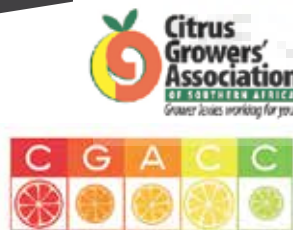


International Citrus Congress

The 14th International Citrus Congress (ICC) was held in Turkey from 6-11 November last year. By Jon Roberts



Jon Roberts



The ICC was postponed twice during the Covid-19 pandemic. The theme for this congress was aptly called "Reframing Citriculture: Better Connections for the Future". Apt, given the upheaval the world has experienced from the onset of the pandemic. The venue, Mersin, lies along the Mediterranean Sea on the fertile planes of Silicia (as it was known in ancient times) and reaches to the city of Adana. This is the main citrus-growing region in Turkey.

The opening lecture, framed the "History of agriculture from as early as the The Neolithic Era: The Changing Way of Life with the beginning of Agriculture" by Prof Dr Mehmet Ozdogan. It traced an ancient agricultural history, dating back to Çatalhöyük, a Neolithic settlement in the area occupied from the mid-seventh to the mid-eighth millennium, where houses were built

of sun-dried brick. It's here that discoveries of impressions of mats and baskets and pottery were found, as well as the presence of Mediterranean shells, metal ores and pigments not locally available, suggesting extensive trade. Agricultural activities showing the domestication of barley, wheat and dairy farming probably formed the main basis of the economy at Çatalhöyük. The location of the settlement on a river, subject to regular flooding suggests that irrigation may have been practiced. Many important figures in the history of civilisation, such as Alexander the Great, Saint Paul, Cleopatra and Mark Anthony met here. Aya Thecla and Prophet Daniel lived in this area and changed the course of history.

Historians believe that citrus fruits have been cultivated in Turkey since ancient times. And the Citrus Medica L., the ancestor of citrus trees, was brought to this region, Anatolia (Türkiye), from India at the end of the 4th century, BC. Turkey is one of the most important citrus-producing countries in the world today, as well as in the Mediterranean. The country is also now among the top three citrus producing countries in the Mediterranean basin and ranks eighth in the world.

With this backdrop, the International Society of Citriculture (ISC) and the organising committee set the theme of "reframing citriculture", by inviting citriculture professionals from around the world to deal with topics that address the challenges facing the industry today.

Challenges that face South African farmers include:

- issues such as drought, extreme weather fluctuation, water quality and scarcity, arguably as a result of climate change and certainly population growth
- continuous challenges presented by the spread of new diseases (e.g. HLB) and phytosanitary disease and pests, such as Alternaria, citrus black spot (CBS) and false codling moth (FCM), also arguably the result of climate change

- slowing demand and oversupply, resulting in socio-political trade barriers of entry into certain markets.

These same challenges are being felt by citrus farmers worldwide. Hence, the titles of the keynote and scientific presentations were well targeted.

There were more than 130 presentations and workshops over the four days. Highlighted here, are just some of the outstanding presentations that critically dealt with the innovative technologies being studied to deal with the challenges noted above that are also relevant to SA, mainly from a breeding perspective.

Breeding for citrus black spot (CBS) resistance, (by Malcolm W. Smith of Bundaberg research station, Australia)

Interestingly, an opening slide showed the vast amount of research spent on chemical and cultural control, which has only produced short-term solutions. Research on finding a lasting genetic resistance is almost zero over the years. Surprisingly, there are two citrus varieties – pummelo and lime – that have robust resistance to CBS and that have been known about for years. Back crosses of pummelo exists in many citrus types. Notably, in sweet orange and grapefruit, but also in lemon and many mandarins. This makes pummelo an obvious donor parent for the potential introgression of CBS resistance into new commercial cultivars. Hybrids between pummelo and mandarin in their breeding programme have shown evidence of CBS resistance. There are problems using pummelo as a breeding parent, including poor peel colour, high furanocoumarins (a potential health risk), and strong segment walls. But techniques are being developed to reduce carrying these traits through to the hybrid. A serious problem is the time it takes from the breeding to fruiting and evaluation for CBS symptoms. As a result, these obstacles have made

the identification of molecular markers a primary objective of their research toward the ultimate goal of timeously producing commercial cultivars resistant to CBS.

HLB-tolerance traits into citrus cultivars by crossing mandarins with an Australian lime (by J.W. Park)

This study selected five F1 "Finger Lime" hybrids that showed different disease responses to the HLB pathogen. One HLB-tolerant and three HLB-sensitive were used to investigate candidate gene(s) associated with disease tolerance. The preliminary data indicated that genes likely to be involved in pathogen-detection and defence response were upregulated in certain genes. In other words, the cell increases its response to a substance or signal from outside the cell to carry out a specific function. An example of upregulation in layman's terms, is the response of liver cells exposed to a toxin, where the cells increase its production of certain enzymes, which in turn increases degradation of these toxins. Currently, the functional relevance of selected genes toward HLB tolerance is under investigation, a study that must be monitored as the disease continues its progress through the citrus world.

An update on the national program for HLB tolerant rootstock evaluation in Australia (by T. Khurshid, F. Gmitter, K. Bowman)

Citrus Research International is carrying out a similar programme, led by Paul Cronjé and his team. As we know, there is no cure for this disease. However, there is a range of rootstocks that have been developed in the US which have indicated some tolerance to HLB disease. SA and Australia have decided to import these rootstocks and to test them for yield and quality, before the arrival of HLB in their countries. Australia will also test these in Indonesia where HLB resides, and SA will probably test for tolerance in African greening areas.

Increased citrus consumption

In terms of supply and demand, reports from Cirad show the consumption of citrus has not been climbing sufficiently to keep ahead of supply. And in some citrus types, such as grapefruit, consumption is flatlining.

Two presentations on "Health benefit of citrus fruit" (by L. Cisneros-Zevallos and Bhimanagouda Patil of the Department of Horticultural Sciences, Texas, US)

These presentations were outstanding and would go a long way in promoting citrus generically worldwide, if the message could be carried to the consumer.

The model in the first presentation by Cisneros-Zevallos, is based on the ability of secondary bioactive compounds to correct low-grade and chronic inflammation states that are responsible for most of the chronic diseases observed in society such as obesity, diabetes, heart disease, neurological disorders, cancer and others. They presented several studies confirming the applicability of the model, including work at Texas A&M research lab, using individual molecules, plant extracts such as Ellagitannins found in various fresh vegetable and fruit (including citrus) when broken down in the stomach by a healthy gut flora into Urolithins. The latter work against obesity and diabetes. In so doing, the model shows the ability of these compounds to reverse these chronic diseases as compared to the use of conventional medicine, which is therapeutic but does not reverse the condition.

The second presentation, by Bhimanagouda Patil, concentrated on extensive research on chemical fingerprinting of different citrus fruits, isolating and separating active molecules



and exploring their health benefits using molecular, animal, and human studies. Health benefits were demonstrated, based on several mechanisms such as antioxidant capacity, activation of enzymes, and induction of programmed cancer cell death. Furthermore, triterpenoids and flavonoids inhibit various tumors.

Their research has demonstrated the effects of selected bioactive compounds on the gut microbiome. Among these bioactives, polymethoxy flavones (PMF) regulated the gut microbiome, showing the potential as a prebiotic to support gut health and prevent many chronic conditions. Similar health benefits were reported for major citrus flavonoids such as hesperetin, naringenin, eriodictyol, isosakuranetin, and their respective glycosides. Citrus-derived flavonoids help prevent inflammatory bowel syndrome by balancing gut microbiota. Due to its positive influence on the gut microbiome, especially on microbes that may prevent chronic health conditions and promote absorption of micronutrients, citrus and their phytonutrients may serve as a source of multipurpose nutraceuticals with major clinical benefits. This will require further preclinical and clinical studies.

Climate change and citrus workshop

Citrus plants are one of the most widely grown fruits worldwide. It's mainly grown in tropical and sub-tropical regions that

require a suitable climatic condition for optimum growth and better quality. Citrus plants are highly sensitive to climate change. Abrupt fluctuations in temperature, water stress, soil conditions and other abiotic stresses significantly affect citrus yield. Climate change and agriculture are interrelated, affecting each other in

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multiple ways. Citrus is affected by factors that cause physiological, anatomical, and biochemical changes leading to reduced yield and fruit quality. As the effects of climate change become more evident, it would be prudent to develop models for the future management of citrus. Significant increases in temperature and drought affect citrus plant development and fruit quality, and in citrus producing countries this year, heatwaves led to pre-harvest fruit drop,

reduction in fruit peel thickness and fruit size, and increased fruit acidity in drought stricken areas. With increasing temperatures, the conditions for certain insects become suitable in places they had not previously established, which potentially can cause new infestations and diseases. Similarly, soil biota will be changed, and some viable organisms may shift their locality for survival. Climate change influences water deficiency, and temperature increase causes an increase in stomatal conductivity and transpiration rate. Climate change directly and indirectly, affects citrus yield due to heat stress, drought, and the CO₂ assimilation process through photosynthesis.

Presentations in this workshop focussed on the possible effects and projections of climate change on plant development, its nutrition, possible diseases, and pests that may affect citrus plants. Work on possible rootstock selection against biotic and abiotic stresses, and reduction in disease development were discussed. This is so that selection and choice of suitable scions and breeding strategies against climate change may be achieved in the future. The rootstocks presented are, likewise, also being evaluated in SA.

Of concern was the last-minute withdrawal of the South African plant-breeding contingent from the Agricultural Research Council (ARC) at the ICC, which resulted in several no-shows during proceedings requiring last minute reshuffling of the programme by the organisers. For whatever reasons, the no-shows stuck out and were concerning. I was asked by many why there was so little or nothing to offer in terms of plant breeding from SA, given that we are the second biggest exporter of citrus in the world. Like Spain, Florida, California, Brazil, Israel, Australia, Turkey and the likes, SA is now more than ever in crucial need of a breeding programme that confronts the same challenges of CBS, HLB and other diseases. The title of the ICC, "Reframing Citriculture: Better Connections for the Future", is surely relevant for contemplation by ARC SA. 



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