Greenhouse Agronomics:

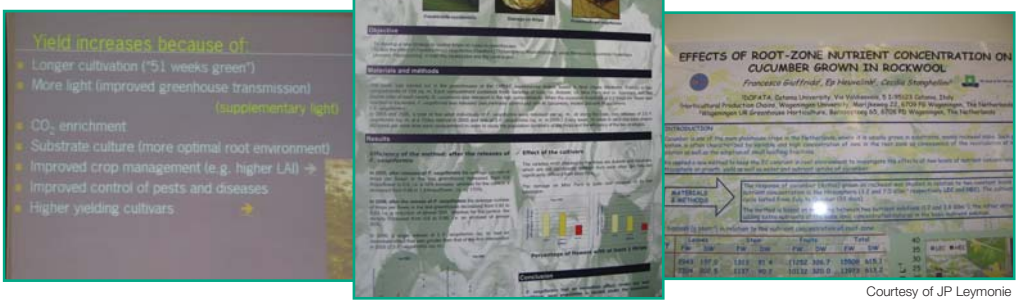
Some Interesting Developments in Water use, Plant Nutrition and Pest Management

The Greensys symposium in Naples was an opportunity also for Agronomists to present the result of their research. Amid papers that reconfirmed- sometimes from a different view-point, what is already documented, a number of papers drew the attention of participants because of their innovative approach either to water use efficiency measurements, water stress detection or the use of deep sea water for irrigation. However, the biggest attention was drawn by oustanding papers given on the interaction between fertilization and disease occurrence, and the early detection of plant damage due to pests and diseases using volatiles sensing.

WATER STRESS DETECTION BY CHLOROPHYLL FLUORESCENCE

The use of Chlorophyll fluorescence (the Fluorimetry technique) is today well known and has reached the commercial stage for predicting nutrient deficiencies. So far however, it had not been used for detecting water stress. The technique has recently been tested by Prof Mojtaba Delshad (University of Tehran, Karaj, Iran). In order to study the effect of water stress on Chlorophyll fluorescence parameters of greenhouse tomato three types of plants (1- cv. Trust as non grafted plants, 2- cv. Trust grafted on Eldorado, 3- cv. Trust grafted on Maxifort), and three growing systems (1- rockwool slab, 2- sawdust bucket, 3- sawdust bucket equipped with a capillary system) were compared within a greenhouse split plot design. The results show that suboptimal water supply expressed by low matric potential and low volumetric water content (v/v) of the growing media can be detected by changes in chlorophyll fluorescence parameters measured by dark adapted method (PEA). In Delshad's experiments, increasing water stress resulted in increasing F0 and reducing of Fm for all growing systems, and then reduced Fv and Fv/Fm ratio. Tomato plants grown in the capillary growing system showed less fluctuation in Chlorophyll fluorescence parameters such as Fv/Fm ratio than those grown in rockwool and sawdust without a capillary system. Under suboptimal water supply, grafted plants expressed better fluorescence parameters, such as higher Fv/Fm ratio, than none grafted plants. On the other hand, under moderate water stress, the use of Fv/Fm as a stress indicator is not sensitive enough. Delshad's conclusions are that other fluorescence parameters should be used as the PI. This work shows that there still is a fair amount of calibration work to do before commercially using the fluorimetry technique for evaluating water stress status of tomato greenhouse plants

Courtesy of Dosatron



Courtesy of JP Leymonie

and then as an irrigation management tool.

SIMPLE TOOLS FOR PREDICTING WATER USE AND WATER USE EFFICIENCY

There are not so many simple tools available in the market that are also precise enough to predict water use. This is why the research presented by Luca Incrocci (University of Pisa, Italy) in Naples, drew the attention. Simul-hydro is a simple tool for predicting the water use and water efficiency in tomato soilless closed-loop cultivations. It is in fact a simple spreadsheet able to calculate the water use, the run-off and some nutrient and water efficiencies according to the quality of the irrigation water used and its total evapotranspiration volume. Using some inputs such as total volume of recirculating nutrient solution (both the mixing tank and the solution retained by the substrate), the ion concentration of the water used to refill the crop evapotranspiration and the total evapotranspiration, the spreadsheet is able to calculate the total water use, the water and nutrient run-off of the crop. It is based on an aggregate model developed by Carmassi (2005) and basically consists of a combination of three simple sub-models: a) a nutrient ion uptake model, independent to the nutrient external concentration of each nutrient (N, P, K, Ca, Mg); b) a non–essential uptake model, with uptake directly correlated to the external ion concentration (for Na and Cl); c) a relationship between the total cations (or anions) concentration and the EC of the recirculating nutrient solution (formula proposed by Sonneveld et al., 1999). Using SIMUL-HYDRO may also be possible to investigate how the hydroponic systems and the water quality may infl uence the water and nutrient efficiency of a tomato soilless culture.

USING DEEP SEA WATER TO PRODUCE HIGH QUALITY TOMATO

It is not new that the application of saline water can have a positive impact on the quality of a number of fruits. A number of papers dealt with this topic in Naples. It is also not new that concentrated deep seawater can been discharged abundantly in processes producing many kinds of goods! So far however, still nobody had a really close look to how the irrigation application of such water could impact on the quality of horticultural crops. This is what Masaharu Kitano (Kochi University, Japan) and his team did, examining the impact of the application of the concentrated deep seawater on the quality of tomato by analyzing phloem transport and fruit quality.

Tomato plants were grown in an NFT system, where the concentrated deep seawater was applied for the short-term salt stress treatment for only two weeks at the stage of rapid fruit growth. Physiological effects of the short-term application of the concentrated deep seawater were analyzed with special reference to the expression of osmoregulation in phloem transport to fruits by using a newly developed method to evaluate fluxes and concentrations of soluble solids in phloem sap. Furthermore, effects on root absorption, leaf photosynthesis, fruit growth, accumulation of sugars, minerals, amino acids and antioxidants in fruits, flavour of fruits and occurrence of blossom-end rot were analyzed. From these physiological analyses, it was evidenced that the short-term application of concentrated deep seawater at the stage of rapid fruit growth can induce the osmoregulation in the phloem transport to fruits and can produce high quality tomatoes enriched in sugar, minerals, functional aminoacids and good flavour without occurrence of extremely small-sized fruits and blossom-end rot.

HEARD ON THE SPOT

Courtesy of JP Leymonie

"Simul-hydro is a simple tool that we have developped for predicting the water use and the water efficiency in tomato soilless closed-loop cultivations"

LUCA. INCROCCI

HEARD ON THE SPOT

Courtesy of JP Leymonie

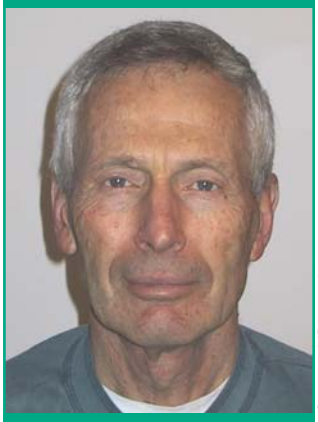
"Short-term application of the concentrated deep seawater at the stage of rapid fruit growth can induce the osmoregulation in the phloem transport to fruits and can produce high quality tomatoes"

KITANO MASAHARU

NITROGEN FERTILIZATION: A DIRECT INCIDENCE ON THE OCCURRENCE OF PYTHIUM AND FUSARIUM

It is well documented that nitrogen (but not only nitrogen!) nutrition of crops has a major impact on plant disease susceptibility to various root pathogens. The exact mechanism of N involvement is unknown but there are indications that it is associated with concentration and NH4:NO3 ratio in solution. The objective of the superb work conducted by B. Bar-Yosef (Agricultural Research Organization, Bet-Dagan, Israel) and presented in Naples was to investigate these relationships in a closed loop irrigation system with Pythium aphanidermatum inoculated cucumber as test crop. Treatments were NH4:NO3:Urea ratio at equal total N concentration (126±14 mg L-1 N) and N concentration at constant NH4:NO3 ratio of 30:70, both in the fill solution. Experiments were carried out in a climate controlled greenhouse with perlite #2 as growth substrate (12 L/plant). Threshold EC for solution discharge was 4.5 dS/m. Three days after planting, the recycled solution in all treatments was inoculated with Pythium aphanidermatum, the causal agent of cucumber root rot disease. Number of dying plants due to Pythium and root/stem rot of cucumber caused by Fusarium oxysporum f. sp. radicis-cucumerinum (the latter stemming from spontaneous infection in the green-

HEARD ON THE SPOT



Courtesy of JP Leymonie

"There may be a crop dependent mechanism explaining the relationship between NH4 and root diseases, complementary to the abiotic effect of high pH on NH3 release from NH4 in solution and its fungicidal eff ect on root pathogens"

BENI BAR YOSEF

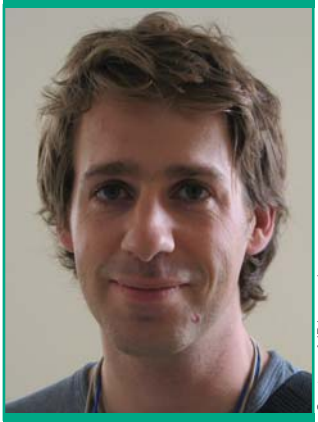
house) was recorded daily. Solutions were analysed daily for EC and pH and weekly for nutrients. Plants were sampled and analysed weekly for dry weight and tissue chemical composition. Results showed that after 40 days of growth, the mortality increased as the NH4:NO3 ratio rose from 20:80 (70% mortality) to 80:20 (94% mortality). In the presence of urea (50NO3:50 urea) the mortality dropped to 22%. At the end of the growing season (day 75) more than 90% of the plants died in all treatments as a result of the Pythium or Fusarium infection. When maintaining a 30:70 NH4:NO3 ratio and increasing total N concentration from 2 to 4-8 and 16 mM, the mortality after 40 days increased from 0 to 18-30 and 74%, respectively, and at 2 mM N no plant died until the end of the experiment. A similar conclusion was drawn from the results of number of days that were required to kill 60% of the initial plant population. Enhanced NH4 concentration in solution decreased the pH, which was negatively correlated with the % mortality (higher pH - lower mortality). Bar Yosef points out that it is unknown if the low NH4 per se caused the reduced mortality, the higher solution pH, or both factors operating together.

The Calcium content in leaves was found to be negatively correlated with the percentage of mortality (higher concentration lower incidence). As NH4 in solution is known to adversely affect Calcium uptake, Bar Yosef suggests that this might present a crop dependent mechanism explaining the relationship between NH4 and root diseases, complementary to the abiotic effect of high pH on NH3 release from NH4 in solution and its fungicidal eff ect on root pathogens.

THE PROMISING RESEARCH: A METHOD TO DETECT STRESS SIGNALS IN A GREENHOUSE, USING VOLATILE SENSING

Early detection and location of plant damage due to pests and pathogens is a major challenge in commercial greenhouse cultivation. It allows the grower to perform site-specific actions instead of full field treatment. Previous laboratory experiments had revealed that sensing volatiles released by the damaged plants might offer a powerful technique to monitor the status of greenhouse crops. Such laboratory experiments that confirm the change of volatile substances released after damage are not new. However, the development and validation of a method to detect plant induced volatiles in a greenhouse was not practiced until now. The objective of the outstanding research lead by Roel Jansen (Wageningen University, Farm Technology Group) and presented in Naples was to ascertain if volatile plant substances released after artificial damage could be detected under greenhouse conditions. A method was developed to analyse the air in a semi-closed greenhouse. This greenhouse was climate controlled and light was supplied with assimilation lamps. Tomato plants were grown in this greenhouse. These plants were artificially damaged on a weekly interval by touching the stems. Small, battery charged continuous flow pumps were used to purge the air surrounding the plants through tubes containing an adsorbent. The analysis of volatile compounds was performed using a high-throughput gas chromatography / mass spectrometry system. The method enabled the detection of baseline level emission and the emission of volatiles released after artificial damage of the tomato plants during a three months growing period. Most dominant volatile compounds after damage were the monoterpenes β-phellandrene, limonene, 2-carene and the sesquiterpene β-caryophyllene. The compounds showed an increase of 100 times compared to baseline level emission. With these results, Jansen and his team proved that it is possible to detect plant damage induced volatiles in a greenhouse. This area of research is very promising! We certainly look forward to reporting on new developments of this method on the occasion of Greensys2009 that will take place in two years in the welcoming city of Quebec (Canada). ■

HEARD ON THE SPOT



Courtesy of JP Leymonie

"we have proved that it is possible to detect baseline emission and plant damage induced volatiles in a greenhouse using dynamic sampling and gas chromatographic - mass spectrometric analysis. This area of research is promising"

ROEL JANSEN