; Cultivars and Plant Improvement; Flowering; Fruit Set, Development and Maturation; Fruit Disorders; Photosynthesis and Productivity; Plant Water Relations and Irrigation; Plant Nutrition and Fertilizing; Pests; Diseases; and Harvesting and Storage.

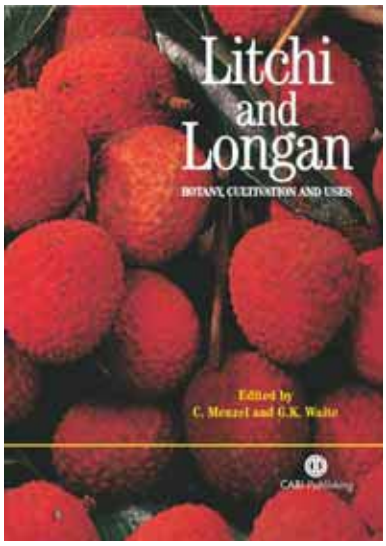
The biotechnology chapter provides a very useful introduction to this area as applied to litchi and longan. This chapter complements the cultivars and plant improvement chapter and thoroughly deals with this complex subject. The flowering chapter could have developed more fully the role of chlorate in longan flowering. Chlorate, a nitrate reductase inhibitor, was recognized for its role of inducing longan flowering from the work in Taiwan using gunpowder.

The fruit set, development and maturation chapter gives an excellent review of embryology and fruit growth. The physiology and the role of growth regulators in fruit development are reviewed in detail. This chapter provides access to literature from China in a succinct form. The limitations of our knowledge of longan fruit growth and development is evidenced by the short review in this chapter.

The photosynthesis and productivity chapter covers canopy photosynthesis to vegetative production and productivity. Pruning is discussed in relation to productivity, a crucial component in minimizing alternate bearing. This is followed by an integrated review of plant water relations and irrigation, and plant nutrition and fertilizing.

Pests and diseases are covered fully in two chapters. The final chapter deals with harvesting and storage. A discussion on preharvest factors on postharvest quality would be a useful addition.

This book is an excellent source book for all those involved in litchi and longan research and production. Those with special interest in these two crops will find this a very fine addition to their personal libraries.



Reviewed by Prof. Robert E. Paull, University of Hawaii, Manoa, Honolulu, HI, USA

El Cultivo del Olivo (Olive Tree Cultivation). 5th Edition. D. Barranco, R. Fernández-Escobar and L. Rallo (eds.). 2004. Junta de Andalucia Consejeria de Agricultura y Pesca and Mundi Prensa Libros S.A. 800p. ISBN 84-8476-190-8 (Mundi-Prensa). € 52,00.

Variedades de Olivo en España (Olive Varieties in Spain). L. Rallo, D. Barranco, J.M. Caballero, C. Del Río, A. Martín, J. Tous and I. Trujillo (eds.). 2004. Junta de Andalucia Consejeria de Agricultura y Pesca, Ministerio de Agricultura Pesca y Alimentación and Mundi Prensa Libros S.A. 478p. ISBN 84-8476-192-4 (Mundi-Prensa). € 75,00.

These two recent books from Spain review much of the current Spanish research concerning olive growing and olive varieties. Both follow a similar format, with overall scientific coordination and editing of chapters written by experts in each area. Spain, the world's largest olive producer, has a long tradition of olive cultivation both for oil and table use. Also, although Spanish horticultural research has gained momentum relatively recently, much of it is dedicated to this crop and has produced extensive and valuable information.

El Cultivo del Olivo (Olive Tree Cultivation) contains 20 chapters dedicated to a full range of aspects of cultivation and production. These include economic trends, physiology, cultivars, propagation methods, orchard design and management, irrigation, mechanical harvest, pests and diseases, and olive oil and table olive processing. The first edition was published in 1996, and has been followed successively by revised and updated versions, of which the current is the fifth edition.

Variedades de Olivo en España (Olive Varieties in Spain) contains a brief history of olive cultivars and cultivation in Spain and then is divided into three major sections: (1) Systematic Pomology of the Spanish Cultivars; (2) Variability and Selection and (3) Breeding and Molecular Biology. Each section is edited by a different group of authors, but all are coordinated by the participation of L. Rallo. Of particular note are the beautiful photographs and morphological descriptions of the principal, secondary and minor Spanish cultivars presented as a monograph in the first section.

Both books contain extensive and valuable information about olive cultivation and cultivars. The writing and presentation are of general high quality with some of the usual variability common to edited books by multiple authors. The contents are clearly centered on Spanish olive cultivars, production systems and research, but, apart from the fact that Spanish olive production has much to offer, individual chapters contain ample international bibliographies. Although written in Spanish, non-Spanish-speaking readers may also obtain plentiful information due to the clear, organized formats and the many photographs, tables and figures.

Reviewed by Hava Rapoport, Instituto de Agricultura Sostenible, C.S.I.C., Córdoba, Spain

Il Pesco: Moderni Indirizzi di Allevamento, Coltivazione, Difesa, Irrigazione, Nutrizione, Conservazione, Trasformazione e Mercato. (The Peach: Modern Address on Training, Culture, Irrigation, Nutrition, Postharvest, Industrial Processing and

Market). C. Fideghelli and S. Sansavini (eds.). 2005. Edagricole, Via Goito 13, Bologna, Italy. 259p. ISBN 88-506-4961-4. € 54.00 (15% discount for ISHS members).

This is an excellent compendium that presents the state of the art of peach culture technology. It offers a wide range of updated information that permits the integration of knowledge and the understanding of a modern industrial peach orchard to growers, technicians, and pomologists. The work consists of 11 chapters developed by 20 Italian authors known world wide by their expertise in each of the subjects treated. It is well conceived and well edited. Each chapter includes a number of excellent color plates. Edagricole continues with a long tradition of providing topical books for horticulturists and this volume is an excellent addition to this collection. Even though written in Italian, the book is easy to read for those who speak Romance languages, yet not fluent in the language of Dante Alighieri

Reviewed by Rodrigo Infante, Universidad de Chile, Chile

NEW TITLES

Ashraf, Muhammad and Harris, John Charles (eds.). 2005. Abiotic Stresses. Plant Resistance through Breeding and Molecular Approaches. Food Products Press, The Haworth Press, Inc., New York. xx + 725p. ISBN 1-56022-964-0 (hardback). $129.95. ISBN 1-56022-965-9 (paperback). $89.95. www.haworthpress.com

Barney, Danny L. and Hummer, Kim E. 2005. Currants, Gooseberries, and Jostaberries. A Guide for Growers, Marketers, and Researchers in North America. Food Products Press, The Haworth Press, Inc., New York. xiv + 266p. ISBN 1-56022-296-5 (hardback). $59.95. ISBN 1-56022-297-2 (paperback). $34.95. www.haworthpress.com

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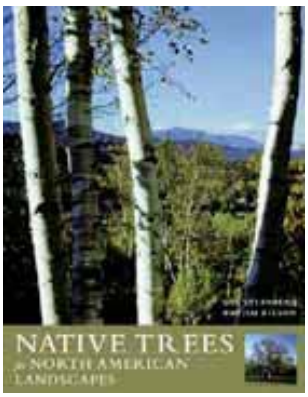
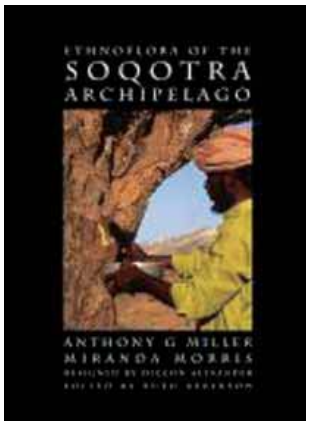
COUNCIL ON BOTANICAL AND HORTICULTURAL LIBRARIES AWARDS

The Council on Botanical and Horticultural Libraries (CBHL), Inc., an international organization devoted to the development, maintenance, and use of libraries, has announced the winners of their 2005 Annual Literature Award. Honored with the CBHL 2005 Annual Literature Award in the General Interest category was "Native Trees for North American Landscapes" by Guy Sternberg and Jim Wilson (Timber Press, Portland, OR, 2004). "Ethnoflora of the Soqotra Archipelago" by Anthony G. Miller and Miranda Morris (Royal Botanic Garden Edinburgh, Portland, OR, 2004) received the CBHL 2005 Annual Literature Award in the Technical category. Previous winners include "Gardens and Historic Plants of the Antebellum South", by James R. Cothran (University of South Carolina Press, Columbia, SC, 2003) for the General Interest category (2004) and "Slipper Orchids of Vietnam", by Leonid Averyanov, Phillip Cribb, Phan Ke Loc and Nguyen Tien Hiep (Timber Press, Portland, OR, 2003; Royal Botanic Gardens Kew, Kew, UK, 2003) for the Technical category (2004).

For more information consult the CBHL website, www.cbhl.net.





Courses and Meetings

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

IFS Annual Conference and Dahlia Greidinger Symposium 2005. Efficient Crop Nutrition: Challenges and Prospects, 14-16 December 2005, Cambridge, UK. Info: The Conference Office, The International Fertiliser Society, PO Box 4, York, YO32 5YS, United Kingdom, Phone and Fax: +44 (0)1904 492 700, email: secretary@fertiliser-society.org, web: http://www.fertiliser-society.org

Greenhouse Crop Production and Engineering Design Short Course, 15-18 January 2006, Tucson, Arizona, USA. Info: Priscilla Files or Jennifer Nelkin, Phone: (520) 626-9566, Fax: (520) 626-1700, email: pfiles@ag.arizona.edu or nelkin@email.arizona.edu, web: http://ag.arizona.edu/ceac

Growers Marketing Forum: Farm to Fork (GMF3), 18-20 January 2006, Tucson, Arizona, USA. Info: Priscilla Files or Jennifer Nelkin, Phone: (520) 626-9566, Fax: (520) 626-1700, email: pfiles@ag.arizona.edu or nelkin@email.arizona.edu, web: http://ag.arizona.edu/ceac

Haploids in Higher Plants III, 12-15 February 2006, Vienna, Austria. Info: Alisher Touraev, Vienna University, Department of Genetics, Phone: +431427754681, Fax: +43142779546, email: haploids2006.genetik@univie.ac.at, web: http://www.univie.ac.at/gem/conference/haploids/

First International Meeting on Cassava Plant Breeding and Biotechnology, 1-5 December 2006, Brasilia, Brazil. Info: Prof. Nagib Nassar, Univ. of Brasilia, email: nagnassa@rudah.com.br, web: http://www.geneconserve.pro.br/meeting/

International Horticultural Exposition for His Majesty the King or "Royal Flora 2006", 1 November 2006 - 31 January 2007, Chiang Mai, Thailand. Devoted to the 60th Anniversary of His Majesty the King of Thailand's Accession to the Throne on 5 May 2006 and His Majesty's 80th Birthday Anniversary on 5 December 2007. Info: Miss Wandee Chotpitakkul, Reed Tradex Co., Ltd., Phone: + 66 2636 7272 Extension 163, Fax: + 66 2636 7282, email: royalflora@reedtradex.co.th

Opportunities

Postdoctoral Fellow - Plant Molecular Virology and Genetics, AVRDC headquarters, Taiwan

Molecular Plant Breeder, AVRDC headquarters, Taiwan

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

Symposia and Workshops

First Int'l Symposium on Natural Preservatives in Food Systems

The First International Symposium on Natural Preservatives in Food Systems, held in Princeton, New Jersey, USA, March 30-31, 2005, was organized by Bakto Flavors, LLC and sponsored by Rutgers - the State University of New Jersey and the International Society for Horticultural Science (ISHS). Dr. Daphna Havkin-Frenkel organized and convened the Symposium. Dr. Chaim Frenkel, Rutgers University, and Dr. Nativ Dudai, ARO, Agricultural Research Organization, Israel, served as members of the Organizing Committee.

Dr. Daphna Havkin-Frenkel introducing Dr. George Burdock.

In the opening remarks Dr. Richard Zimmerman, ISHS representative, welcomed the conferees and outlined the scope of ISHS involvements in international meetings and emphasized the interest in Natural Preservatives. In the following remarks, Dr. Jozef Kokini, Chair of Food Science Department at Rutgers University, expressed gratification for the involvement in and sponsorship of the meeting by Rutgers University.

Around 100 participants arrived from the US, Europe, South Korea, Japan, China, Australia and other countries. The congress carried 20 oral presentations, 9 poster boards as well as a workshop on Antioxidant Measurements and on Methods for Antimicrobial Activity.

The meeting focused on two main themes, namely, Natural Antioxidants, and Natural Antimicrobials. Speakers discussed the prevalence, biological activity and application of natural preservatives to food systems.

In a plenary session Dr. Elizabeth Sloan, President Sloan Trends, Inc., assessed trends in the use of natural foods, indicating a significant and strongly growing preference, among varied consumer groups in the US, for the use of natural foods, including natural preservatives and, furthermore, that this phenomenon is in accord with consumer preference in Europe and other global regions. Thus, a fundamental economic rationale is emerging for the use of natural preservatives in food systems.

Dr. Richard Dixon, Samuel Robert Noble Foundation, Oklahoma, USA, discussed the occurrence and future prospects of engineering

New Jersey grown cranberry fruit ready for harvest. Cranberry fruit is praised for a high content of flavonoids, iso-flavonoids and other health promoting phytochemicals.

isoflavonoids in plant tissues for human health. Nicholi Vorsa, Rutgers University, indicated that abundance of flavonoids, including isoflavonoid in blueberry and related berry crops represent an important source of health promoting compounds as well as antimicrobials, antioxidants.

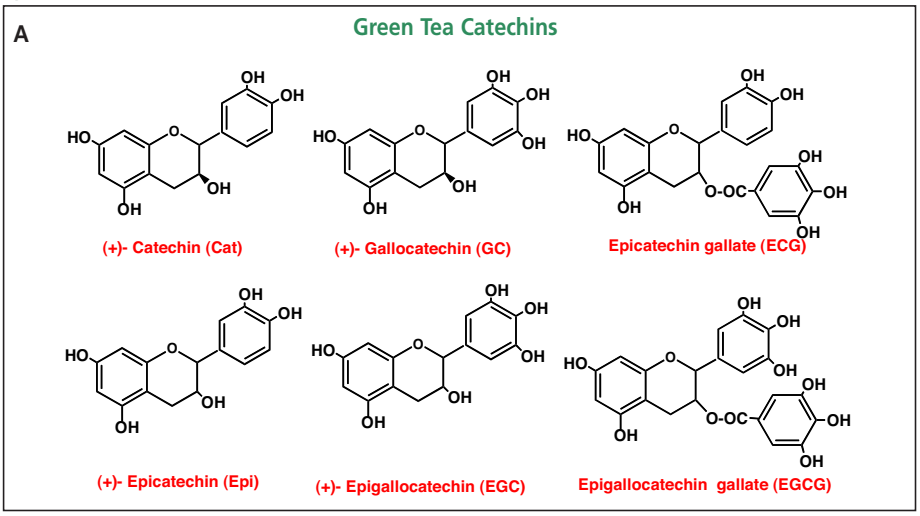
The molecular basis for antioxidant efficacy of flavonoids and other phenolic compounds was clarified by Dr. Karen Schaich and Dr. Chi-Tang Ho, Rutgers University, who argued that resonance structures in aromatic compounds serve to stabilize captured free radicals. Though the antioxidant value of phytochemicals, flavonoids or other phenolic compounds is widely recognized, the utilization of these natural reagents, in the context of a food system, may not be straight forward. Accordingly, Dr. Edwin Frankel, University of California, Davis, California, USA, and Karen Schaich, Rutgers University, pointed out the need for relevant and standardized measurement of natural antioxidant efficacy, particularly as it might be influenced by the microenvironment in different foods.

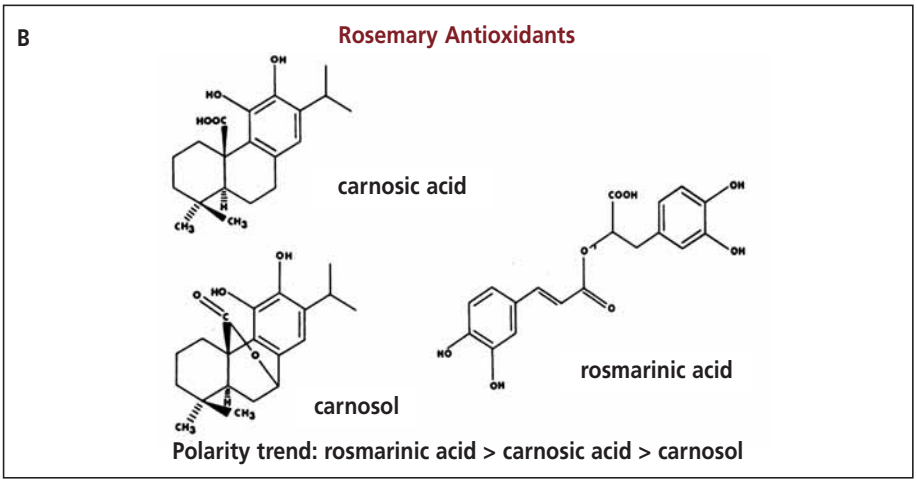
Cathy Dorko, Denisco, USA, outlined an industrial perspective on the manufacturing and application of antioxidants to food systems. John Finley, A.M. Todd, Pennsylvania, USA, discussed the health benefits of naturally occurring antioxidants in fresh produce and strategies to supplement foods with these compounds when there is consumer resistance to the consumption of fruits and vegetables.

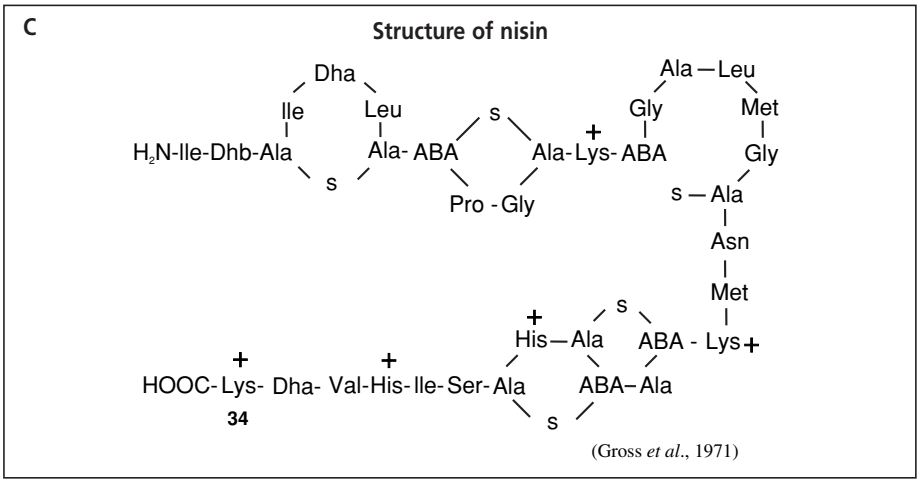
Dr. Michael Davidson, University of Tennessee, USA, opened the session on natural antimicrobials. He indicated the occurrence of antimicrobials in plants, animals, microorganisms and from mineral source, indicating also their potential application to foods. Dr. Thomas Montville and Dr. Michael Chikindas, Rutgers University, provided an interesting aspect of this theme in a discussion on the emergence of new pathogens and lactic acid bacteria as source of some important antimicrobials.

Practical aspects of antimicrobials selection and application were discussed by Lynn Silver, LL Silver Consulting, NJ, USA, who emphasized

A. Catechins, known for their antioxidant and health promoting properties, found in green tea. B. Carnosic acid, carnosol and rosmarinic acid are major antioxidants found in rosemary plants. C. Structure of nicin, a naturally occurring anti-microbial compound in microorganisms.







the need for new technologies and approaches to overcome persisting problems in detection, de-replication and toxicity of new antimicrobials. Dr. Per V. Nielsen, Technical University of Denmark, presented new technologies for releasing antimicrobials onto packaged foods from packaging film. In a similar vein, Stanley Sacharow, the Packaging Group, Inc., East Brunswick, NJ, USA, elaborated further on the rationale for the use of packaging technology for food preservation.

The importance of essential oils as another source of plant natural preservatives and usefulness of the compounds as important source of antimicrobials and antioxidants for the preservation of foods and animal feed was outli-

An example of selection line of Organum rich in carvacrol, a potent antioxidant.

Peppermint, grown in Israel for high antioxidant content.

ned by Dr. Katja Svoboda and Dr. John Brooker, Scottish Agricultural College, Scotland, UK. Dr. Samir Droby, ARO, the Agricultural Research Organization, Israel, described the use of these compounds for the preservation of fresh fruits and vegetables. Strategy for selection and field production of carvacrol-rich essential oil from Oregano was described by Hans van der Mheen, Applied Plant Research, and Hans Jensema, Ropapharm, The Netherlands.

The overall issue of safety and approval for consumption of ingredients from natural sources was reviewed by Dr. George Burdock, Burdock Associates, DC, USA.

A strong attendance in and strong endorsement for a conference, the first of a kind, led to a decision to stage the Second International Symposium on Natural Preservatives for Food, Feed and Cosmetics in Amsterdam, The Nederlands, in 2006.

Chaim Frenkel

Contact

Prof. Chaim Frenkel, Department of Plant Biology and Pathology, Cook College, Rutgers - The State University of New Jersey, New Brunswick, NJ 08901-8520, USA

Section Nuts and Mediterranean Climate Fruits

Fifth Int'l Symposium on Olive Growing

Participants of the Symposium.

Olive Culture is a Working Group of the ISHS Section Nuts and Mediterranean Climate Fruits. The First Olive Symposium was held in Spain (1989). The second, third and fourth symposia were organized in Israel (1993), Greece (1997) and Italy (2000).

The 5th International Symposium on Olive Growing was organized by Ankara University, Turkish Society for Horticultural Science, Bornova Olive Research Institute, and National Olive and Olive Oil Council (UZZK) and was held in Izmir Crowne Plaza Hotel, Turkey, from 27 September until 2 October 2004. During the opening ceremony Prof. U. Aksoy, Chairperson of the Horticultural Department of Ege University and ISHS Board Member, Prof. A. Tanrisever, Chairperson of the Turkish Society for Horticultural Science, and Ms. D. Atac, Chairperson of the Aegean Exporters Union delivered speeches about the related societies, the symposium and the olive. Prof. S. Lavee, a senior member of the Executive Committee of the ISHS Working Group on Olive Culture, read the letter of Prof. C. Vitagliano, convener of the previous (fourth) symposium, who could not attend for his serious health problem. We hope he will recover very soon. In a ceremony organized by Dr. S. Ozisik, Director of the Olive Research Institute, Izmir, memorial plaques (name of person or institution written on a slice of an olive tree trunk) were awarded to people who spent more than 20 years of research on olive. TARIS, the biggest olive oil union in Turkey, invited the participants to a Welcome Cocktail Party with delicious Turkish food.

The symposium consisted of 13 sessions inside 7 sections: Crop Management, Plant Protection, Germplasm and Genetic Improvement, Biology and Physiology, Olive and Oil Technology, Propagation and Nursery, and Economics and Marketing. Because of the very low submission of papers to the section of Economics and Marketing, this section was replaced by a Workshop.

Dr. L. Ferguson presented an invited paper to open the section on Crop Management, dealing with irrigation, pruning, fertilization and soil tillage. During three related sessions, 17 oral and 25 poster contributions were presented.

The Plant Protection section had two sessions, with 12 oral and 18 poster presentations. At the end a satellite symposium was held by Dow-Agro Science Company, with reports on some organic pesticides developed for olive fly.

The invited paper of the Germplasm and Genetic Improvement section was presented by Prof. L. Rallo, dealing with the development of biotechnology, germplasm and genetic improvement. Ten oral and 32 poster contributions were presented in two related sessions.

A memorial ceremony was organized by the Chairman of the Olive and Oil Technology section in honor of Dr. Bianchi, an Italian researcher, who recently passed away. Nine oral and 18 poster contributions were presented in this section.

A workshop on "The Olive Economics & Marketing and Politics in the World and Turkey" was organized by Dr. R. Tunalioglu, Agricultural Economics Research Institute. Six oral and 1 poster contributions were presented.

Organizing Committee.

Prof. S. Lavee presented the invited paper of the Biology and Physiology section, with alternate bearing, flowering and fertilization. Ten oral and 16 poster contributions were presented in two related sessions.

Dr. J.M. Caballero presented the invited paper of the section on Propagation and Nursery Practices, speaking about the trends in this sector and the terminology problems when talking about plant material. During two related sessions 5 oral and 4 poster contributions were presented.

Thus, in total, 69 oral and 114 poster contributions were presented. A total of 150 researchers, scientists, responsibles of state and private institutes and companies participated from 18 countries: Jordan, Australia, USA, Portugal, Croatia, France, Tunisia, Israel, Italy, South Africa, Spain, Iran, Greece, Syria, Pakistan, Peru, Libya and Turkey.

During the symposium, a small meeting was held for improving the coordination among the ISHS Working Group on Olive Culture and the FAO Olive Research Networks. This meeting was attended by Mr. F. Taher, Prof. L. Rallo, Dr. B. Karray and Dr. M.T. Özkaya from ESCORENA and AARINENA.

The Executive Committee of the ISHS Working Group on Olive Culture also met during the symposium and was attended by Prof. U. Aksoy, Dr. L. Ferguson, Prof. S. Lavee, Prof. L. Rallo, Dr. J.M. Caballero and Dr. M.T. Özkaya. The application of the Portuguese Society for Horticultural Science for organizing and hosting the 6th International Symposium on Olive Growing in 2008 was discussed and approved. It was agreed that until the next symposium the Executive Committee members are Dr. J.M. Caballero, Prof. S. Lavee, Prof. D. Voyiatzis, Prof. C. Vitagliano and Dr. M.T. Özkaya, all of them former conveners or co-conveners, led by the next one, to be named by Portugal. The committee also discussed how to increase the number of participants for the symposium and members for the working group.

At the closing ceremony, after a general evaluation of the symposium and speeches done by some participants, the Portuguese Society for Horticultural Science proposed in a very nice presentation its country to hold the 6th International Symposium on Olive Growing in 2008. The organized tours and visits allowed for the audience to get acquainted with the development of the olive sector in Turkey and the main touristic and cultural sites of the area. A technical tour organized by its head official was done to Akhisar District, one of the important Turkish areas for table olive production. A modern table olive orchard and table olive processing companies were visited. After closing, a small technical trip was organized to the Olive Research Institute. The participants had the opportunity to see the laboratories and some experimental plots.

A post symposium technical and touristic trip was done to the Aydin province, organized by its Governor. Some more tours were organized for accompanying persons to Izmir, Cemse, Ilica, Alacati, Ephesus, Aphrodisias, Nysa and Virgin Mary.

On the scientific point of view a statistic evaluation can be done for the symposium. According to this evaluation 12 papers on harvesting, 2 papers on fertilization, 18 papers on irrigation, 4 papers on pruning, 29 papers on pomology, breeding and adaptation, 10 papers on biotechnology, 38 papers on biology and physiology, 34 papers on plant protection, 12 papers on table olive, 25 papers on olive oil and 12 papers on economy and marketing have been presented. The presentations show that the researchers are mainly focusing on quality improvement and labor decreasing by mechanisation of harvesting and pruning. Most of the papers were also focusing on environmental protection in crop management and in table olive and olive oil processing. Here are some samples: 1) The effects of irrigation with olive mill wastewater (OMW) on some soil characteristics. It was observed that while both treatments, a) 160 m^3 ha^{-1} per year of OMW with biological degradation and b) without biological degradation but pH value corrected, increased the amount of P_2O_5 and K_2O respectively in soil sampling; no soil toxicity was detected. 2) Soil conservation practices in olive orchards. It was observed that soil with cover crops (without any soil tillage) has benefits; a) in soil moisture content during the year and in the soil profile, b) in machine traffic ability and labor performance, c) in maximizing olive quality, d) in reducing the negative environmental impact of olive farming, e) in contributing to a better image of agriculture. 3) Commercial cultivation of olive on saline water under extreme desert conditions. It was observed that while the orchard was irrigated and supplied annually with ca. 9000 m^3 water, the combination of desert climatic conditions and saline water irrigation allows high production with relatively good oil quality. Especially these and some presentations about high and very-high density planting were very interesting and useful, especially for the growers. Also, the importance of mechanization in olive growing, new techniques for cultivation such as harvest-aids, and new training systems for super intensive olive orchards were discussed during the symposium.

For general evaluation, in the other sessions, generally organic farming, plant protection for ecological production, microbiological treatments for wastewater degradation and fermentation of table olives, oliviculture in drought conditions, origin labeling during marketing, anti-cancer and antioxidant effects of olive leaf extracts, olive and olive oil marketing problems, selection for salt, sanitary, drought etc., and molecular characterizations of the cultivars were discussed during whole symposium.

Mücahit Taha Özkaya

Opening speech of M.T. Özkaya, convener (left) and U. Aksoy, ISHS representative (right).

Contact

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website: www.olive2004turkiye.com

Fifth Int'l Congress on Cactus Pear and Cochineal

Cactus pear (*Opuntia ficus-indica*, Cactaceae) is a xerophytic plant and an emergent crop, which evolved commercially during the second half of the 20th century. The plant probably originated in Central Mexico, the region presenting the widest germplasm variability as well as the largest number of uses. The first wave of dispersal of cactus pear came right after discovery of the Americas, reaching Spain and Mediterranean Europe, North Africa, India and other places, where the Spaniards were present.

The physiological features conferring cactus pear drought tolerance, its adaptability and its utilization as human food and animal feed, as well as its suitability for the recovery of degraded lands of semiarid tropics, have raise global interest and drove the most recent trend of dispersal. Nowadays, the domesticated cactus pear is found in North America, South America - mostly Brazil, Peru, Bolivia, Argentina and Chile, many countries of sub-Saharan Africa, Eritrea and Ethiopia in NE Africa, Yemen, Syria, Lebanon, Israel, Turkey, etc. in the Near East, and even as far as inland China. Other countries having large areas of wild cactus pear are Madagascar and Australia.

As a horticultural commodity cactus pear - the fresh fruit - is still a newcomer in the global fruit markets, restricted to certain groups of Mexican, Italian and South African heritage and mostly reaching the North American and European markets. It is slowly gaining acceptance as an exotic produce in other markets. The consumption of tender pads is even less known and at this point is only popular in Mexico, where they are consumed as any other leafy vegetable all year round. On the opposite, forage cactus pear is widely used in livestock raising, covering up to 300,000 ha in Brazil alone. Cactus pear is advantageously used as a host for the cochineal insect, the raw material for carminic acid, a natural red dye, of great historical importance but also suitable for use in the food industry.

A cactus pear selection from INIFAP with high productivity of red fruits, the preferred color in the export market. Generation of new varieties will further position this crop and benefit farmers of the semiarid areas.

Mexico is the largest grower of fresh cactus pears (>60,000 ha) as such, it has encouraged research and extension work on a regular basis, it is perhaps the most important source of information on this plant. However most of this information is available only in Spanish, greatly limiting access by interested parties of other parts of the globe. In this regard the interaction with international organizations such as ISHS represents a unique opportunity to strengthen international exchange of information.

Cactus pear may represent an opportunity for those countries having large semiarid areas. The information presented at these international events will foster scientific and technical cooperation. The continuity of the research efforts and the integration of research teams allow the solution of the most important problems: generation of new fruit varieties with better quality, more productive and nutritive forage varieties, techniques of land reclamation based on cactus pear, new agro-industrial developments of cactus products and above all, the educational effect on people who still haven't been exposed to this novel crop and who represent an interesting consumer base.

Since 1986 researchers, extensionists and growers have merged efforts to conduct national congresses on a regular basis. These meetings have a unique format, which includes the scientific and technical presentations along with workshops and laboratory practices for growers and technicians, exhibits for new agro-industrial applications as well as field tours covering hot topics on orchard management and new developments.

In August 2004, the Universidad Autonoma de Chapingo (UACH), CACTUSNET (an international network supported by FAO) and INIFAP (Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias) joined efforts to organize the X National Congress on the Knowledge and Use of Cactus Pear and Other Valuable Cacti jointly with the V International Congress on Cactus Pear and Cochineal, under the sponsorship of FAO, the Secretariat of Agriculture, Livestock and Water Resources and Fisheries (SAGARPA), the Mexico State Government, and the National Council of Cactus Pear Growers.

FAO played a significant role, making possible the participation of researchers from the international scientific community. An agreement with ISHS will allow the access to the information presented in the congress to international readers through an *Acta Horticulturae* issue planned for 2005. The event was held at the main campus of the UACH, close to Mexico City, and conveniently located nearby the Pyramids Region, the most important area for fruit production and Milpa Alta the area specialized on vegetable cactus pear.

Part of the international group visiting the Breeding Program of Colegio de Postgraduados at Montecillos, Mexico.

The topics covered a full range of interests: Anatomy and Morphology, Ecology, Ecophysiology and Biochemistry, Pests and Diseases, Ethnobotany and Biomedical Applications, Breeding and Biotechnology, Production and Marketing of Cactus Fruits and Tender Pads, Forage Production, Post-harvest Technology, Cactus Pear and Desertification and Other Cacti of Economical Value.

The event was organized as bilingual and included 121 presentations, from which 42 were intended for the international audience. Overall, the attendance reached 452 people: 42% researchers and extensionists and 58% farmers and students. Representatives of 11 countries - Mexico, Argentina, Chile, Brazil, USA, Peru, Cuba, Italy, Tunisia, South Africa and India - attended the international sessions. An unexpected significant increase on airfares and recent security regulations prevented attendance of scientists from 8 countries, however some of their contributions were received and discussed at the poster session and the information will be available in *Acta Horticulturae*.

Candelario Mondragon Jacobo

Contact

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Fifth Int'l Symposium on Mineral Nutrition of Fruit Plants

The Vth International Symposium on Mineral Nutrition of Fruit Plants was held in Talca (Chile), on 16-21 January 2005. The program included a three-day presymposium tour (16-18 January) to subtropical and temperate fruit orchards and experiment stations in Central Chile. The tour included grapes (wine and table), avocados, cherimoyas, strawberries, apples and pears, with special emphasis on fertilizer application, soil conditions and plant growth (roots and top).

The meeting was held at the Campus of the Universidad de Talca between 19-21 January and was sponsored by the Universidad de Talca and New Ag Magazine, under the auspices of the Chilean Society for Fruit Culture (SOCHIFRUT). The main topics covered during the meeting were: Plant Growth and Nutrient Cycling, Methods and Effects of Fertilizer Application, and Nutrient Analysis and Management. A total of 91 people from 21 countries attended 38 oral and 26 poster presentations. In the afternoon of the second day, there was a field trip to a nearby orchard planted with apples, blueberries and wine grapes. During the field trip there was an emphasis on discussions about root growth, soil conditions, nutrient deficiency symptoms and plant performance.

Participants of the Symposium.

Nickel deficiency in pecan tree. Photo by courtesy of Wood et al., 2005.

Even though in orchard management the cost of fertilizers is relatively low (usually less than 15%), mineral nutrients have great impact on fruit yield and quality, as well as on water quality and contamination. Despite new technological advances that have increased the amount of information available to growers and technical staff, this information is not useful unless it is based on sound physiological and economical knowledge. Thus, there is an increasing demand for the integration of knowledge from different disciplines related to the interaction of mineral nutrients with various factors that impact fruit plant growth and development.

With regards to previous symposia, there was greater emphasis on the interaction of nutrients with other factors and conditions in the orchard. In this regard, the following topics received greater attention from attendees:

- Root growth and activity should acquire greater importance in the future, as they relate to nutrient use and plant growth and performance.

Delayed bud break on pecan as influence of Ni deficiency (degree of Ni deficiency decreasing from left to right). Photo by courtesy of Wood et al., 2005.

- The role of stomata in the uptake of foliar-applied nutrients should be studied in different species, since the data presented at the symposium would suggest that they have a more important role than previously defined.
- In order to improve the prediction of physiological disorders in fruit, the incorporation of variables other that nutrient status is generally beneficial.

Procedure of fruit infiltration under vacuum with magnesium. This methodology is used to predict the incidence of bitter pit (a calcium-related disorder) that occurs during postharvest.

Lysimeter of the University of Talca Agricultural Experimental Station. This system is used to learn about the uptake of nutrients during the season in fruit trees.

- A better knowledge of nutrient cycling in orchards should allow an improvement in timing and dosage of applied nutrients, with positive impacts on plant performance, fruit quality and environmental aspects. In this respect, an expansion in the use of the tools of precision agriculture should aid in adjusting fertilizer application and timing.
- Mineral nutrition has to be considered as part of an integral management of fruit orchard, since different orchard practices such as irrigation, pruning, thinning, etc. would impact on plant nutrient use and efficiency.

Jorge B. Retamales

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Section Pome and Stone Fruits

Fifth Int'l Cherry Symposium

The Fifth International Cherry Symposium was held in Bursa, Turkey from 6-10 June 2005 under the auspices of the ISHS and organized by Uludag University and Ataturk Central Horticultural Research Institute. More than 350 participants from 42 countries attended the meeting, which is more than double the number of attendance compared to the previous international cherry meetings. The popular participation to this meeting indicates the increasing interest in cherries worldwide. The FAO statistic data also show that the worldwide cherry export value increased dramatically in recent years. This value reached to about half a billion US$ in 2003, which is a 50% increase compared to the year 2000.

During the five days of the meeting, 8 invited speeches, 56 oral contributions and 119 posters were presented in 14 oral and two poster sessions. After each oral session a final summarizing discussion on action points and future collaborations was facilitated by the chairperson, presenting authors and audiences. Of these 183 scientific presentations, 37 were on rootstock and variety evaluation, 34 on crop production and management, 24 on physiology and plant growth, 16 on quality and post harvest technology, 15 on pest and disease management, 14 on breeding, 12 on genetics and biotechnology, 11 on nutrition irrigation and soil management, 11 on propagation, 3 on economics, marketing and industry development, 3 on processing and technology, and 3 on environmental management and sustainable production.

On the first day of the meeting, four sessions of the symposium met and four invited speeches were presented. In the first session, invited speaker Dr. Sansavini from Italy gave an overview on the sweet cherry breeding trends in Europe and Asia, while invited speaker Dr. Kaska from Turkey summarized the changes of sweet cherry production and export in Turkey in recent years. Invited speaker Dr. Lang from the USA introduced their computer modelling to manage sweet cherry orchards. In the third session of the meeting, invited speaker Dr. Whiting from the USA gave some information about the phenological aspects of high density sweet cherry orchards. While the morning session on Monday focused on floral biology and fertility, the last session on Monday and two sessions on

Opening speech by the Convener, Dr. Atilla Eris.

Participants of the Symposium.

Tuesday morning included presentations on rootstock and variety evaluation. Invited speaker Dr. Hrotko from Hungary, informed the audience about the recent progress in cherry rootstock research. On Tuesday afternoon, a tour to the historical city of Nicea was organized and a technical visit to Atatürk Central Horticultural Research Institute took place to view the genetic materials of sweet cherry rootstocks and cultivars. These trips gave the participants the possibility to take a break from the intensive sessions.

The first session presentations on Wednesday focused on plant physiology aspects of sweet cherries and were followed by a session on breeding and genetics of cherries. Invited speaker Dr. Kappel from Canada gave an overview on cherry breeding in the 'New World'. Both poster discussion sessions were scheduled on Wednesday afternoon to give the participants the opportunity to meet and discuss their questions about the poster presentations with the presenting authors of the posters. The topics included in the first session on Thursday morning were related to irrigation and its effect on cherry quality. Invited speaker Dr. Lauri from France gave an integrated view on sweet cherry tree architecture, physiology and management. The first session of the Thursday afternoon meeting included presentations about the fruit cracking in sweet cherries and invited speaker Dr. Sekse from Norway informed the audience about some recent advances in fruit cracking in sweet cherries. The last session of Thursday included topics related to sweet cherry pest and disease management. Presentations about fruit quality and post harvest physiology of both sweet and sour cherries were introduced in the morning sessions of Friday.

A pre-symposium tour included trips to visit the historical places in Istanbul. On the other hand, participants attending the post-symposium tour had a chance to see cherry orchards in the provinces of Canakkale and Izmir. Besides, they also visited the ancient cities of Troy and Ephesus and the Gallipoli district.

In the business meeting of the ISHS Working Group on Cherry Production the participants voted to organize the 6th International Cherry Symposium in Chile in 2009. Dr. Atilla Eris from Turkey was elected as new Chair and Dr. Marlene Ayala from Chile as Vice Chair for the next term. Furthermore, the participants were informed about the deadlines and guidelines for preparation of the manuscripts for the Symposium proceedings, which will be published as a volume of *Acta Horticulturae*.

Atilla Eris

Participants in the cherry orchard of Atatürk Central Horticultural Institute.

Contact

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Third Int'l Symposium on Tropical and Subtropical Fruits

Section Tropical and Subtropical Fruits - Commission Biotechnology and Molecular Biology - Commission Education and Training

The Third International Symposium on Tropical and Subtropical Fruits (3rd ISTSF) was held at Fortaleza, Brazil. Fortaleza is located in Northeast Brazil, and is the capital of Ceará State, one of the most important fruit production areas in the country. Third fruit producer in the world, Brazil is now aiming to increase domestic and oversea consumption to gradually expand its orchards, not only an expansion in size, but also a rise in productivity, thanks to the introduction of modern technologies. Brazil went from a total production of 11.5 million tons/year in 1973 to 43 million tons today ranking after China and India in total production.

The Symposium was hosted by the University of Brasília (UnB) together with Embrapa and attracted more than 250 participants from 20 countries.

The symposium started with two technical tours: On 8 and 9 September, participants had the opportunity to visit mango and grape growing areas with modern technologies, including packinghouses in the semi-arid region of Petrolina and Juazeiro in São Francisco River Valley. On 11 and 12 September, participants visited the agrobelt project of Baixo Acaraú, in the lowlands of Ceará state, consisting of small holders growing papaya, banana and melon, followed by Serra do Ibiapaba, in the highlands, where large companies are growing successfully rose and organic passion fruit and acerola for concentrate juice for export.

During the course of the week (12-17 September 2004), current advances in practical aspects, and in basic subjects were presented in 23 conferences, 37 oral papers, 22 workshops and 146 posters. After an official welcome by Prof. Osvaldo K. Yamanishi (convener), and Prof. Rod Drew (ISHS), Dr. Pedro Jaime de Carvalho Genú from Embrapa presented an overview on the role of fruit production in Brazil. At the beginning of each workday, in the morning and in the afternoon, conferences were presented by experts from all over the world.

The very first day, conservation through genebanks of tropical and subtropical fruits in Brazil, impact of breeding on fruit production in warm climates of Brazil, and germplasm resources of tropical and subtropical fruits in China, established an interesting overview on these subjects. Biotechnology and Genomics were covered by themes such as the state of the art of transgenic fruit crops and its perspectives, the integration of genetic breeding, functional and comparative genomics of citrus included in the wide research program CITEST, and the use of papaya as a model tropical fruit species for development of conservation and breeding technologies.

Opening ceremony. From left to right: representatives of ISHS, Frutal Institute, Ceara Government, 3rd ISTSF Convener, President of Brazilian Society for Fruit Crop Science and EMBRAPA - Brazilian Agricultural Research Corporation.

The second day brought themes of the deepest interest of growers, horticulturists and technicians that attended the meeting, covering Integrated Fruit Production (IFP) under the government point of view, IFP as a reality in fruit growing, integrated production of mango and grape in the San Francisco Valley, Brazil, marketing tendencies of tropical fruits and IFP in Brazil, and postharvest handling of horticultural crops produced under IFP systems. The afternoon session was dedicated to Crop Management, with conferences on production of sapindaceae fruits in China, pineapple crop management in response to Brazilian market demands, glyphosate: secondary effects on plants and physiological implications.

During the third day there were conferences on Pest and Disease Management, and specifically dealing with strategies for the use and enhancement of biological control of postharvest fruit decays, integrated management of tropical fruit diseases, and a case study of apple integrated pest management in Santa Catarina State using *Neoseiulus californicus* (Acari: Phytoseiidae) for the control of *Panonychus ulmi* (Acari: Tetranychidae). In the afternoon, themes dealt with Postharvest Technology, covering fruit softening during ripening - causes and regulation, effect of volatiles to maintain postharvest quali-

Poster session.

Rod Drew tasting Brazilian fruits.

ty of tropical and subtropical fruits, and alleviation of low temperature injury in tropical and subtropical fruits.

Last, but not least, several conferences on Food Safety & Traceability, describing safety related issues for the production, packing, and distribution of fresh fruits in the USA and traceability for fruits in nature and industrialized. Followed by matters on Economics and Market, showing Brazil at the center of the worldwide fruit market, economics and market and "A brand, a quality, a market".

A distinctive action of the 3rd ISTSF was the opportunity to promote six workshops, during late afternoons and early nights. Despite the fact of such unusual schedule, the attendance to the workshops on Tuesday and Thursday was surprisingly high. **Fresh Fruits and the Prevention of Degenerative Diseases**: Fresh fruits have a key role in the diet of people in tropical regions, not only for the flavor and attractiveness, or for being sources of nutrients like vitamins and minerals. There is a great interest in their properties related to disease control, especially the prevention of degenerative diseases like cancer and brain aging. The chemopreventive action has been mainly attributed to phenolic compounds, especially anthocyanins and flavonoids. The Workshop discussed the antioxidant properties of fruits, from the point of view of fruit composition, action, and human nutrition aspects. **Particle Film Technology**: The purpose of this workshop was to address and explore the effects of particle film technology, on tree canopy microclimate and physiology, yield and fruit quality, and pest and disease management under various environmental conditions. It was also examined how this technology integrates into existing conventional, IPM strategies, and organic production systems. **Tropical Fruit Breeding: Where we are now, and where we are going**: This workshop provided a broad overview on tropical fruit breeding program goals, recent developments in selection methodology, and a discussion on how breeding programs and their many cooperators envision the future of variety/hybrid development. **Challenges of Irradiated Fruits**: In this workshop it was discussed how irradiation technology helps to eliminate the threat of harmful microorganisms, making food safer for consumption, remembering that today, improved food safety is everyone's concern. **New Potential Fruit Crops: Constraints and Research**: This workshop dealt with native fruits from Asian and American centers of origin and their potentialities to be explored commercially as well as their agronomic and botanical characteristics, breeding programs in course, and research and marketing needed to shift from an unknown exotic fruit to a well accepted fruit worldwide. **Bio-regulators in Fruit Production: Present and Future Perspectives**: This workshop showed the recent advances and future trends in the use of PGRs in fruit production in Brazil.

Group of participants at the closing ceremony.

Rod Drew (representative of ISHS), Osvaldo Kiyoshi Yamanishi (convener of 3rd ISTSF) and Roedhy Poerwanto (convener of 4th ISTSF, Indonesia, 2008).

The symposium closed with three technical tours on 17 September, visiting experimental fields of the Brazilian Agriculture Research Corporation (Embrapa) at the Tropical Agroindustry unit, fruit processing companies and commercial orchards of tropical and exotic fruits located in the agrobelt project in the neighborhoods of Fortaleza. The agrobelt project, which established a real production oasis in the remote northeast, makes several sustainable crops viable in the state. Six fruits were strategically given priority: banana, melon, table grape, mango, papaya, and pineapple. The potential of the international market, the production capacity, and the quality of these fruits were the determining factors in the selection of these crops. Ceará Ports was another place visited at the Pecém complex. Pecém is in the neighborhood of Fortaleza (60 km). Due to its efficient logistics, strategic position and excellent infrastructure the port has become the main exit for Brazilian tropical fruits such as melon, banana, mango and papaya.

Besides the extensive program of the 3rd ISTSF, two other activities were achieved: the 11th International Fruit, Flower and Agroindustry Week (11th FRUTAL), an institutional, commercial and technical exhibition. The Frutal Institute, an important organization for fruit agribusiness in the Brazilian Northeast, promoted the event, featuring 350 booths spread out over 15,000 m^2 and exhibiting supplies, machines and equipment as well as services for the entire irrigated horticulture industry. The First International Seminar on Lychee in Brazil took place in the following week, at Limeira, São Paulo State.

At the business meeting that took place on the third day of the symposium, Dr. Roedhy Poerwanto from Indonesia accepted the task to take over the next Symposium. The Fourth International Symposium on Tropical and Subtropical Fruits will be held in Indonesia in 2008.

Osvaldo K. Yamanishi and Celso V. Pommer

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Model-IT 2005, from Pig Growth to Bread Making...

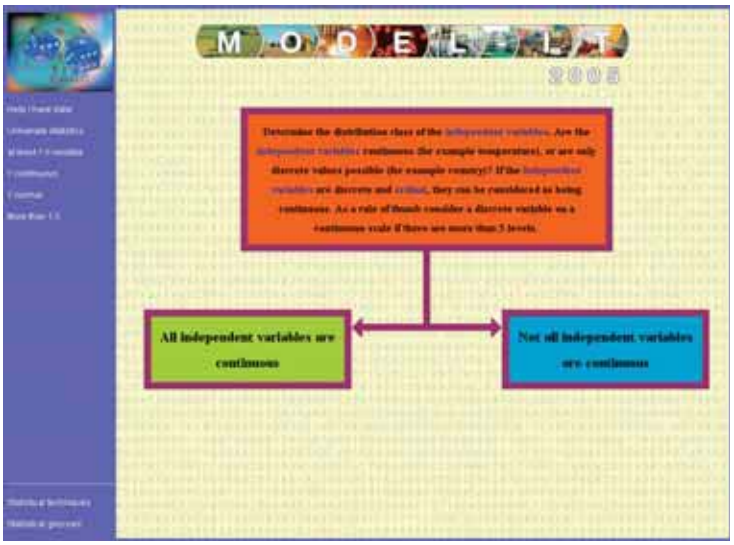
The 3rd International Symposium on Applications of Modelling as an Innovative Technology in the Agri-Food-Chain (Leuven, Belgium) was organised as an initiative of Working Group 5 of COST action 924. Model-IT 2005 was organised to serve as a meeting place for industry and research, facilitating the application of models throughout the chain. Model-IT 2005 aimed at the wider agri-food chain, from cultivation of raw agricultural materials up to and including storage, retail and consumption of the finished products. Upon this platform we sought new concepts of modelling in the agri-food chain, the integration of expertise towards a more efficient experimental approach, the input of innovative methodologies in this field of research, and practical, model-based applications. For proper chain management, good and reliable predictive models covering all kind of aspects are necessary to control and optimise the food chain with respect to quality and safety.

The symposium was organised around four themes, together covering the area of modelling in the agri-food chain: *Production Modelling and Chain Management*, *Predictive Microbiology*, *Transport Phenomena and Numerical Discretisation* and *Quality Modelling*. In total, 37 oral and 54 poster presentations were presented attracting 134 participants coming from 29 countries from all over the globe. The contributions were a good reflection of the diversity of the agri-food chain covering topics ranging from pig growth to bread making. The symposium attracted both fundamental and applied approaches, including integrated approaches covering the whole chain from field to table. In general the presentations were of a high standard. It was good to welcome returning participants that had participated in the previous Model-IT meetings as well. Apparently this meeting has found its own niche with people where the added value of modelling as a tool to enhance understanding and to increase the practical applicability of scientific expertise is clearly recognised.

The symposium offered two invited speakers from neighbouring domains highlighting the application of modelling within their own domain. Bart de Moor (K.U.Leuven, Belgium) gave an overview on bioinformatics, addressing how classical and newly developed algorithms can be used to generate insight in the biological processes showing the activity or expression of thousands of genes simultaneously. He presented some future perspectives on the development of bioinformatics, including some visionary discussions on technology, algorithms, systems biology and computational biomedicine. Filip de Ridder (Johnson & Johnson Pharma-ceutical Research and Development, Belgium) elaborated on clinical drug development. Over the last decade there has been an increasing interest in the use of modelling to extract and integrate information, to improve understanding on drug assimilation and to optimize the design of clinical trials. De Ridder outlined the general framework of clinical drug development focusing on the features that make the application of modelling and simulation worthwhile. The third invited speaker, Julio Banga (IIM-CSIC, Spain), gave a technical overview on model-based optimisation, an issue that sooner or later will affect everyone working in the area of modelling. Several techniques were discussed how to find the best solution in an efficient and systematic way, using model-based simulation to evaluate all possible candidate solutions. In this contribution, computer-aided optimisation was presented as the ultimate tool to improve food processing.

Furthermore, the symposium offered the participants four workshops specially prepared for this occasion. The workshop on *Dynamic process simulation for design, operation and control* gave a practical introduction to transient simulation methods for design, operation and control purposes in the agri-food chain. The workshop on *Predictive modelling as an essential tool in Risk Analysis* focused on the modelling and calculation steps involved when conducting a Risk Analysis in the field of food safety. A third workshop called *Help, I have data!* guided the participants through the statistical landscape giving a survey of the most important statistical techniques presenting a data analysis decision tree to select the right statistical technique for a given set of experimental data (see Fig. 1). Finally, a workshop was presented on *Design of experiments* showing how the efficiency of Research & Development can be improved by optimising your experimental design guaranteeing that the preset goals are being reached at minimum costs.

Figure 1. Screenshot of the web based data analysis decision tree developed for the workshop *Help, I have data.* By answering a number of dichotomous questions this tree guides you to the right statistical technique for a given set of experimental data.



In line with the previous Model-IT conferences in Wageningen (The Netherlands, 1998) and Palmerston North (New Zealand, 2001) the proceedings (*Acta Horticulturae* 674) were made available at the start of Model-IT, both printed and online through the ISHS web site.

Maarten Hertog

The conveners

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Int'l Tropical Fruits Workshop (Citrus and Mango)

Sultan Qaboos University (SQU), Muscat, Oman was the venue for a four day (20-23 March 2005) workshop focused primarily on current and future research on witches' broom disease of lime (WBDL) and mango sudden decline disease. The four-day workshop was organized by the SQU College of Agricultural and Marine Sciences (CAMS) in collaboration with the US Embassy in Muscat, International Society for Horticultural Science (ISHS), International Society of Citriculture, and United States Department of Agriculture (USDA). During the workshop sessions, experts from Oman and abroad reviewed the following issues: the status of citrus and mango in the producing countries around the world; the status of WBDL research; mango sudden decline research; and strategies for regional and international collaboration on WBDL and mango sudden decline.

A group picture of conference participants.

The opening ceremony, under the patronage of Dr. Hamed al Salmi, SQU Vice-President, was attended by H.E. Richard Baltimore III, US Ambassador to Oman, senior members of the SQU administration and faculty, a large number of participants from Oman, and 15 experts from six foreign countries. The participants of the workshop were welcomed by Dr. Ali al Bimani, Assistant Vice President, who reiterated SQU's desire to support regional and international collaboration for conducting research on citrus and mango.

The workshop addressed issues concerning the spread, management, and control of diseases of citrus and mango, two major tropical fruits that have special importance in Oman. Lime (*Citrus aurantifolia*) is ranked the second most important crop in the Arabian Peninsula after dates. It has been in decline due to witches' broom disease (WBDL) caused by a phytoplasma. Mango (*Mangifera indica*) has been devastated in the years since 1998 when a new fungal disease, mango sudden decline, caused by *Ceratocystis fimbriata*, entered the country and now poses a serious threat. WBDL has its origin in Oman, but the origin of mango sudden decline is probably Brazil. Both of the diseases have been spreading within the region. WBDL is currently the major cause of destruction of lime in Iran whilst mango sudden decline has recently been reported in Pakistan with the potential for further spread in the Indo-Pakistan subcontinent.

Participants visiting a mango orchard in the Batinah region of Oman.

Witches' Broom Disease of Lime (WBDL)

In his opening address, Dr. Fahad Al Said, Assistant Professor and Chairperson of the Workshop Organizing Committee, recalled how some 20 years ago, lime was ranked the second most important crop after dates in Oman and how its production had declined drastically over the years, primarily due to WBDL. Witches' broom disease was first reported in northern Oman in the early 1970s. Since then the disease has spread to UAE (reported in 1989) and Southeastern Iran (reported in 1998). Technical sessions on WBDL covered a wide range of related topics, including disease spread, diagnosis and transmission, vectors and alternative hosts, phytoplasma control using terpenes, citrus breeding for resistance using molecular and biotechnological tools, tolerance studies, and management by cultural practices.

Mango Sudden Decline

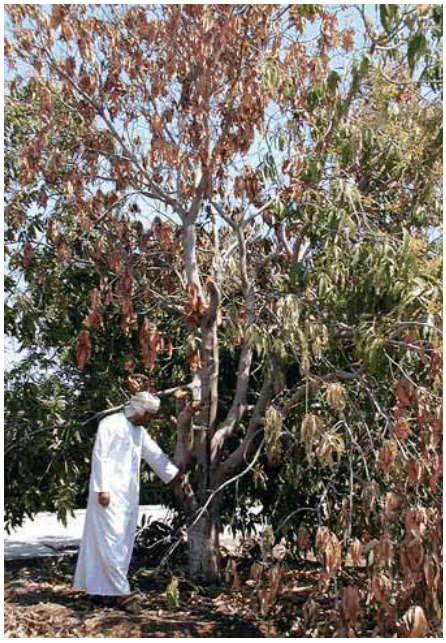
Since 1998, mango sudden decline has devastated mango production in Oman. The pathogen is especially virulent on local mango cultivars and local material used as rootstocks for exotic scions. The pathogen is carried between trees by a bark beetle. Recognizing the serious threat posed by the disease, Dr. Mike Deadman, Head of the Crop Sciences Department at SQU, spoke about the current status and epidemiology of the disease in Oman. During the technical sessions topics discussed included the control and management of the disease, the impact of similar diseases in USA, Brazil, Pakistan, Sicily, and Iran and pathological and histopathological aspects of the mango decline in Oman.

Field Tour

The participants visited mango- and citrus-growing areas of the Al Batinah region in northern Oman. They visited farms with infected trees and discussed various aspects of disease management with local growers. The tour included a visit to an Agricultural Research Station of the Ministry of Agriculture and Fisheries where screening trials for mango sudden decline resistant rootstocks are taking place. The participants also visited the Agricultural Experiment Station of SQU where a terpene application trial for the control of WBDL was evaluated.

Emerging Diseases

Prof. Joseph Bové reported on newly discovered diseases that may potentially enter the Middle East region. Huanglongbing and citrus sudden death (CSD) are among diseases reported in Sao Paulo, Brazil. The insect vectors of these diseases have been reported in the Mid East. Professor Randy Ploetz identified mango diseases such as mango malformation as a potential threat to local production. Quarantine and other preventative measures were discussed.



Mango tree infected with Mango Sudden Decline.

Workshop Recommendations

Professor Randy Ploetz (mango decline panelist), Professor Joseph Bové (WBDL panelist), and Dr. Fahad Al-Said (moderator) discussed workshop recommendations with participants, summarized as follows:

Witches' Broom Disease of Lime

1. Strengthen breeding programs for developing acid lime resistant to WBDL. Somatic hybridization was recognized as a key strategy to develop resistant germplasm. The University of Florida - Citrus Research and Education Center has developed germplasm ready for field trials and a collaborative program was discussed.
2. Conduct research including the use of terpenes through microinjection and foliar spray; studies on vectors and alternative hosts of Candidatus *Phytoplasma aurantifolia* in the region; studies on the epidemiology of WBDL; and studies on pathogenic anatomy of rootstocks.
3. Disease management research on the effects of various environmental conditions and cultural practices, such as fertilizer application and irrigation, citrus rootstock replanting, and field sanitation.
4. Screening trials for disease resistance and tolerance, replacement of traditional method of lime propagation by air-layering. Special attention needs to be paid to citrus tristeza virus (CTV) resistance in the selection of potential rootstocks.
5. Research on alternative citrus species (e.g. Tahiti lime and lemon as potential replacements for lime).
6. Educate farmers (via the Ministry of Agriculture extension service) to accept other acid citrus fruits as alternative to lime.
7. Local and regional collaboration among participants and researchers to study WBDL disease.

Mango Decline

1. Study the etiology of the disease and the primary causing agent and the sequence of events between infection and tree death using large plants with a well developed trunk rather than seedling trees.
2. Study the epidemiology of mango sudden decline, including alternate hosts and vectors.
3. Research on local resistant trees using local polyembryonic seedlings.
4. Study the effectiveness of current quarantine measures against importing of disease-infected fruit trees.
5. Evaluation of alternative disease management strategies including the use of physical barriers to the bark beetle and the use of terpenes.

Symptoms of Witches' Broom Disease of Lime (WBDL) on *Citrus aurantifolia.*

6. Local quarantine and eradication measures for the removal of infected trees and branches.
7. Regional collaboration among researchers in countries where mango sudden decline has been reported and methods to strengthen local collaboration between the Ministry of Agriculture and Sultan Qaboos University in Oman to combat the disease.

Proceedings from this workshop are forthcoming.

Contact

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New ISHS Members

ISHS is pleased to welcome the following new members:

NEW INDIVIDUAL MEMBERS:

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Calendar of ISHS Events

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YEAR 2005

- October 5-7, 2005, Freemantle, WA (Australia): **III International Phylloxera Symposium.** Info: Dr. Kevin Powell, Department of Primary Industries, Rutherglen Centre, RMB 1145, Rutherglen, VIC 3685, Australia. Phone: (61)260304500, Fax: (61)260304600, email: kevin.powell@dpi.vic.gov.au
- October 10-14, 2005, Daytona Beach (USA): **International Symposium on Biotechnology of Temperate Fruit Crops and Tropical Species.** Info: Dr. Ralph Scorza, USDA-ARS Appalachian Fruit Research Station, 2217 Wiltshire Rd., Kearneysville, WV 25430, USA. Phone: (1)3047253451, Fax: (1)3047282340, email: rscorza@afrs.ars.usda.gov or Dr. Richard Litz, University of Florida/IFAS, Horticultural Sciences Department, 18905 SW 280 St., Homestead, FL 33031-3314, USA. Phone: (1)3052467001ext310, Fax: (1)3052467003, email: rel@ifas.ufl.edu web: conference.ifas.ufl.edu/ishscrops
- November 8-10, 2005, Nairobi (Kenya): **I International Symposium on Small-holder Fruit Production.** Info: Stella Muasya, ICRAF, PO Box 30677, Nairobi, Kenya. Phone: (254)207224229, Fax: (254)207224255, email: s.muasya@cgiar.org
- November 13-15, 2005, Al Ain (United Arab Emirates): **III International Conference on Date Palm.** Info: Prof. Dr. Abdelouahhab Zaid, Chief Technical Advisor, Date Palm Research & Development Programme, UAE University, UNDP Coordinator General of DPGN, PO Box 81908, Al Ain, UAE. Phone: (971)37832334, Fax: (971)37832472, email: zaid@uaeu.ac.ae web: datepalm.uaeu.ac.ae

NEW

- November 22-24 2005, Kuala Lumpur (Malaysia): **I International Symposium on Papaya.** Info: Dr. Abd. Shukor Abd. Rahman, Horticulture Research Centre, MARDI, GPO Box 12301, 50774 Kuala Lumpur, Malaysia. Phone: (603)89437263, Fax: (603)89487590, email: arshukor@mardi.my web: www.mardi.my/papaya/
- December 1-7, 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 web: www.rubusribes.cl
- December 5-8 2005, Lucknow - Uttar Pradesh (India): **I International Guava Symposium.** Info: Prof. Dr. R.K. Pathak, Central Institute of Subtropical Horticulture, Rehmankhera, PO Kalkori, Lucknow 227 107, India. Phone: (91)5222841022, Fax: (91)5222841025, email: intguavasymp@cishlko.org web: www.intguavasymp.net

YEAR 2006

- February 5-10, 2006, Sun City, Johannesburg (South Africa): **VIII International Mango Symposium.** Info: Event Dynamics Africa, Jenny Dickerson, PO Box 98009, Sloane Park, 2152, South Africa. Phone: (27) 11 440 8027, Fax: (27)11 786 5683, email: jenny@edafrica.co.za web: www.mangosa2006.co.za
- February 19-24, 2006, Agadir (Morocco): **International Symposium on Advances in Soil and Soilless Cultivation under Protected Environment.** Info: Conveners Dr. A Hanafi and Dr. W.H. Schnitzler, Institut Agronomique et Véterinaire Hassan II, Complexe Horticole, PO BOX 12042, Cité Balnéaire, Agadir 80.000, Morocco. Phone: (212)48248152 or 61177968, Fax: (212)48248152, email: hanafi@iavcha.ac.ma web: www.iavcha.ac.ma/ishs-morocco2006
- February 21-24, 2006, Rotorua (New Zealand): **VI International Kiwifruit Symposium.** Info: Dr. Bob Martin, Market Access and Technical Manager, Zespri International Ltd., 400 Maunganuit Rd., Mount Maunganui (PO Box 4043, Manganui South), New Zealand. Phone: (64)75751591 or 21595128, Fax: (64)75751340, email: bob.martin@zespri.com web: www.kiwi2006.com
- February 22-25, 2006, San Remo (Italy): **The Labiatae: Advances in Production, Biotechnology and Utilization.** Info: Dr. Barbara Ruffoni, CRA Experimental Institute of Floriculture, Corso Inglesi 508, 18038 San Remo, Italy. Phone: (39)0184667251, Fax: (39)0184695072, email: b.ruffoni@istflori.it web: www.istflori.it
- February 28 - March 2, 2006, Wolfville, Nova Scotia (Canada): **I International Organic Apple and Pear Symposium.** Info: Dr. Ralph Martin, Box 550, SNAC, Truro, NS, B2N 5E3, Canada. Phone: (1)9028936679, Fax: (1)9028967095, email: rmartin@nsac.ns.ca or Dr. Charlie Embree, AAFC, 32 Main Street, Kentville, NS, B4N 1J5, Canada. Phone: (1)9026795708, Fax: (1)9026792311, email: embreec@agr.gc.ca web: www.oacc.info/applesymposium

NEW

- March 28-31, 2006, Lorca - Murcia (Spain): **VI International Symposium on Artichoke, Cardoon and their Wild Relatives.** Info: Ir. Regino Aragón Pallarés, Dpto. Horticultura, IMIDA, C/ Mayor, S/N, 30150 La Alberca (Murcia), Spain. Phone: (34)968366773, Fax: (34)968366792, email: regino.aragon@carm.es or Dr. Juan A. Fernández, Departamento Producción Vegetal, Universidad Politécnica de Cartagena, Paseo Alfonso XIII, 52, 30203 Cartagena, Spain. Phone: (34)968325446, Fax: (34)968325435, email: juan.fernandez@upct.es Symposium Secretariat: Viajes CajaMurcia, Gran Via Escultor Salzillo 5. Entlo. Drcha., 30004 Murcia, Spain. Phone: (34)968225476, Fax: (34)968223101, email: congresos@viajescajamurcia.com web: www.viajescajamurcia.com/artichoke
- March 30 - April 5, 2006, San Diego, California (USA): **VII International Protea Research Symposium.** Info: Dennis Perry, Perry's Panorama, PO Box 540, Somis, CA 93066-0540, USA. Phone: (1)8056423267, Fax: (1)8056425967, email: perrypan@adelphia.net or Dr. Kenneth W. Leonhardt, Dept of Horticulture, University of Hawaii, 3190 Maile Way, Rm 102, Honolulu, HI 96822-2232, USA. email: leonhard@hawaii.edu web: www.ipa2006conference.org
- April 1-5, 2006, Guangzhou (China): **II International Symposium on Loquat.** Info: Dr. Shunquan Lin, College of Horticulture, South China Agricultural University, Guangzhou 510642, Wushan, China. Phone: (86)2085288262, Fax: (86)2085282107, email: cmliu@scau.edu.cn
- April 24-27, 2006, Almería (Spain): **Symposium on Greenhouse Cooling: Methods, Technologies and Plant Response.** Info: Dr. Jerónimo Pérez Parra, Estación Experimental de Cajamar, Autovía del Mediterráneo Km. 416,7, 04710 El Ejido, Almería, Spain. Phone: (34)950580569, Fax: (34)950580450, email: jpparra@cajamar.es web: www.coolingsympalmeria06.com
- May 7-11, 2006, Amman (Jordan): **I International Symposium on Fresh Food Quality Standards: Better Food by Quality and Assurance.** Info: Dr. A. Fardous, Director General, National Center for Agricultural Research and Technology Transfer, PO Box 639, Baq'a, 19381 Amman, Jordan. Phone: (962)64726680, Fax: (962)64726099 or (962)665356519, email: garyouti@ncartt.gov.jo or

NEW

Prof. Dr. W.H. Schnitzler, Technical Univ. of Munchen, Inst. of Vegetable Crops Science, Weihenstephan, 85354 Freising, Germany. Phone: (49)8161713427, Fax: (49)8161714491, email: whs@wzw.tum.de

- May 22-26, 2006, Antalya (Turkey): **XX International Symposium on Virus and Virus-like Diseases of Temperate Fruit Crops and XI International Symposium on Small Fruit Virus Diseases.** Info: Prof. Dr. Kadriye Çaglayan, Mustafa Kemal University, Agriculture Faculty, Plant Protection Department, 31034 Antakya-Hatay, Turkey. Phone: (90)3262455836 Ext.1347, Fax: (90)3262455832, email: caglayan@mku.edu.tr and Prof. Dr. Filiz Ertunc, Ankara University, Faculty of Agriculture, Department of Plant Protection, 06110 Ankara, Turkey. Phone: (90)3123170550 ext.1120, Fax: (90)3123187029, email: ertunc@agri.ankara.edu.tr web: www.fv2006.gen.tr

NEW

- June 6-8, 2006, Tunis (Tunisia): **X International Symposium on the Processing Tomato.** Info: Abdellatif B'Chir, GICA, 77 avenue Taïeb M'Hiri, 1002 Tunis, Tunisia. Phone: (216)71782633 Fax: (216)71783206, email: secretariat@worldtomatocongress.com or Sophie Colvine, AMITOM, Phone: (44)1387820322, Fax: (44)1387820322, email: colvine@tomate.org web: www.worldtomatocongress.com
- June 7-10, 2006, Presov (Slovak Republic): **I International Symposium on Chamomile Research, Development and Production.** Info: Dr. Ivan Salamon, Department of Ecology, FHPV Presov University, 17th November Street #1, 071 16 Presov, Slovakia. Phone: (421)517725361 or (421)907186500, Fax: (421)517725547 or (421)517710803, email: salamon@fhpv.unipo.sk web: www.chamomile.szm.sk

NEW

- July 2-6, 2006, Udine (Italy): **IX International Conference on Grape Genetics and Breeding.** Info: Prof. Enrico Peterlunger, Università di Udine, Dip. di Scienze Agrarie e Ambientale, Via delle Scienze 208, 33100 Udine, Italy. Phone: (39)0432558629, Fax: (39)0432558603, email: peterlunger@uniud.it web: www.grapebreeding2006.com

- August 13-19, 2006, Seoul (Korea): **XXVII International Horticultural Congress. web: www.ihc2006.org**

- August 28 - September 2, 2006, Mildura, VIC (Australia): **V International Symposium on Irrigation of Horticultural Crops.** Info: Dr. Ian Goodwin, Senior Irrigation Scientist, Horticulture Physiology Section, Department of Primary Industries, Private Bag #1, Tatura 3616 VIC, Australia. Phone: (61)358335240 or (61)409351962, Fax: (61)358335299, email: ian.goodwin@dpi.vic.gov.au
- September 11-15, 2006, San Remo (Italy): **XXII International EUCARPIA Symposium - Section Ornamentals: Breeding for Beauty.** Info: Dr. Tito Schiva or Dr. Antonio Mercuri, CRA Istituto Sperimentale per la Floricoltura, Corso degli Inglesi 508, 18038 San Remo (IM), Italy. Phone: (39)0184694846, Fax: (39)0184694856, email: a.mercuri@istflori.it web: www.istflori.it
- October 3-7, 2006, N'Zérékoré (Guinea): **I International Symposium Contribution of African Botanica to Humanity.** Info: Dr. Nianga Nicephore Malo, Director UDECOM, 69 Chablis, Sector Aylmer, Gatineau, QC J9H 5P9, Canada. Phone: (1)8196849029, Fax: (1)8192462945, email: malo@ccophymed.com web: www.botaniqueafricaine.com
- October 16-17, 2006, Adana (Turkey): **I International Symposium on Pomegranate and Minor Mediterranean Fruits.** Info: Prof. Dr. Ahsen Isik Özgüven, Cukurova University Agricultural Faculty, Horticultural Department, Ziraat Fakültesi Bahçe Bitkileri Bölümü 01330, Adana, Turkey. . Phone: (90)3223386564, Fax: (90)3223386388, email: ahsen@cu.edu.tr
- October 28-30, 2006, Mashhad (Iran): **II International Symposium on Saffron Biology and Technology - ISSBT.** Info: Prof. Dr. A. Koocheki, CESC, Faculty of Agriculture, Ferdowsi University of Mashhad, PO Box 91775-1163, Mashhad, Iran. Phone: (98)5117610760 or (98)5118788494, Fax: (98)5118787430, email: akooch@ferdowsi.um.ac.ir or saffron-ir@ferdowsi.um.ac.ir web: saffron-ir.um.ac.ir
- October 29 - November 2, 2006, Wageningen (Netherlands): **Models for Plant Growth, Environmental Control & Farm Management in Protected Cultivation - HortiModel2006.** Info: Dr. Ep Heuvelink, Horticultural Productions Chains Group, Wageningen University, Marijkeweg 22, 6709 PG Wageningen, Netherlands. Phone: (31)317483679, Fax: (31)317484709, email: programme@hortimodel2006.nl web: www.hortimodel2006.nl

NEW

- December 3-6, 2006, San Antonio, TX (USA): **IV International ISHS Symposium and VIII National Symposium on Stand Establishment.** Info: Prof. Daniel I. Leskovar, Texas Agricultural Experiment Station, Texas A&M University, 1619 Garner Field Rd., Uvalde, TX 78801, USA. Phone: (1)8302789151x140, Fax: (1)512-278-1570, email: d-leskovar@tamu.edu

Additional information at www.ishs.org/calendar

CALL FOR CONTRIBUTIONS TO THE CONGRESS

At the time of the IHC 2006, 16 symposia and a series of smaller workshops will be organized (see for additional information www.ihc2006.org). The organizers encourage the submission of oral and poster contributions that relate to the current programme. However, the submission of posters to a common theme are very much welcome. Whenever sufficient posters on such a theme are received, the subject will be followed up with a workshop.

EDUCATION IN IHC 2006, SEOUL, KOREA - PLEASE SUBMIT POSTERS

It is planned to hold a Workshop concerned with 'Education and Training as Required by Horticulture Worldwide' ('The Public Market Place for Horticultural Education & Training'). All facets of these subjects are open for consideration such as course content, structure and delivery to students and other clients at all levels. Posters related to delivery for post- qualifying (MBA style), work-based learning, post graduate research apprenticeships, mature entrants and delivery as extension, consultancy and advisory processes are especially encouraged. Your submission of relevant Posters is welcome and encouraged. It is also planned to hold a discussion of these Posters and these will be grouped together. Offers of Posters in this subject should be made to the Congress Organisers as outlined in the *Second Announcement* recently mailed out from Seoul, Korea. REMEMBER THE DEADLINE IS 15th December 2005 for sending them your Abstract.

Professor G.R. Dixon, Chair of the ISHS Commission Education and Training

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685	III International Symposium on Persimmon	58
684	Meeting of the Physiology Section of the European Association for Potato Research	56
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