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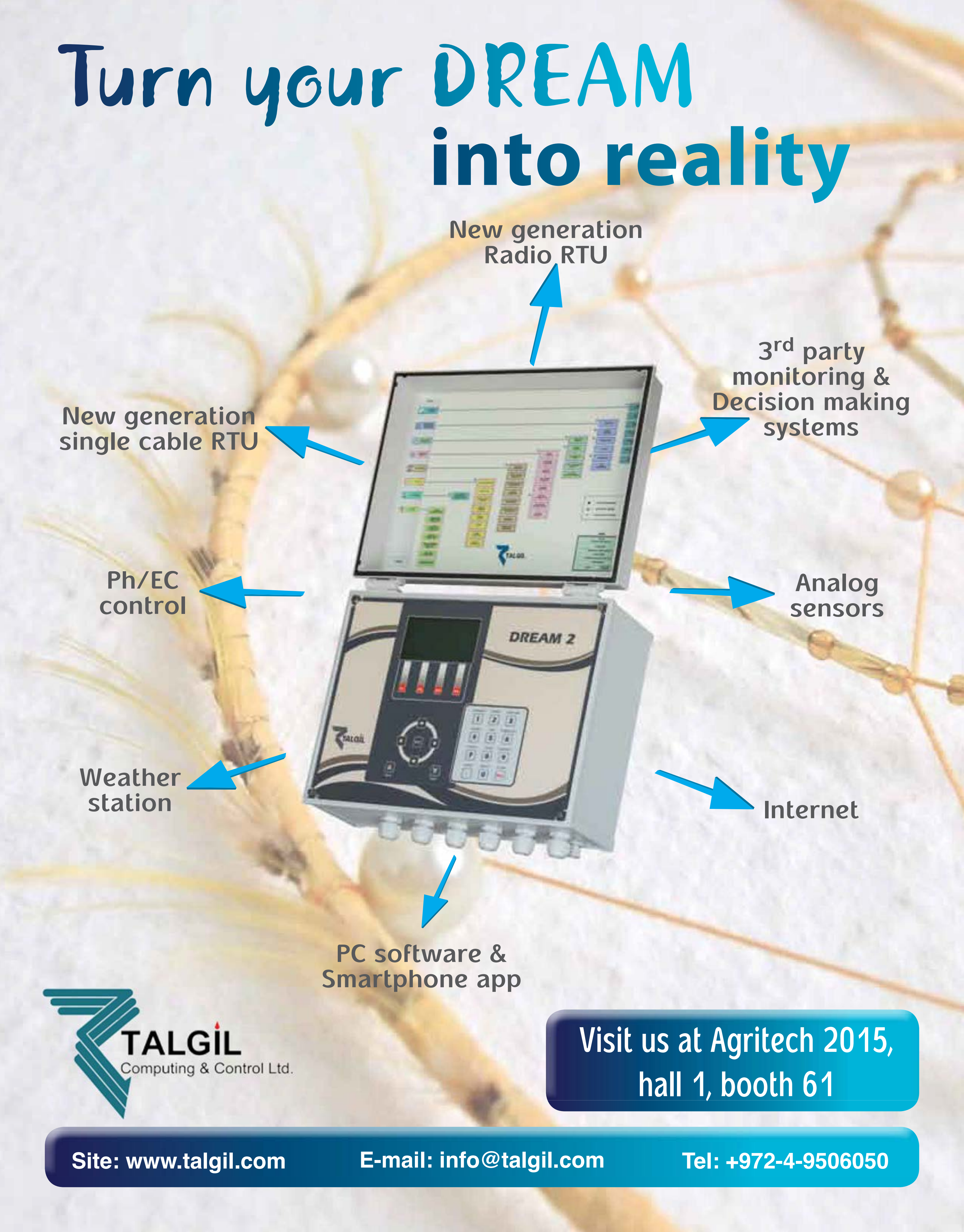
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INTERNATIONAL WATER & IRRIGATION

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ON THE COVER
Netafim, the global leader and pioneer of drip, is kicking off its 50th anniversary at **Agritech Israel 2015**. Based on the theme "50 Years of Shaping the Future with Smart Irrigation Solutions", Netafim's celebrations at the exhibition will be highlighted by the launch of its next-generation low-flow drippers. **Be sure to visit the company during Agritech at Hall 1, Booth #30.**

www.netafim.com

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Measuring water stress in grapevines through the use of thermal diffusivity and vapor pressure deficit sensors
In this article we describe how developments in technology are being used to to provide important decision support in irrigated agriculture

Measuring the effect of irrigation regimes on the yield and quality of Hydroponic Cut Roses
In this article we provide updates on research of which irrigation regime most ideally suits low-input greenhouse management for rose production in the south-Mediterranean area

Capturing sprinkler irrigation water to increase efficiency and profitability in the cultivation of container grown ornamental plants
In this article we provide updates on how researchers are quantifying how much irrigation water is being lost due to wrongly positioned sprinklers in plant nurseries and the steps taken to improve the situation

Precise Irrigation - Innovative sensor for crops water status

Saturas, a portfolio company of The Trendlines Group's Trendlines Agtech and the Migal Galilee Research Institute, is developing advanced sensor for precise irrigation.
Moshe Meron, Ph.D., a veteran researcher in the field of irrigation at the Migal Galilee Research Institute in Kiryat Shmona, invented the concept of the Saturas innovation: a miniature sensor embedded into tree trunks that measures the stem water potential of the tree. Stem Water Potential is a scientifically recognized, highly accurate parameter for determining water status in crops but, today it can only be measured by a complex and limited manual device.
With all due respect to saving water, in many countries, water for agriculture remains subsidized, but precision irrigation has added value, which is much more important to the farmer: the increase in yield, both quantity and quality. For the farmer, precise irrigation means higher income, less risk and losses, and saving water. Today, most farmers typically overwater crops by up to 20% "just to be on the safe side". Overwatering puts pressure on an already scarce and expensive resource, increases pollution from nutrient-rich runoff, affects the quality of the fruit, and reduces profitability.
Different water sensors for irrigation control have existed for 40 years, but Anat Solomon Halgoa, CEO of Saturas, explains why their sensor is innovative. "The older and simpler sensors are positioned in the soil and measure the moisture of the soil and provide statistical data. To water precisely, you would need six to nine sensors per hectare. "This is not economically viable," she says. "Other solutions measure the amount of shrinkage and expansion of the fruit or the trunk, but this measurement is problematic, insufficient, and are difficult to interpret," according to Halgoa.
Saturas' sensor is tiny, easy to use, relatively inexpensive and due to the accurate measurement only 1-2 sensors are required per hectare, therefor cost effective. For farmers in developed countries, who have achieved fairly precise irrigation, the solution can increase yields by 5%. For the farmer in Africa or Asia, the increase can be up to 20%. "It is clear to us that in the coming years, it is easier to talk with farmers from more industrialized areas," says Halgoa, "but the real potential is in Asia, Africa, and possibly South America."
In 2016, the company expects to have a product ready for market. First's tests in Avocado, Mango, Peach and Citrus obtained good and promising results. At the moment Saturas is raising funds to reach a final commercialized product.
For contact:
anat@saturas-ag.com;
www.saturas-ag.com

Jain Irrigation acquires PureSense assets

According to officials of the company, the acquisition will bolster the company's overall irrigation expertise. PureSense's field monitoring and irrigation management technology combined with Jain's global irrigation manufacturing gives farmers the ability to increase crop yields while managing limited resources.
According to Aric Olson, president of Jain Irrigation, when they were in operation PureSense delivered both great innovation and technological expertise using data and facts to assist farmers in making better day-to-day water, fertilizer, weather, and pest management decisions that have a decisive impact on farm profitability.
"We are looking forward to build upon the foundation that PureSense has created." Summed up Mr. Olson
At their peak, PureSense equipment was deployed on more than 1,400 farms that produced more than 50 different varieties of crops.

Californians preparing for a dry summer

In a somewhat controversial move, California water officials drafted a set of mandatory conservation regulations outlining varying degrees to which communities will be required to cut back on water use, ranging from 8 to 36 percent, depending on their history of water consumption.
The regulations - slated for approval in early May - are part of California's first-ever attempt at mandatory rationing. Earlier this month, Gov. Jerry Brown issued an executive order requiring a 25 percent reduction in urban water use, a historic step in a series of measures aimed at conservation ahead of the

state's fourth consecutive year of drought. Under the mandate proposed Saturday, which If approved by the State Water Resources Control Board will go into effect by the end of May, it will be up to individual water agencies to ensure that the communities they serve meet their required reductions. Failure to do so could result in up to $500 a day in fines.
The cuts won't have a tremendous affect on those communities with already low water consumption like San Francisco, which would need only an 8 percent reduction. It's places like Newport Beach and Beverly Hills, with required reductions of 32 and 36 percent, that face a real challenge.
The emergency regulations, taken in response to severe drought conditions, place the burden of water conservation primarily on the shoulders of working class residents, while leaving the vast agribusiness giants and other large corporate interests--which consume the overwhelming majority of the state's water resources--untouched.

Newly developed technology claims to purify waste water in less tha three minutes

A Mexican firm claims to have developed a new technique that can recover and purify sea and waste water in just two and a half minutes, regardless of the content of pollutants and microorganisms.
The System PQUA, works with a mixture of dissociating elements, capable of separating and removing all contaminants, as well as organic and inorganic pollutants.
The company's engineers developed a number of dissociating elements, and after extensive testing on different types of contaminated water, implemented a unique methodology that indicates what and how much of each element should be combined.
The corporation has a pilot plant in their offices that was used to demonstrate the purification process, which uses gravity to save energy.
In the initial phase of the purification

process solid, organic and inorganic matter as well as heavy metals are removed by precipitation and gravity after which a sludge settles at the bottom of the reactor.
Subsequently, the water is conducted to a clarifier tank, to sediment the excess charge of dissolved elements; then the liquid reaches a filter to remove turbidity and is finally passed by polishing tank that eliminates odors, colors and flavors.
The treated water is transported to a container where ozone is added to ensure its purity, and it finally is ready to drink. The resulting liquid is fresh, odourless and has a neutral taste.

Micro irrigation systems market to surpass the eight billion dollar mark by 2020

A recent research report released by Transparency Market Research under the title of as "Micro Irrigation Systems - Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2014 - 2020", has prophesyzed that the sector, which was valued at just under three billion US dollars 2013, is expected to reach a value of more than eight billion dollars by 2020, an increase of close to 200%.
The research study based on the micro irrigation systems market is formulated with an aim to provide a complete coverage of underlying technological and various economic issues driving the micro irrigation systems market both in terms of growth and restraints.
Using Porter's five force model analysis, market attractiveness analysis and value chain analysis, the report includes the detailed analysis of the company profiles and market trends to provide better understanding in terms of global competition.
According to the report, the two most important types of micro irrigation systems remain drip irrigation and sprinkler irrigation, with sprinkler irrigation systems have been the most dominating segment within the micro irrigation systems market.

The overall segmentation has been done to provide strategic insights for each category and also enable stakeholders to gain considerable business intelligence within the market.
Among the key industry players profiled in the report are the Lindsay Corporation, Jain Irrigation Systems Ltd., The Toro Company and Netafim Ltd., among many others. North America, Europe, Asia-Pacific remain the key regions detailed in the micro irrigation systems market report.

Ghana commissions $126 million desalination water plant

Ghanian President Mahama inaugurated the first ever 126-million dollar desalination water plant project at Nungua in the Greater-Accra Region.
The project, executed by ABENGOA, a Spanish innovative technology company, is scheduled supply about 13 million gallons of water daily to about 500,000 residents in Teshie, Nungua and Tema regions, all of situated in Greater-Accra.
The desalinated water is being sold to Ghana Water Company Limited under a 25-year build-own-operate-transfer (BOOT) model for distribution to households and businesses.
The project is expected to create 400 direct and indirect jobs with revenue forecast of about 1,300 million dollars over the 25-year period.
President Mahama said provision of the water projects formed part of government's transformation programme, as both residents and industries would benefit from the facility.
Ms Maria Alonso, Spanish Ambassador in Ghana, said since 2011 Ghana had been the second Spanish trading partner in Africa, going pn to provide assurances that such relations would be strengthened in other sectors.

UK gets water shortage warning

Much of England and Wales could face serious water shortages next year unless there is significant rainfall over the winter months, the Environment Agency warned.
The recent wet weather has done little to replenish water levels in rivers and reservoirs already low after one of the driest periods on record.
Six water companies have already initiated drought management plans to ensure supplies to customers remain unaffected.

The Environment Agency says the situation will not improve unless there is 120% of the average rainfall between now and next April.
Barbara Young, the Agency's chief executive, said: "We should not become complacent just because we have had heavy rainfall in the last few days.
"England and Wales has had an exceptionally dry summer and autumn and while water supplies have provided us throughout this period and supplies are secure for the coming winter, unless we receive higher than average rainfall between now and March we could be faced with water restrictions and serious water shortages in 2004."

The period from February until now has been the second driest in England and Wales since 1921.
The worst hit region is the South East where over the past three months some parts have seen as little as 30% of their average rainfall leaving many rivers flowing at only 20% of normal for the time of year.
The Environment Agency recently granted Thames Water two drought permits, allowing it to increase abstraction from the River Thames and a groundwater source for the next four months.

Decisions are awaited on applications for permits from United Utilities and South East Water, while Southern Water, Severn Trent, and Welsh Water are all expected to ask for permits. Among the Agency's tips for saving water are to replace worn tap washers to prevent dripping, use the minimum amount of water for boiling kettles and saucepans, select half-load programmes on dishwashers and washing machines wherever possible, and wash vegetables in a bowl rather than under a running tap.

An additional 290 hectare of farmland in the Balrampur district to be under irrigation

Around 290 hectares of additional agricultural land will come under irrigated after the completion of Kanhar Irrigation Dam situated in the Balrampur district of Uttar Pradesh state in India.
The region's government has also set aside sufficient funding to irrigate additional land of 1300 hectares under cultivation after the irrigation projects in Balrampur-Ramanujganj district is completed.
According to a recent statement, the Chhattisgarh Government has adopted a long-term view on the development of water resources, and ready with a Master Plan for development of rivers and other water bodies till the year 2025.
In the meantime, to minimize he gap between developed irrigation capacity and actual irrigation capacity, old irrigation schemes are to be renewed.
At present, 34.87 per cent ground water is currently being utilized in the region for agriculture.

100,000 Mexicans without water after oil spill

Some 100,000 people living in Southern Mexico were left without drinking water after rivers were contaminated by an oil spill, believed to have been caused by thieves who tapped a pipeline.
Authorities reopened two out of four water filtration plants that had closed after the weekend spill, which initially left half a million people without clean water in the city of Villahermosa, Tabasco state.

Municipal officials said the number of people without water dropped to 100,000, but the two other filtration facilities took a long time to recommence operations due to the amount of time needed by cleanup crews to large quantities of crude oil that had settled near the plants.
Thieves tapped a large oil pipeline operated by state-run energy firm Pemex on Sunday, causing oil to gush into local rivers.
The Tabasco state government urged residents to ration water until they could manage to clean up the mess completely.
Stealing oil has become a lucrative activity among drug cartels, forcing Pemex to stop shipping finished fuel through its pipelines after discovering 3,674 illegal taps last year.
The thefts have caused other environmental disasters in the past, with the most serious being a deadly explosion people in the central Mexican town of San Martin Texmelucan that occurred in December of 2010, which killed 29.

UAE plans to cut water consumption by 30% within the next 15 years.

According to a senior government official, the United Arab Republic (UAE) have plans in place that will see them to reduce their water consumption by 30 per cent by the year 2030. The savings will be made through a federal framework for economic growth and social development through sustainable initiatives.

The UAE Minister for Environment and Water, made the announcement at the recently concluded seventh World Water Forum in Korea, which featured 30,000 international government leaders and focused on addressing the increasing global water security challenge.
The high-level UAE delegation, played an important role in identifying and advancing solutions aimed at ensuring a sustainable water future.
The delegation also highlighted STEP, Abu Dhabi's Strategic Tunnel Enhancement Programme, which when completed in 2016, will be one of the largest gravity-driven hydraulic wastewater network tunnels in the world. ■

Galcon Smart™ is a revolutionary concept introducing a full line of smart controllers

Building on its own legacy as a manufacturer of the highest quality irrigation controllers, Galcon has continued to innovatively develop its unique products to meet the world's changing technologies and water needs and has become the leading provider of smart irrigation solutions for residential, turf & landscape and agricultural worldwide.

Efficiency today means communication connectivity and remote management.

Galcon Smart™ brings traditional irrigation solutions to the Internet of Things, enabling you to monitor and control every aspect of your water usage from anywhere you are in the world - at anytime.

Complete control is in the palm of your hand as you manage your system using your I-Phone, Android, laptop or any smart device with a variety of communications protocols, including radio, cellular, Wi-Fi and Bluetooth.

The primary advantage Galcon Smart™ gives you is precision and that means no more wasted water.

Galcon Smart™ products are proven to save you 30% and more on your water costs by allowing you to start and stop your usage according to changing conditions.

Galcon Smart™ systems monitor the weather information and automatically adjust the water schedule and usage accordingly. This not only saves you money on your water bill but also increases yield and minimizes operational costs.

This has made Galcon a global leader of Smart Irrigation. Awarded the prestigious Product of the Year 2013 by the European Irrigation Association (the EIA) for the GSI system and the first to be recognized by the EPA as an approved WaterSense solution, for the Cyber Rain system, Galcon Smart™ is redefining the precision irrigation industry.

Agricultural operators are saving water and money with Galcon Smart™ from the vineyards of the Napa Valley to the farms in Australia. Turf & Landscape contractors use Galcon Smart™ to lower costs and improve the beauty of their facilities. Galcon Smart™ is already installed in thousands of installations including famous resorts and hotels, the Milan Expo 2015, U.S. school districts, Fox Studios in Hollywood, Shanghai's highest tower and thousands of others in every type of climate.

In 2015 Galcon is planning to increase its Galcon Smart™ offering with additional Bluetooth and WIFI Controllers. ■

galcon

www.galconc.com

Israel

Ami-Tens

Advanced Tensiometers and Samplers

Ami-Tens Ltd., from Israel, Is one of the most experienced companies in production and marketing of Tensiometers and Soil-water samplers, used as basic and reliable devices to evaluate soil moisture and chemical content of water in the soil.

The traditional products of the company are:

a) **Mechanical Tensiometers** - a manual, reliable device that shows the water tension in the soil, which reflects the availability rate of water to the plant's roots.

b) Manual **Soil-Water samplers**.- Most popular devices through which the farmer can easily draw a sample of water from the soil and analyze it either on site or at a lab.

The company offers a few sub-models for sandy or shallow soils, for different depths etc. Recently **Ami-Tens** is focused on adapting its products to Electronic remote-control/monitoring, either through wired or wireless systems. The company has developed a few models of Analog Electronic Tensiometers. Equipped with an Analog Transmitter, with a standard output (4-20mA or 0-2/5V), these sensors can be linked to most of existing Irrigation controllers or data loggers in the market. The data logging, alarming or auto-control are done through the Logging/Control unit. If required, complete sets, including data Loggers and tensiometers, can be supplied through **Ami-Tens** itself.

Ami-Tens continues the development of new products and applications to modernize its product line and adapt it to the era of on-line and remote control, without neglecting the big market of simple, low cost products. **Ami Tens** is seeking new dealers, from any country, to expand its overseas markets. (Come and visit us in Agritech TLV, Hall 1, booth No.100)

Analog Tensiometer

www.amitens.co.il

Israel

TalGil

Mini-AGG

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Big features
Simple to use

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The Mini-AGG is a Professional, cost effective, small size agriculture timer. It combines the simplicity of time based controllers with professional features such as fertilization and filter backflush. The Mini-AGG has both AC & DC models. It has a flexible configuration (No output gets lost) and is modular -

2/4/6/8/10 outputs.

There are 3 independent irrigation programs, each with 6 start times.

It can control up to 2 fertilizer injectors with a booster pump and backflush up to 4 filters by time or by DP sensor.

Programing is done easily on the big customized LCD and with the help of the unique graphical representation of the system and current status.

DREAM2 - Rest Adaptor

Big data meets DREAM2

Talgil has developed a new and powerful adaptor, which allows any company (monitoring systems, crop disease prediction, Agronomic consultation, decision making...) to communicate directly via the internet with the DREAM2 server.

The communication is 2-way, so other companies can choose between just receiving data from the DREAM2 (Flow, accumulations, analog sensor readings, alarms..), or additionally applying it in their algorithms and then use the same adaptor to send back commands to the controller, including - Start or stop a program, change a water or fertilizer dosage, change the interval between cycles and more.

This new adaptor allows combing the strongest professional irrigation controller in the world with the agronomic knowledge and knowhow of virtually any company in the world.

www.talgil.com

Israel

Rivulis Irrigation

S2000 Micro Sprinkler

The S2000 Micro Sprinklers are the ideal choice for a wide range of applications including irrigation, cooling, and frost protection for orchards and

groves. Built to last, the S2000 Micro Sprinkler line incorporates a strong bridge, built-in anti-insect device, and a wear resistant design.
The S2000 Micro Sprinkler delivers a consistent spray pattern at a low angle, avoiding low hanging branches. The sprinklers can be configured with add-on features such as a spinner with a range limiter, for a smaller wetting diameter around young trees or a trunk protector to keep the spray away from the tree trunks.

The sprinklers can be installed on the ground with a plastic stake or hung from a wire. The S2000 Flow Regulated Micro Sprinkler has the added feature of flow regulation, extending the use of the sprinklers to applications with sloping fields and long lateral runs.

Features
Built-in anti-insect device
Wear resistant design

www.rivulis.com

Israel

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Du-component PC dripline

Single piece, dual component PC dripper
PC labyrinth in a one-piece dripper
PC dripper for thin wall and medium wall thickness driplines
Dripper flow rate: 1.0 l/h
Lateral diameter 12-22 mm
Lateral wall thickness 0.15-0.4 mm (6-16 mil).

www.metzerplas.com

Spain

AZUD

State-of-the-art technology, maximum uniformity and anti-siphon system

AZUD PREMIER PC AS is the flat Pressure Compensating bond-on in multi-seasonal driplines developed by AZUD. Its design is based on three key elements:

1. **Anti-siphon system:** It prevents the introduction of contaminants inside the emitter.
2. **Maximum resistance to clogging:** the design of the labyrinth, with DS Technology, and H.E.X. protection system guarantee a high resistance to clogging.
3. **Higher pressure-compensating range:** thanks to the combination of SILITEC membrane and the ELIPSIS chamber.

The main application of this product is the Sub-surface Drip Irrigation for multiseasonal crops, but also it is used for irrigation in intensive crops, for tree exploitations and irrigation in greenhouses.

www.azud.com

Israel

A.R.I.

NEW: complete line of composite material check valves from 1½" -10"

A.R.I., in response to our customer needs, has expanded the size range of our family of NR-010 "Regev Lite" check valves.
The NR-010 line of check valves is optimized for low pressure (10 bar) and is designed for installation in greenhouses, irrigation systems, swimming pools, storage tanks and water transmission systems.
They are specially designed for both horizontal and vertical installation after pumps and booster pumps.

Benefits:

- Compact structure, lightweight
- Easy to maintain
- Uninterrupted flow passage
- Full and quiet closure
- Low head losses
- Enhanced sealing system
- Components made of corrosion-resistant materials
- Saves on installation costs
- Available for purchase with a limit switch
- Check valve in sizes 1½" & 2" - with a removable cover that allows for cleaning, maintenance and replacement of spare parts without the need to download it from the line.

The NR-10 is currently available in diameters 1½"-8", soon to be available also in 10".
For more details: ari@ari.co.il

www.arivalves.com

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Assessing the potential of utilizing solar energy in pressurized irrigation networks

Introduction

In recent years the growing use of various forms of irrigation in agriculture has increased energy demands and the high energy tariffs, which follow an upward trend, have created an increasingly untenable situation in the sector.

In the Southeast of Spain, one of mainland Europe's most active agricultural centers, statistics show that energy consumption in the irrigation district and on-farm irrigation systems accounted between 18% and 29% of the total annual energy consumed during water supply.

Nevertheless, the water supply at basin level, running from the water source to the pumping station within the irrigation district represents the highest energy consumption.

irrigation agriculture has increased energy demands and the high energy tariffs, have created an increasingly untenable situation in the sector

Consumption that can range from between 0.06 kilowatts per metric cube of surface water up to one kilowatt per metric cube for external water transfers.

Over the years a number of possible scenarios have been developed to reduce the energy consumption of the irrigated areas to improve the efficiancy of water and energy. Energy efficiency criteria incorporated into the design of networks layout and pumping stations, while contiguous studies have developed strategies in order to improve management, reducing the energy requirements of the irrigation networks and with it reducing energy costs.

Throughout Spain, electricity is generated mainly from fossil fuels and minerals, which are not only non-renewable but also produce significant environmental impacts.

Recently, the incorporation of renewable energy in water distribution systems is being considered as a new alternative, especially in urban supply systems, with an eye to reducing negative effects on the environment while at the same time enablng sustainable development in different productive sectors.
Another alternative being considers is the installation of hybrid systems that will hopefully generate an optimal combination of several energy sources, among them solar, wind and hydro, which would make for a reduction in energy costs contributing to the sustainable management of water distribution systems.

In the agricultural sector the implementation of renewable energy resources is becoming increasingly common, such as the use of solar energy to power in pumping systems for irrigation, although, at least for the time being, these energy resources are only being applied in small farms with low power requirements *(not exceeding 10 kW)*.

In order to recieve a clearer picture of the possible benefits potential benefits, both economic and environmental, of the joint application of energy saving measures and renewable energy in one irrigation district with high power requirements, a series of tests were carried out in the Guadalquivir river basin in Southern Spain.

Material and methods

The study area is situated in the Bembézar Margen Izquierda *(BMI)* irrigation district is located in the Guadalquivir river basin of Córoba in Southern Spain. ***(See Figure One)***.

The climate of the region is typically Mediterranean, with annual rainfall concentrated mainly in autumn and spring, with long dry spells in summer, with an average annual rainfall in the area is 540 mm and the average temperature is 17.9°C.
The total irrigated area of BMI is around four thousand

Figure One: *Location of the Bembézar Margen Izquierda irrigation district*

hectares, cultivating a very wide diversity of crops, in particular Citrus fruit, with maize and wheat also widely grown.
Irrigation water for the region is diverted from the Bembézar dam to the pumping station, operated using four main pumps of 800 kW backed up by three auxiliary pumps generating 315 kW, ensuring a service pressure of 30 m at hydrant level.

Energy saving scenarios

In order to arrive an accurate assessment of energy costs, four management scenarios were proposed to analyze energy consumption, CO 2 emissions and the energy costs in the BMI region. The first scenario represented the current operation of the studied irrigation district, while the remaining three were designed to represent alternative management strategies.

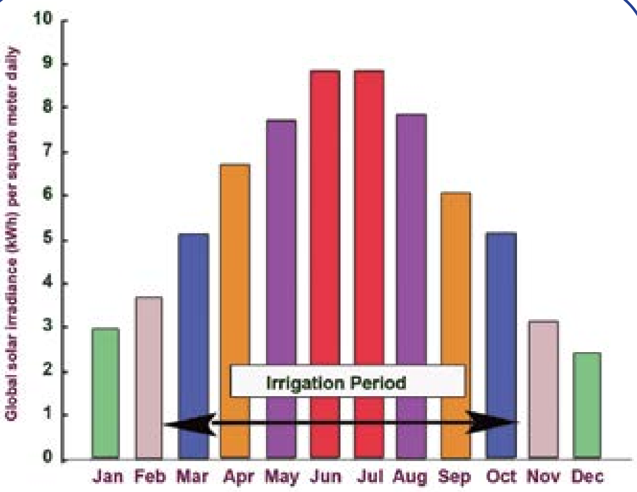


Figure Two: *Global solar irradiance at selected Bembézar Margen Izquierda irrigation district during course of the trial period*

Scenario One represented the current management of the pressurized network, organized on-demand, so all the sectors could be irrigated 24 hours daily. The current pressure head, situated at the pumping station, was fixed to 52 meter cube in order to ensure a minimum pressure head of 30 meter cube at pumping station level.

Scenario Two represented two independent sectors, according to two topological dimensionless coordinates, under semi-arranged demand where farmers were organized in two irrigation schedules of 12 hours per day, with the required pressure head at the pumping station different for each sector.

Scenario Three represented a photovoltaic *(PV)* system designed to produce the annual energy required by the sector with the lowest energy requirements in sector two, combining sectoring *(energy saving strategy)* with the use of renewable energy resources.

Scenario Four was designed to be similar to Scenario three, although the PV system was designed to supply energy to the sector with the highest energy requirements in scenario two. ***(See Figure Two)***.

Results

Evaluation of potential energy savings with Scenario One compared to Scenarios Two, Three and Four

The daily energy requirements in every month for on-demand operation *(Scenario One)* and sectoring operation *(Scenarios Two, Three and Four)* are shown in ***Table One***.
The average energy savings when the network operates in sectors reached 30.8%, with this value found to be practically constant for all months.
The total annual energy requirements in Scenario One amounted to 4,319 Megawatt-hours *(MWh)* annually, while in Scenarios Two, Three and Four they amounted to 2,985

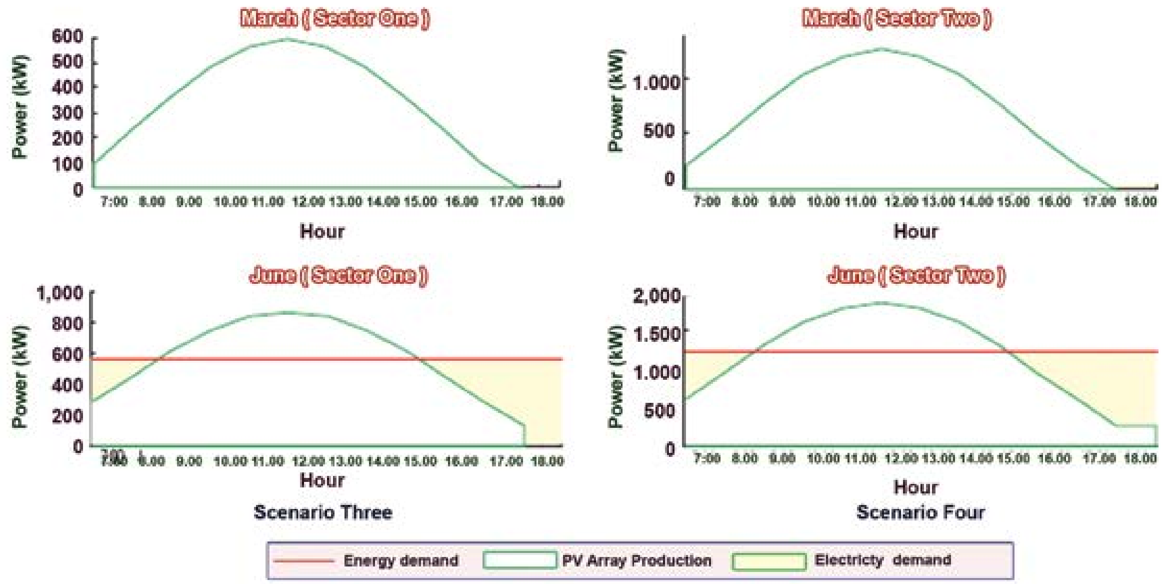


Figure Three: *Average hourly photovoltaic array energy production, pumping energy requirements (Sectors One and Two) and external energy requirements for 1 MW (Scenario Three) and 2.1 MW (Scenario Four) solar photovoltaic systems*

Megawatt-hours *(MWh)* annually.
When sectoring, Scenario One demanded 31% MWh of the annual energy requirements while Scenario Two demanded 67%.

Optimum PV system (scenario 3 vs. scenario 4)
In the previous analysis, the total energy requirements were seen to reduce when the network was operated in two irrigation turns *(two sectors)*, with the PV system produced different results.
Scenario Three was used to evaluate the feasibility of installing a PV system to supply the annual energy requirements used in Sector One which produced 918 MWh annually.
In this permutation, Sector One would irrigate for a total of twelve hours during the hours of sunlight, with the power supplied by solar energy while Scenario Four was operated solely at Sector Two, irrigating for 12 hours at night, while consuming energy from conventional resources but taking advantage of less expensive energy rates.
Contrarily, Sector Four was supplied with water using solar energy in Scenario Two *(2,067 MWh annually)* while Scenario One would irrigate at night.
In order to calculate the size of the PV array, the daily energy requirements in the more restrictive month *(June)* were considered while Scenario Three was taken into account to provide the daily energy demands for March in Sector One of 6,751.4 kilowatt hour *(kWh)* daily and scenario four for the daily energy demands simulated in the Sector Two of 15,201.9 kilowatt hours daily averages.
PV production and purchased from the electricity supplier as well as the balance between the annual energy demand is shown in ***Table Two***.
In these scenarios the energy produced by the 1MW PV

Table One: Average daily energy requirements (kWh daily) and potential energy requirements (%) for on-demand (Scenario One) and for supply according to sectors (Scenarios Two, Three and Four)

	March	April	May	June	July	August	September	October
Scenario One	1,511	13,458	24,778	31,789	30,867	25,152	12,139	1,478
Scenarios Two, Three and Four								
Sector One	339	2,894	5,324	6,751	6,556	5,245	2,586	311
Sector Two	708	6,514	11,966	15,202	14.798	11,900	5751	726
Sectors One and Two	1,047	9,409	7,291	21,953	21,354	17,145	8,337	1,037
	(30.7%)	(30.1%)	(30.2%)	(30.9%)	(30.8%)	(31.8%)	(31.3%)	(29.8%)

Table Two: Annual Energy Balance

	Scenario One	Scenario Two	Scenario Three	Scenario Four
Energy Demand (MWh annually)				
Sector One	4,319	2,067	2,067	2,067
Sector Two	-	918	918	918
Total	-	2,985	2,985	2,985
Photovoltalic array production (MWh annually)				
Total	-	-	1648	3543
Purchased Energy in quantities (MWh annually)				
Sector One	4,319	2,985	2,067	354
Sector Two	-		148	918
Total			2,215	1,272
Purchased Energy in terms of percentages (MWh annually)				
Sector One	100%	100%	16%	100%
Sector Two	-		100%	17%
Total			74%	42.6%

system in Scenario Three is used to irrigate Scenario One. What has to be taken into account, however, is that for a few hours, additional energy was required, making up just 16% of the annual energy requirements. Consequently, the total energy that needs to be purchased from the energy supplier in Scenario Three amounted to 2,215 MWh, 74% of the total energy demand.

The 2.1 MW PV system laid out in Scenario Four was seen to produce 83% of the annual energy demanded by S2. The energy purchased in this scenario was 1,272 MWh, equivalent to 42.6% of the total annual energy demand.

> Any measure to reduce energy demand is liable to make a onsiderable contribution to profitability

Table Three: Energy cost analysis

	Scenario One	Scenario Two	Scenario Three	Scenario Four
Energy Cost (€)				
Sector One	-	82,617	17,731	91,797
Sector Two	-	248,051	206,709	42,641
Total	475,085	330,668	224,440	134,258
Energy costs according to area (€ per Hectare)	11.8.8	82.7	56.1	33.6
Energy Cost Savings (%)	0	30.4	52.8	33.6

Economic viability

In the BMI region, operating costs result in general from the electricity consumption in the pumping station, with the impacts of the implementation of energy saving measures were quantified.

The energy costs for the four Scenarios are shown in ***Table Three***.

Conclusions

In Spain, the irrigated areas with pressurized irrigation networks are usually organized on-demand and, for that reason, require a great deal of energy for their operation, so much so that energy consumption in irrigation *(water pumping)* accounts for between 50%-70% of the total greenhouse gas *(GHG emissions)* of the agricultural sector. As energy consumption in the pumping stations and GHG emissions are directly linked, water supply generates significant GHG emissions, meaning any measure to reduce energy demand is liable to make a considerable contribution to the reduction of the greenhouse effect, while from the farmer's perspective, the continued increases in electricity tariffs encourage the necessity of adopting energy saving measures that would reduce the total energy costs.

Effects of different drip irrigation regimes on cotton yield in the saline–sodic soils of Northwest China

Introduction

Soil salinity and sodicity, either individually or collectively are a global problem posing significant threats to the sustainable development of agriculture, in particular in the arid and semiarid regions of the World.

A typical example of the problems caused by salinity and sodicity can be readily found in Xinjiang, a typical arid region of Northwest China, where salinization and sodification of soils have been causing serious land degradation issues for many years. It is estimated that one third of the arable land of the region is affected, greatly reducing agricultural output in the area.

> Soil salinity and sodicity, either individually or collectively are a global problem posing significant threats to the sustainable development of agriculture

The salinity problems of Xinjiang are exacerbated by the region's inland arid conditions and water resource shortages. Under saline conditions, the reduced growth of crops is caused by the effect of the osmosis, which greatly increases clay dispersion and reduces aggregate stability, resulting in a decline in air permeability, infiltration and hydraulic conductivity.
These factors will inevitably hinder root respiration, reducing plant growth and activity of soil organisms.
Drip irrigation, thanks to its characteristic of applying water at a low discharge rate and high frequency over a long period of time provides consistent soil water levels in the root zone, reducing salinity levels in soil water by leaching, particularly in the region of drip emitters.
As a result of these factors, drip irrigation scheduling has consistently been proven to be highly important in salt leaching efficienc, with previous research having confirmed its impact on different levels of soil matric potential *(SMP)* to trigger drip irrigation in arid and semiarid regions
Previous studies on the subject have focussed in particular on the damaging effects of soil salinity, sodicity and soil hydraulic properties, with particular emphasis on improving levels of soil salt movement and plant health.
Correspondingly, a limited number of studies have been carried in an effort to gain a deeper understanding of the actions of soil nutrients during the reclamation process under drip irrigation.
It is generally understood that soil structure and root activity decline with increasing sodicity in a saline-sodic soil, in the process reducing nutrient mobilities and leading to nutrient deficiencies, leaving organic matter and mineral nutrients in saline-sodic soils are generally at low levels.

The objectives of this study were held in Xinjiang with the following aims:

- To investigate the effects of drip irrigation triggered by different SMP thresholds on the distribution of soil mineral nutrients *(inorganic N, available P and K)*;
- To measure the effects of different SMP thresholds on soil carbon-to-nitrogen *(C:N)* ratio and seed cotton yield during three years of land reclamation under drip irrigation.

Materials and methods

The field experiments were conducted over the space of three years on a saline wasteland located in the middle of the Jungger Basin situated in the Xinjiang Province, Northwest China.
The area has a typical inland arid climate with annual precipitation of about 105 mm, mainly concentrated in the summer months, while the average depth to groundwater

ranges between 2.5-3.0 meters.

The soils in the area are typified as being chloride-sulfate-type saline-sodic soils, with the climate and special geographical conditions combing to make this region liable to accumulate salt on the soil surface.

The nutrient concentration of soil samples at different soil depths are shown in ***Tables One and Two***.

Plot layout and irrigation water management

The tests covered a total of five water treatments *(S1-S5)* based on the SMP, measured with tensiometers located at a depth of 20 cm beneath a dripper, situated near the center of the plot for each treatment ***(See Figure One)***.

Treatments were replicated three times in a completely randomized block design, made up from plots consisted of twenty rows of cotton planted on 10 raised *(15 cms)* beds, spaced at 0.8 meters apart.

The beds were mulched with white polyethylene sheets after sowing. Each bed was 0.4 meters wide and 3.8 meters long, while the plots were eight meters long by four meters wide.

Each treatment area was irrigated using an independent irrigation system that consisted of a water tank containing 1000 liters to which 30 drip lines were attached, at the ratio of ten tubes per plot, with the tank placed at a height of one meter above ground level in order to maintain water pressure.

The drip tubes, with 20 cm emitter intervals between each dripper were placed at the center of each raised bed.

To enable the seedlings to emerge, 40 mm of water was applied to all treatments immediately after seeding, while scheduled and irrigation treatments were initiated around three weeks after seeding in each of the three years that the tests were held.

The on-site tensiometers were read three times daily at 8:00, 12:00 and 18:00.

Plant management

Seeds of cotton were sown on during the second week in May for the three years of tests. The cotton seeds were

sown ten cms apart in double rows with the rows were 30 cms apart.
Almost immediately after their emergence, the plants were thinned to a spacing of 30 cm.
The cotton harvest got under way at the end of September and was completed by the third week of November, making for an average harvest duration of 53 days.
In each of the three years, the cotton was hand picked at four to seven day intervals, with the total weight per plot was checked at each harvest time.

Fertilizer management
A basic dose of of a compound fertilizer *(16% N, 35% P_2O_5 and 8% K_2O)* was applied at the rate of 450 kilograms per hectare at the time of plowing before seeding, with the fertilizer dose supplemented with urea *(46% N)*, applied through the irrigation system.

During the course of the trial, the levels of soil salinity, sodicity and nutrients were significantly affected by the soil matric potential thresholds under drip irrigation

Table One: Soil texture and bulk density of the initial soil profile at Xinjiang, Northwest China

Soil depth (cms)	Soil mechanical composition (%)			Soil texture	Soil bulk density
	Clay	Silt	Sand		
0-40	1.18	93.5	5.34	Silt	1.33
41-60	1.03	99.0	0.00	Silt	1.43
61-90	0.54	95.4	4.07	Silt	1.47
91-120	0.41	96.0	3.56	Silt	1.56
121-180	0.26	96.1	3.68	Silt	1.38

Soil sampling and chemistry analyses
In a saline soil, the soil salinity distributions clearly showed leaching near the drip lines, an area where the root density has been found to be at its maximum level.
Since the low ECe zones were found to be within 40 cms of the dripper, a soil depth interval of 0-40 cm was analyzed.

Soil samples were obtained on soil cores from each plot before seeding as well as the end of the irrigation season.

Results and discussion

Weather and irrigation
The summer temperatures for year one of the test were higher than those in the two following years, although during the other months, the mean temperatures were very similar among the three years ***(See Figure Two)***.

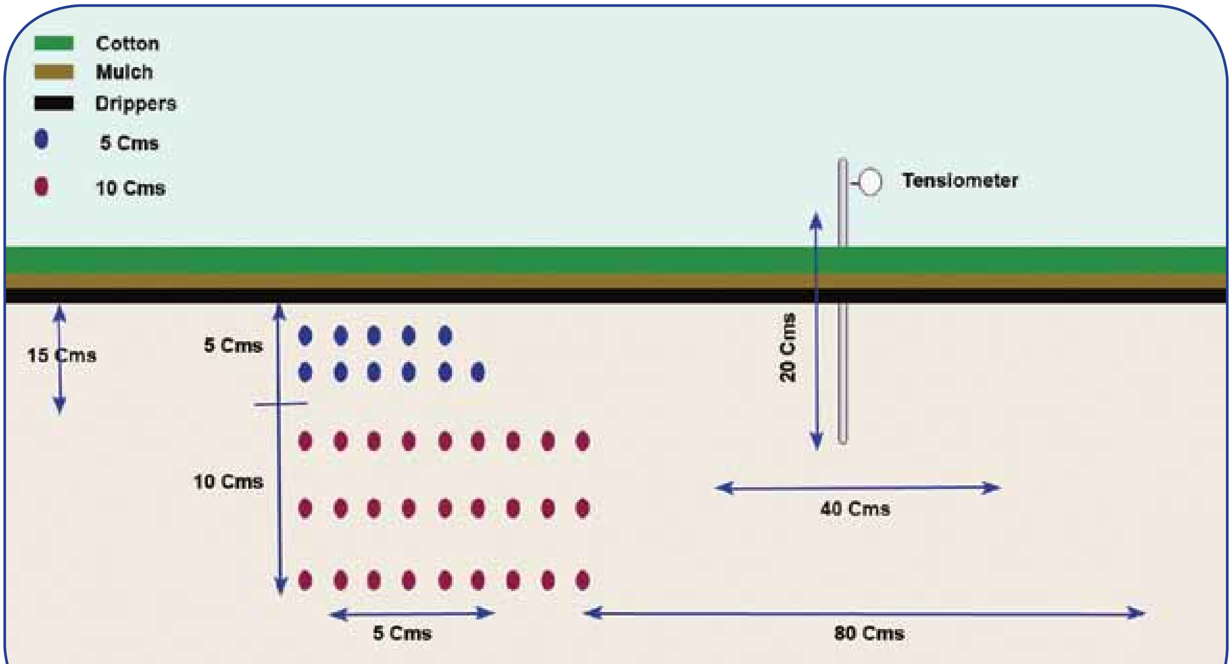


Figure One: *Dimensions of beds and position of the tensiometer and soil sampling*

Table 2: The concentration of total N and available P and K and inorganic N (NO3 - -N and NH4 + -N) at the test site in Xinjiang, Northwest

Soil depth (cms)	Total N (%)	Available P (mg-kg$^{1)}$)	Available K (mg-kg$^{1)}$)	NO_{3-}N (mg-kg$^{1)}$)	NH_{4-}N (mg-kg$^{1)}$)
0-30	0.03	4.06	115.4	8.4	18.7
31-60	0.02	2.44	119.5	10.6	9.9
61-90	0.02	1.83	132.0	10.3	10.8
91-120	0.01	2.23	82.4	11.1	9.9
121-180	0.02	0.81	701.	11.5	9.0

Total rainfall during the experimental period was 71mm, 81.mm and 115 mm in year one, year two and year three respectively. Before cotton emerged, all treatment plots were irrigated with the same amount of water to ensure uniform germination. After that, irrigation treatments were triggered by different SMP thresholds.

Higher SMP threshold resulted in longer irrigation times and

hence greater amounts of irrigation being applied ***(See Table Three)***. The highest quantity of irrigation water was applied in S1 *(-5 kPa)* each year, while the maximum *(665.6 mm)* was applied in year one.

Spatial and temporal changes in soil nutrients

Soil N

In this study, soil inorganic N *(NO3 - -N and NH4 + -N)* distribution within 40 cm depth was analyzed after irrigation ceased for each treatment in year two. The two types of inorganic N accumulated mainly in the upper soil layer *(0-20 cm)*. After the first growing season, a significant increase in total N was observed in the upper 40 cm of soil in all treatments, compared with those before seeding.

Soil available P

The soil available P distributions in the soil profile were similar to those for soil inorganic N. By the end of the final

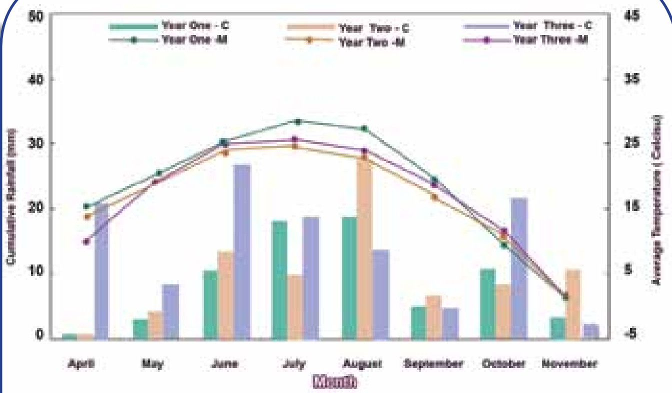


Figure Two: *Monthly rainfall and mean temperature during experimental stages during trial years one, two and three*

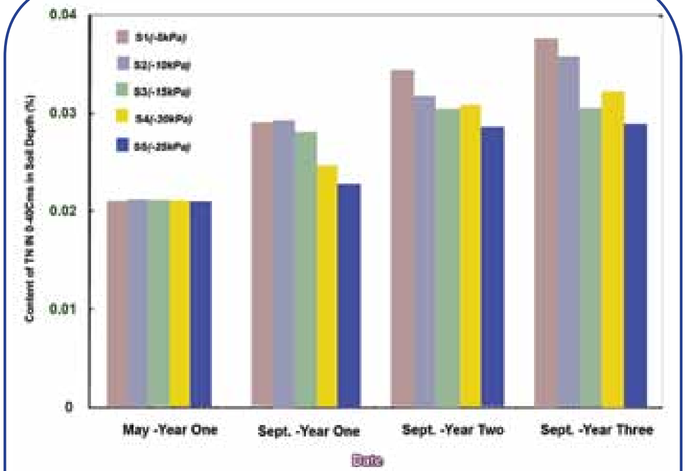


Figure Three: *Total nitrogen (TN) content at 0–40 cm depth before seeding in year one and after irrigation terminated in years one, two and three for each treatment*

year of the test, the average value of soil available P in 0-40 cm depth had increased to 11.1-6.8 mg kg-1 for S1-S5 treatment.

Soil available K

After At the end of the final year of the tests, the soil available K was seen to have arrived at a range of range of 155-179 mg kg-1 in 0-40 cm depth of soil for the five treatments. At higher SMP thresholds, soil reclamation was observed to be more efficient both for nutrients and for structure, which ratified the differences among the five treatments in SOC each year.

Cotton yield and soil carbon-to-nitrogen (C:N) ratio

The highest seed cotton yields for both years two and three were in the S1 Treatment sector, where the yields were 67 and 84% of the average level for non-saline soil in this region, respectively.

Conclusions

During the course of the trial, the levels of soil salinity, sodicity

Table Three: Irrigation treatments and amount of applied water for each treatment during the experimental stages in years one, two and three

Year	Treatments	Fresh water for seedlings (mm)	During treatment	
			Irrigation Times	Water depth (mm)
Year One	S1 (-5kPa)	40	68	666
	S2 (-10kPa)	40	47	460
	S3 (-15kPa)	40	30	293
	S4 (-20kPa)	40	28	274
	S5 (-25kPa)	40	26	254
Year Two	S1 (-5kPa)	40	65	636
	S2 (-10kPa)	40	47	460
	S3 (-15kPa)	40	38	372
	S4 (-20kPa)	40	37	362
	S5 (-25kPa)	40	25	244
Year Three	S1 (-5kPa)	40	65	627
	S2 (-10kPa)	40	56	541
	S3 (-15kPa)	40	38	363
	S4 (-20kPa)	40	28	274
	S5 (-25kPa)	40	24	235

and nutrients were significantly affected by the soil matric potential thresholds under drip irrigation.

With the reclamation in both soil chemical and physical properties, there were dramatic increases in soil N, P and K concentration by the end of 3 years of the experiment.

The soil concentration of inorganic and total N, available P and K was proportional to the SMP thresholds, as higher SMP resulted in more efficient soil reclamation.

Overall, considering the soil reclamation efficiency, soil nutrient stocks and cotton yield, SMP thresholds of -5 and -10 kPa were deemed the most effective to be used to gauge as effective measures to trigger irrigation in the first three years of saline-sodic soil reclamation in Xinjiang, Northwest China.

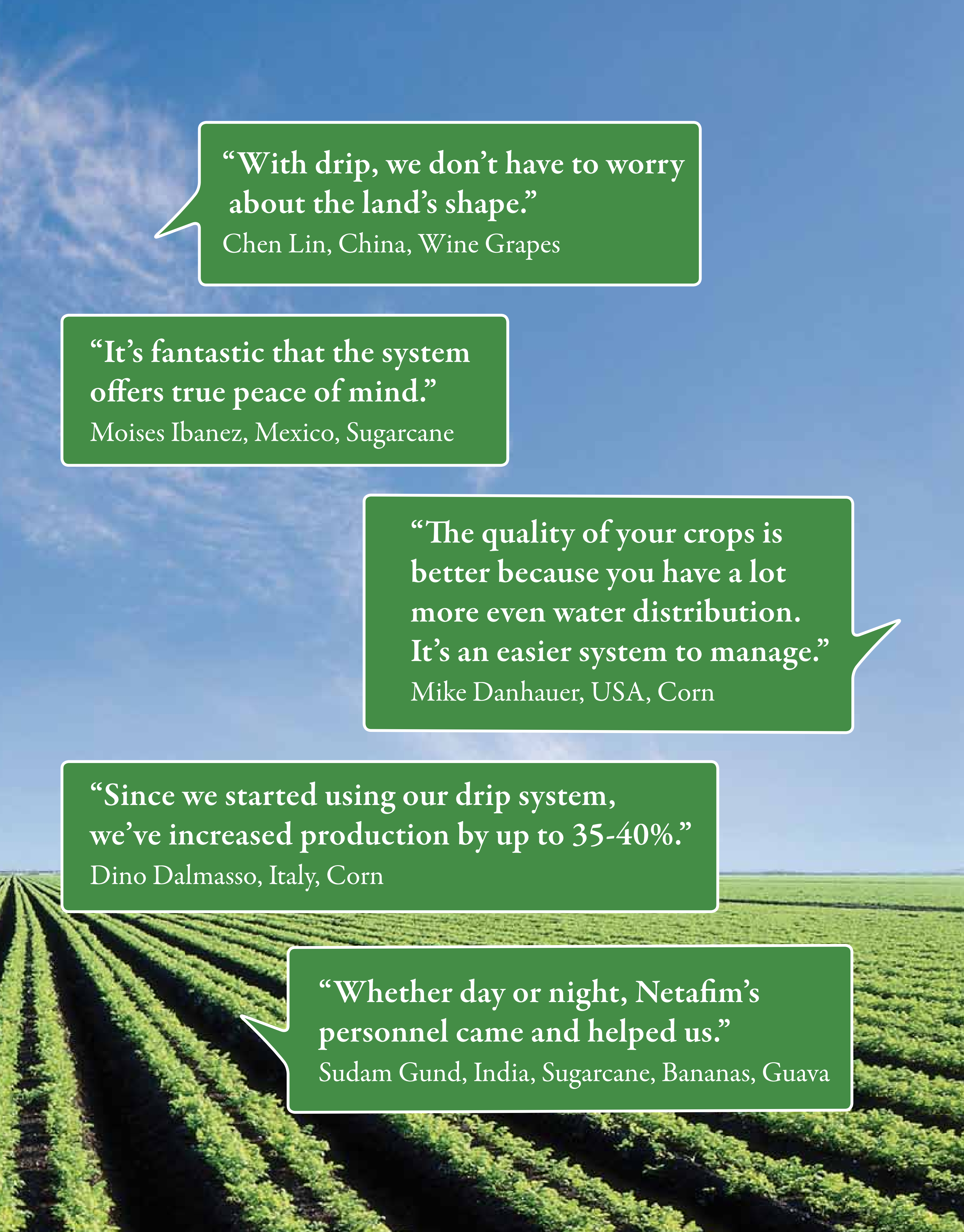
Soil carbon-to-nitrogen *(C:N)* ratio was observed to be one of the key factors influencing soil organic matter *(SOM)* decomposition, with relatively high C:N ratio liable to result in the competition for nitrogen meaning an adverse impact on crop yields.

In saline-sodic soil, the sum of the osmotic and matric stresses was seen to limit crop yields, while the amount of applied N, P and K taken up by the crop and the amount of C produced by the crop in the form of roots and foliage was seen to increase.

International Water & Irrigation takes a look at Netafim's customer testimonials

Recently our staff had a chance to view Netafim's video testimonials of customers throughout the world. Below are a few of the many testimonials appearing on the Netafim website.

To see more, go to:
www.netafim.com/customer-testimonials



"With drip, we don't have to worry about the land's shape."
Chen Lin, China, Wine Grapes

"It's fantastic that the system offers true peace of mind."
Moises Ibanez, Mexico, Sugarcane

"The quality of your crops is better because you have a lot more even water distribution. It's an easier system to manage."
Mike Danhauer, USA, Corn

"Since we started using our drip system, we've increased production by up to 35-40%."
Dino Dalmasso, Italy, Corn

"Whether day or night, Netafim's personnel came and helped us."
Sudam Gund, India, Sugarcane, Bananas, Guava

Measuring water stress in grapevines through the use of thermal diffusivity and vapor pressure deficit sensors

Introduction

Measuring soil and plant water status to provide decision support in irrigated agriculture is on the brink of a breakthrough, with the development of robust and reliable field sensors being made available to growers.

Previous research on water stress measurement through utilizing thermal diffusivity and vapor pressure deficit sensors has led to the suggestion that water dynamics within a plant will be better understood through the combination of data gathered from both sap flow and stem diameter variation, in particular to enable accurate measurement of plant water status in a grapevine cane under conditions of increasing water stress.

Measuring soil and plant water status to provide decision support in irrigated agriculture is on the brink of a considerable breakthrough, with the development of robust and reliable field sensors being made available to growers

The perception gained was that change in stem water content was the driving force behind the changing thermal diffusivity, as transpiration drained stored water from the plant stem.

In order to understand more on measuring water stress in grapevines through the use of thermal diffusivity and vapor pressure deficit sensors a series of field trials were carried out using an improved thermal diffusivity(TD) sensor implanted in the xylem tissue of Cabernet-Sauvignon grapevines in a commercial vineyard.

The purpose of the research was to test to what levels the incorporation of a vapor pressure deficit *(VPD)* sensor into the TD sensor would allow the response of the plant to be compared to the daily atmospheric demand that drove changes in sap flow and stem water storage.

To provide a clear picture, a mathematical algorithm designed to provide accurate reporting a single 'crop water stress' figure was developed, aimed to provide vineyard managers with a simple and robust daily value, which would integrate the crop's response over the previous diurnal cycle.

Despite considerable efforts to the contrary, to date, there is no simple strategy in place where irrigators can arrive at a daily crop water stress quotients that will allow them to confront the challenge of applying exactly the correct quantity of water to their vines.

To provide a clearer picture, a series of field trials into crop water stress was carried out over two consecutive growing seasons in the Riverland region of South Australia, a region which is currently producing more than half the vast continent's wine production.

Field Trial Methodology

Field trials were conducted at a 250 Hectare vineyard, situated close to the town of Waikerie in the South Australian Riverland.

The trials were based around five treatments T0 though to T5 were instrumented, having irrigation rates as follows:

- T1 - 6.6 ML per Hectare
- T2: 3.3 ML. per Hectare
- T3: 2.3 ML. per Hectare
- T4: 1.7 ML. per Hectare
- T5: 0.6 ML. per Hectare

Each of the treatments consisted of five vines rows, with the measurement instrumentation placed in the center of

A thermal diffusity sensor in operation

the central row of each block, providing buffer zones on all sides, with two sensors per treatment were deployed; one sensor in each of two adjacent vines.

Soil moisture tension sensors were located at four depths between the two adjacent vines in which plant-based sensors were installed at depths of 10 cms, 20 cms, 40 cms and 80 cms depths, adjacent to the active root zone of the two vines.

A three-core SDI-12 cable provided by a nearby weather station connected all crop water stress sensors and soil moisture sensors back to the data logger, which recorded not only climate, soil moisture, VPD and TD data, but also monitored various diagnostic parameters reporting operating and error conditions within the sensors. Data was automatically uploaded each day to an FTP server, allowing researchers remote access to the data with all measurements were made at a 15 minute interval.

The plant's response was integrated over the full 24-h diurnal cycle between the resting phases of the plants.

Materials and methods

Thermal Diffusivity

Thermal diffusivity *(TD2)* is a property of a material that describes the thermal time of a plant, with an ideal state being 'thermal constant" with TD2 being used to measure
how quickly the vine's temperature will change in response to a sudden change in heat input.

At work in the process of maintaining a 'thermal constant" state are the opposing actions of thermal conductivity *(trying to take the heat away)* and thermal storage

a strong relationship between soil moisture conditions and levels of crop water stress in vineyards

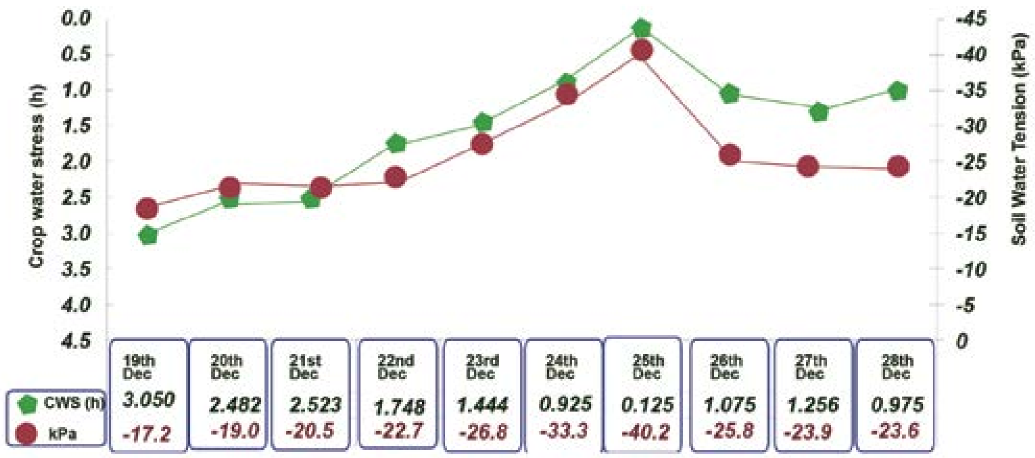


Figure One: *'Crop water stress' versus average soil moisture tension for a one-week period: when irrigation was withheld. The steady increase in crop water stress corresponds well with the increasingly dry soil conditions* *(trying to store the heat within the plant)*. Thermal diffusivity can be described as the ratio of these two properties; the thermal conductivity divided by the material's volumetric heat capacity.

To achieve a full picture the correct operation of this thermal diffusivity sensor depends upon good thermal contact with the surrounding plant tissue. Although poor thermal contact may not neccesarily damage the plant, it causes its temperature to rise more than normal as it attempts to push the same amount of heat through a far smaller contact area.
The sensor is in place to detect and reports this error.

Vapor Pressure Deficit

Another means of assessing the value of VPD is through assessing the atmospheric demand for water or the 'drying power' of the air. VPD is usually measured in pressure units, in most cases either millibars or kilopascals, with the data gathered basically a combination of temperature and relative humidity, grouped together as a single value. VPD values run in the opposite way to RH vales, so when RH is high VPD is low.

The higher the VPD value, the greater the potential the air has for sucking moisture out of the plant,
with VPD providing what is, for the grower, a more accurate picture of how plants relate to temperature and humidity.

A well positioned sensor measuring the air temperature and humidity close to, or just below, the crop canopy is adequate for providing a good indication of actual leaf conditions.

Water Dynamics

The effects of plant water dynamics on the thermal diffusivity sensor can be described as two-fold, although, in both instances, the plant sensor is sensitive to both sap flow and tissue water content.

Plant water content changes during the day as plant water status changes, a fact that researchers have been aware for decades, thanks to the use of dendrometers, which have in the past proven that stem diameters shrink during periods of maximum transpiration.

The tests carried out reaffirmed the theory that plant tissue is capable of "relaxing " and even "recharging" overnight from the stresses caused by daily transpiration. Theoretically the grapevine's tissue density increases, making for a steadily decreasing thermal diffusivity, and as a result. The component of heat stored by the extra water in the surrounding tissue causes the tissue density to increase.

These changes in the local cell water content have a knock-on effect on the wood-to-water ratio which will influence tissue density, causing changes in the local volumetric heat capacity.

Data from field trials of the sensor in grapevines showed that unstressed vines have a CWS of over three hours, and stressed vines have a CWS measured only in minutes.

Results and discussion

Efficient irrigation remains a very important factor in grapevine production in water-short regions. In order to improve irrigation management in vineyards a plant based technique capable of diagnosing the onset and severity of water stress is proposed.

This technique, based on the proven actuality that stem water potential can play a part in providing a reliable indicator of grapevines water status, although not without its disadvantages,

The use of thermal diffusivity and vapor pressure deficit sensors is a procedure that requires to be assessed continuously over a sustained period, with particualr emphasis on measuring the close relationship between mean daily sap flow decrease and stem water potential.

According to data gathered during this more than year long trial, the information can be used as an accurate and simple signal for real-time irrigation scheduling in vineyards, requiring only a small number of sensors generating data which can be easily gathered and simple to understand.

Possible discrepancies of the method due to seasonal fluctuations in VPD and evaporative demand are expected to be negligible due to the inherent ability of grapevines to regulate their transpiration rate, thus exerting fine control over transpiration under completely different evaporative conditions.

Despite the data gleaned being limited, the amount of useful information gathered suggests a strong relationship between soil moisture conditions and levels of crop water stress in vineyards.

Wastewater Treatment and Recycling treated wastewater for Agriculture

Ofer Levy

The treatment of wastewater and its recycling for agricultural irrigation is an extremely important solution for the water shortage problem. Mekorot treats about 160 million cubic meters of wastewater per year, totaling about 35% of the wastewater in Israel.

In total about 430 million cubic meters of treated wastewater are reclaimed in Israel for agricultural use. This makes up about 85% of Israel's total wastewater - a world record. Of this, Mekorot recycles 60% high quality treated wastewater for irrigating agricultural crops in compliance with the highest available standards!

Mekorot's strategic goal for the coming decade is to increase the use of treated wastewater for irrigation to 90%. To achieve this goal, Mekorot investigates substantial resources in developing innovative, advanced technologies - both in an effort to increase the output and to improve the quality of the treated wastewater while at the same time reducing costs. High quality treated wastewater that is used for irrigating agricultural crops frees up the fresh water that had previously been supplied to the agriculture sector - for use in the domestic sector. Thus, this important activity contributes toward improving Israel's water balance.

Through recycling treated wastewater to the Negev, Mekorot accomplishes multiple objectives: optimum utilization of the treated wastewater, diversion of a greater amount of freshwater for household and industrial sector consumption, creation of green orchards and fertile agricultural lands in areas that were previously arid and barren, reducing the potential for groundwater pollution due to lack or treatment and non-disposal of wastewater, and providing a solution to the problem of the pollution of coastal waters as a result of the direct discharge of raw sewage into the sea.

Photo: Eli Degani

Besor reservoir

Wastewater treatment

Wastewater treatment is typically a four-stage process: pretreatment, primary treatment, secondary treatment and tertiary treatment. Mekorot's activities in its wastewater treatment facilities integrates novel physical, chemical and biological techniques based on the principle of putting microorganism sludge in contact with high-load wastewater while providing a massive supply of oxygen (aerobic conditions). This process drastically shortens the time it takes for the natural treatment to take place: from weeks or months to less than 24 hours, at the end of which we are left with high quality secondary treated wastewater, which is suitable for limited irrigation of agricultural crops.

In addition to improving the water balance, wastewater treatment is extremely important for preserving the environment, for maintaining the biological balance and for reducing groundwater pollution.

Photo: Moshe Shai

Shafdan

The SHAFDAN - the Tel Aviv Area Wastewater Treatment Plant

One example of Mekorot's activity in the area of wastewater treatment is the SHAFDAN - the Tel Aviv Area Wastewater Treatment Plant under the ownership of Igudan (the Dan Region Association of Towns for Sewage and Environmental Issues). The SHAFDAN is the largest wastewater treatment plant in Israel and in the entire Middle East. There are seven member municipalities in the association and other communities are connected to it as well. It serves a population of over 2 million in the densest, most highly populated region in Israel - the Dan Region. The SHAFDAN, which is considered the largest and most advanced plant of its kind in the Middle East, handles about 130 million cubic meters of wastewater per year. Mekorot has been responsible for operating the wastewater treatment facility for over 40 years. After the water is treated at the SHAFDAN, Mekorot sends the treated wastewater to its "Third Negev Line" where the treated wastewater (purified effluent) is injected into the ground via injection fields, where it undergoes filtration and natural treatment enabling its quality to improve to a very high grade (tertiary treatment), and seasonal as well as perennial storage using a unique method.

Treated wastewater recycling

Mekorot is considered one of the leading companies worldwide in terms of recycling treated wastewater - both in terms of quantity and in terms of quality. Mekorot recycles 60% high quality treated wastewater for irrigating agricultural crops in compliance with the highest standards!

The way the treated wastewater recycling systems are managed enables total separation between the treated wastewater which have been injected into the water table and the natural groundwater. The separation is achieved by maintaining a pumping regime via boreholes, which ensure water levels which prevent the injected water from mixing with the natural groundwater.

The treated wastewater recycling enables directing additional freshwater for household and industrial uses.

The "Third Negev Line" supplying treated wastewater for agriculture

One example of a Mekorot recycling project supplying treated wastewater that has undergone tertiary treatment for irrigating all sorts of crops is the "Third Negev Line" project. For this project, Mekorot treats the SHAFDAN treated wastewater through tertiary treatment. The treatment is done by injecting the treated waters into the Mekorot mechanical-biological wastewater treatment facility at the Yavne and Sorek Sites, into the subterranean strata of the coastal aquifer. In the course of the injection, the treated wastewaters undergo physio-chemical and biological processes, which substantially improve their quality. This section of the coastal aquifer serves as a seasonal and perennial storage site for the large quantities of reclaimed water. The treated wastewater is stored in the aquifer using a special method as mentioned earlier, which prevents the treated wastewater from mixing with the natural groundwater!

During the dry months, Mekorot reclaims these treated wastewaters from underground and transports them via the "Third Negev Line" for irrigation. Thanks to the high

Photo: Eli Degani

quality of the treated wastewater produced after the tertiary treatment, these waters are suitable for unrestricted irrigation of all kinds of crops, in accordance with all requirements, free of health concerns.

The Third Negev Line system, which went into full-scale operation in November 1989, enabled the separation of two supply systems: the potable water supply line (the eastern Yarkon-Negev pipeline and the western Yarkon-Negev pipeline), and an irrigation water supply system. In order to identify and prevent confusion between the freshwater and reclaimed water systems, different colors were assigned to the respective systems' facilities.

The upcoming era - membrane treatment of treated wastewater

Within Mekorot's research and development efforts to develop new water technologies, Mekorot has been researching the membrane treatment of treated wastewater to upgrade it to drinking water grade. At its experimental plant at the SHAFDAN site, a semi-industrial facility is running, processing treated wastewater and bring it to a high quality grade, like the quality of the treated wastewater at the "Third Negev Line", such that it will become suitable for unrestricted irrigation of all sorts of crops.

This need for technology is due to the forecast for coming years, according to which we will have a surplus of treated wastewater from the wastewater treatment plants in the Tel Aviv area. The solution for this is to be based on the technology being developed by Mekorot.

The resulting water will be used for various purposes: agricultural, for unrestricted irrigation of crops, aquifer replenishment and industrial use. The resulting water quality is close to that of the "Third Negev Line" plant, where the secondary treated wastewater is injected into the aquifer through sandy percolation ponds for tertiary treatment using the Soil-Aquifer Treatment (SAT) method.

Measuring the effect of irrigation regimes on the yield and quality of Hydroponic Cut Roses

Introduction

Water management efficiency is an essential factor in the profitable cultivation of non food crops, with ornamental plants.

Over the years, considerable research has been carried out on irrigation strategies with the aim of developing solutions which would ensure enhanced water use efficiency while at the same time, making little or no indent into the grower' s profit margin.

The general consensus in the plant nursery industry is that efficient automated irrigation methods remain a necessity

> Efficient automated irrigation methods remain a necessity in professional cultivation

in professional cultivation, and methods employed should be based on proper calibration of all aspects of the greenhouse environment, taking in solar radiation, air temperature and relative humidity, as well as plant canopy temperature, leaf transpiration and/or substrate moisture level.

Despite these conclusions having been drawn drawn, some aspects related to the quantities of irrigation water to be fed to the plant remain incompletely clarified, especially in the areas characterized by high temperature and low relative humidity.

For that reason, further studies to gain a greater understanding on the influence of water supplies for ornamental crops were recently carried out, The aim of the study was provide a more in-depth definition of appropriate irrigation protocols for high-quality production and reduced water use in the Mediterranean or high temperature climates.

To understand more a series of research was carried out on the irrigation management of roses. The research took place in Sicily, in the South of the country, a region characterized by its mild winters and hot-dry summers.

In this trial, different irrigation control methods based on climatic parameters were compared. The integrated solar radiation system used was identified as the most objective and effective method for the operation of an automated irrigation system, as, though restrictive with water supply, the system did not limit plant growth neither flowers production and quality.

The trials were conducted on rose plants grown under a soilless platform, under decreasing water supplies.
The overall aim of the study was to evaluate the effects of different irrigation regimes on cut rose yield and quality based on solar radiation values.

Materials and methods

Greenhouse Facilities and Plant Material
The trial was carried out over a period of just over one year in an unheated *(28°C day/14°C night)* single-span EW oriented greenhouse *(25 meters × 8 meters)* built on a steel structure and covered in 0.15 mm thick polyethylene, The greenhouse was situated within the Research Unit for Mediterranean Flower Species near Palermo in the coastal plain of North Western Sicily.

Plants of the cultivar 'Red France', grafted on Rosa indicia major rootstock, were grown in 80 L polyethylene bags filled with a mixture of coconut coir dust and perlite, cultivated within a semi-closed hydroponic system.

The plants were arrange in completely randomized blocks design, replicated four times, with each replicate consisted of 27 plants *(three bags)*.

Each bag *(0.5 m²)* contained nine plants, making for a total density of 4.3 plants per square meter. All the plants were cultivated following the 'bending' technique in which weaker and unmarketable stems were bent horizontally in order to promote basal shoot formation and to increase plant canopy and light interception

Irrigation Control
Water, macro and micro-nutrients were supplied to plants through a drip fertigation system *(1 dripper per plant, providing 2 Liters per hour)* with irrigation and fertilization being administered by an on-site computer.

The pH and the electrical conductivity of the nutrient solution were maintained at 6.0 and 2.0 decisiemens per meter *(dS/m)*, respectively.

Three irrigation regimes, high *[HIR]*, medium *[MIR]* and low [LIR) were tested: every regime was characterized by the same duration of irrigations two and three minutes each for the winter and summer periods.

Irrigation was administered daily, according to a preset level of accumulated radiation exposures of 150, 300 and 450 *(kJ/m²)* during winter, respectively and 300, 600 and 900 kJ/m2, during summer. The reason for the variation of radiation levels was to achieve a picture of different total water supplies for all treatments in every season.

The accumulated radiation was measured by a solar radiation sensor, with all irrigation events as well as accumulative radiation readings were collected by a data-logger.

Measurements and Data Analysis
Flower stems were harvested by cutting to the second node from their origin.
Productive *(number of flower stems/ plant, number of leaves/stem, stem fresh and dry weight, dry matter partitioning, water use efficiency)* and biometrical (stem length and thickness, bud length and width) parameters were measured during the trial.

Dry weight of the biomass was determined after they spent 48 hours in an oven *(at 105°C)* when harvested stems reached a constant value.

Water use efficiency *(WUE)* was calculated as the ratio between dry biomass produced and plants total water supply.

Average daily accumulated solar radiation ranged from a minimum of 142 kJ/m²
In December of the trial year, reaching a maximum of 945 kJ/m² in the previous September.

Regarding cut flower production, no significant differences were observed among treatments *(average 14.0 stems/ plant)* despite of the irrigation regimes used ***(See Table One)***.

Stem length and thickness were not affected by the irrigation regimes, with an average 52.5 cms in length and 5.5 mm

low irrigation regimes appear to be the most efficient alternative for a low-input greenhouse management in rose production in the south-Mediterranean area

Table One:- Effect of irrigation regimes on cut rose yield and quality

Irrigation regime	Stems/plant (number)	Stem length (cms)	Stem thickness (mm)	Bud length (cms)	Bud width (cms)	Leaves/stem (number)
HIR	15.5	52,3	6.1	3.6	3.3	8.3
MIR	14.1	53.1	5.0	3.5	3.1	8.3
LIR	12.4	52.2	5.5	3.6	3.0	8.4

Table Two:- Effect of irrigation regimes on cut rose fresh and dry weight and dry matter partitioning.

Irrigation regime	Cut rose fresh weight (grams)	Cut rose dry weight (grams)	Bud dry weight (grams)	Stem dry weight (grams)	Leaf dry weight (grams)
HIR	23.2	14.6	5.5	4.7	4.3
MIR	20.9	14.3	5.7	4.5	4.1
LIR	22.1	14.1	5.6	4.5	4.0

in thickness being recorded, with no major differences being recorded among the three treatments ***(See Table One)***.

Similarly, no significant differences were observed among the irrigation regimes used regarding to the flower bud length *(average 3.6 cm)* and bud width *(average 3.1 cm)* ***(See Table One)***.

In addition, it was observed that leaf production was not influenced by the irrigation regimes, averaging 8.3 leaves/stem across the three treatments ***(See Table One)***, while variations in irrigation regimes had no effect on cut rose fresh and dry weight of the roses, which averaged 22.1 and 14.3 grams respectively across all treatments ***(See Table Two)***.

Regarding the dry matter partitioning, irrigation regimes did not influence the dry weight of flower buds, with an average of 5.5 grams recorded irrespective of the treatments ***(See Table Two)***.

No significant differences were recorded among the three treatments as far as stem and leaf dry weight, which averaged 4.6 and 4.1 grams respectively in all of the irrigation regimes ***(See Table Two)***.

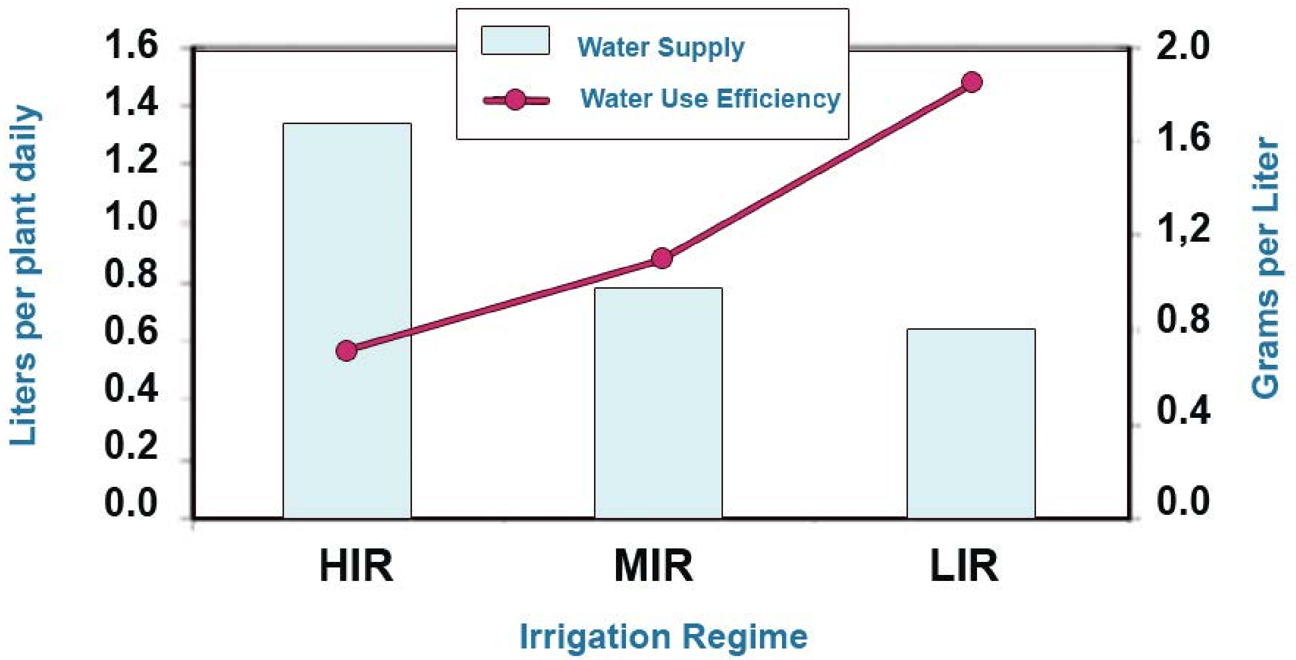


Figure One: *Water supply and water use efficiency of hydroponic rose plants under different irrigation regimes*

The irrigation regimes were observed to differ significantly in water supply, with plants grown with HIR showed higher supply *(1.3 liter per plant daily)*, whereas plants grown with MIR at 0.8 liter per plant daily and LIR at 0.6 liter per plant daily ***(See Figure One)***.
The tests also showed that the water use efficiency was highly affected by irrigation regimes as plants grown with LIR evidenced higher WUE at 1.8 grams per liter, while plants grown with MIR were characterized by lower values at 1.1 grams per liter and LIR by even less at 0.7 grams per liter.

Discussion

Results showed that the low irrigation regime was more effective for soilless culture cultivated roses as it was observed there were no differences on flower yield and quality compared to medium and high irrigation regimes with a lower water supply and higher water use efficiency under the low irrigation regime.
These outcomes confirm previous findings in which different irrigation control methods displayed a similar yield for cultivation of cut roses, through a series of different water supplies.

The results from this trial partially agree with previous research, which claim that the total number of rose stems decreased significantly in water-stressed plants, even though the number of extra-quality stems was not affected, as was the mean length and weight of the flower stems.

Differences in water use efficiency among the three irrigation regimes Corroborate previous research findings, which claim that roses grown under a reduced water supply showed higher water use efficiency, while plants irrigated with larger water quantities were characterized by lower values.

Low irrigation regimes appear to be the most efficient means for operating a low-input greenhouse management for rose production in the south-Mediterranean area, providing both water and energy saving, with reducing ground pollution and production costs.

An irrigation regime based on a high level of accumulated radiation aligned with a reduced water delivery may be an efficient solution for a sustainable irrigation strategy from an environmental as well economic point of view.

Dorot's new 80-A Angle Valve

Dorot Control Valves ("Dorot") is pleased to present the new 80-A Angle Valve, an innovative valve specifically designed for agricultural applications, combining high quality, affordability, ease of installation and durable construction

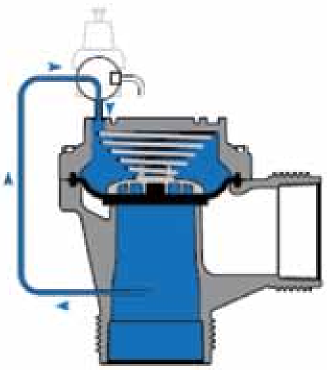
The 80-A Angle Valve completes the 80 series, adding a 3" and 4" diameter valves to the existing range of valves up to 2" diameter. The 80-A Angle Valve has an angle globe-pattern, activated by a fully-supported diaphragm.

The valve is durable and made of corrosion free materials. The uniquely designed valve diaphragm allows stable regulation even at low flow conditions. In addition, the angular design of the valve allows the customer additional savings by eliminating the need for accessories to creating an angle, and also has a high-capacity design with extremely low pressure losses.
The 80-A Angle Valve is a compact unit, which saves space and costs. It is available with universal threads or flanges with a variety of end connections.

An innovative valve specifically designed for agricultural applications

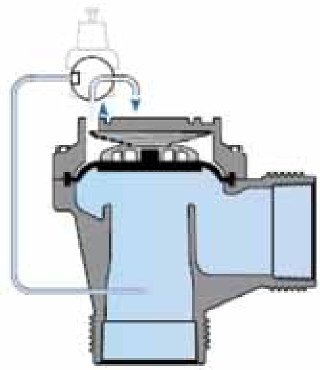
The valve was designed primarily for the agricultural sector, as Dorot identified a transition in use toward plastic valves from metal bodies because of its many advantages and the 80-A Angle Valve provides a perfect solution for these market needs.
In addition to all these benefits, the 80-A Angle valve has a wide range of control applications, is simple for use and is strong and reliable in its unique construction.

Closed mode



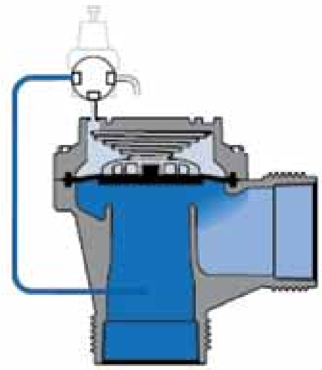
When inlet pressure is applied to the control chamber the valve closes drip-tight.

Open mode

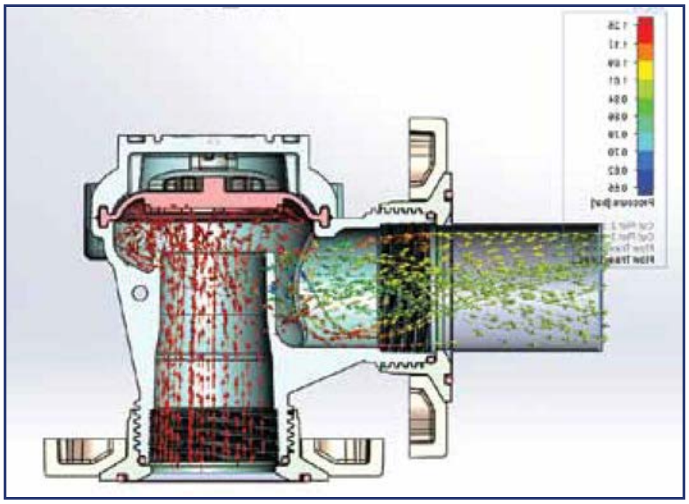


When the operating pressure is relieved from the control chamber, the line pressure at the valve inlet opens the valve.

Modulating mode



The position of the diaphragm is dictated by the volume of water in the control chamber, which is regulated by the pilot system in order to maintain a preset pressure value.



The 80-A Angle valve has a wide range of control applications, is simple for use, and is strong and reliable in its unique construction

Capturing sprinkler irrigation water to increase efficiency and profitability in the cultivation of container grown ornamental plants

Introduction

Like a number of segments of the horticultural industry, bodies involved in container nursery cultivation are facing severe restrictions on water availability.

Unlike other forms of cultivation, container substrate, water deficits can be measured directly by a number of methods:

- By weighing
- Indirectly with sensors
- Simulation through using a combination of models and local weather data

Like a number of segments of the horticultural industry, bodies involved in container nursery cultivation are facing severe restrictions on water availability

Evapotranspiration (ET)-based irrigation scheduling, designed to apply water in proportion to plant demand, is repeatedly being recommended as the best management practice for conserving water.

Although considerable research has been carried out to find the most efficient means of measuring ET levels in containers during production, comparatively little research has been carried out to evaluate the ability of containerized plants to capture sprinkler irrigation water.
Irrigation capture is an important factor for the reason that while containers take up only a fraction of the production area even when closely spaced, there still remains a potential for plant canopies to influence the proportion of sprinkler irrigation water that is captured relative to that which falls unintercepted between containers.

For the purpose of this study, the terminology "capture factor" or CF was used to describe the areas of sprinkler irrigation capture, based on the supposition that if the CF is greater than one, then it indicates the plant canopy is capturing water that would otherwise fall between containers. A CF level of less than one indicates the plant canopy is directing water outside the container that would otherwise fall into the container.
It has previously been observed that the way that plants are laid out in containers in a nursery will have an effect on irrigation capture, while the sprinkler irrigation system in use is liable to also have an effect on

Previous tests carried out have ascertained that when "Wobbler" type sprinkler heads are used they will generally bring about an improvement in CF when compared to impact sprinklers when containers are closely-spaced, but their efficiency will diminish the further apart the containers are. Research has also shown that increasing the sprinkler nozzle height from 1.2 meters to 3.6 meters will increase the CF in a nursery, although placements greater than 3.6 meters did not increase CF levels.

In order to gain a clearer picture, a series of trials were recently carried out, with the objective of evaluating the effect that plant size, container diameter, and container spacing have on CF, while, at the same time, to compare irrigation capture levels of wobbler vs. impact sprinklers, using commonly grown ornamental plant species exhibiting a range of growth habits to make an accurate assessment.

Materials and Methods

The tests were carried out by the University of Florida at their test center in Gainesville.
Impact sprinkler heads fitted with No. 8 nozzles rated

Plant Nursery

Container spacing imposes a physical limitation on potential water capture because each plant, on average, can only capture water within the area allotted the container

at 11.4 L•min-1; on 1.2-m tall risers fitted with 207-kPa pressure regulators were situated at each of the four corners of the irrigation zone. Spray patterns were adjusted to achieve uniformity coefficient greater than 95%. A 10 meter by 12-meter windbreak shelter composed of woven, polypropylene groundcloth was attached to a metal frame structure around the perimeter of the irrigation zone provided wind protection during irrigation testing.

Test One: Plant species comparison

Seven ornamental plant species grown in 16-cm-diameter containers and 27-cm diameter containers and representing various growth habits were surveyed for their capacity to capture sprinkler irrigation water The established growth habits of the species shown in Table One were used as a yardstick, with ten plants of each plant species and container size being planted in two classes of containers. Measuring either 16 mm or 24 mm in diameter.

Table One: Influence of plant species on the capture of sprinkler irrigation at a wide spacing arrangement (Experiment One)

	Growth Character-istics	16 cm. container			27 cm. container		
		Plant Height(cm)	Plant Width(cm)	CF	Plant Height(cm)	Plant Width(cm)	CF
African Lily	GC	18	32	1.17	32	59	1.57
Japanese Boxwood	US	26	25	1.65	50	42	2.34
Burfordii Nana'	SBS	24	34	1.82	32	62	2.87
Winter Jasmine	SV	32	47	1.54	61	59	2.27
Parsoni	BS	29	48	1.98	27	72	2.39
Indian Hawthorn	S	26	38	2.53	35	73	3.88
Red Ruffle	GL	24	30	1.51	35	46	177

The capture factor (CF) is classed as the volume of irrigation water captured by a specific container containing a palnt, divided by the volume of water captured by the same container which does not contain a plant.

Abbreviations: GC- Groundcover, US- upright spreading, SBS- semi-broad spreading, SV-spreading vine, BS- broad spreading, S- spreading, GL-globose (circular spreading)

Impact sprinkler

Wobbler sprinkler

For the puposes of the trial, the top area of the container was the only critical container attribute for this study, with the average diameter of each container *(two perpendicular measurements)* being taken into account for CF calculations.

The overall findings of these tests were that grouping plants with similar irrigation requirements within container nurseries can readily be adopted as a best management practice

Plant height was calculated as the distance from the substrate surface to the top of the canopy, while plant width was set as the average of two perpendicular measurements of the plant canopy, with one of them being the widest. The plant size index was calico-lated as the average of plant height and plant width.

Irrigation capture measurements entailed placing each container in a similar-sized pail to collect any leachate during testing, with aluminum foil used to form a barrier between the container and drainage collection pail to prevent irrigation water from directly entering the drainage collection pail.

For each plant species and container size, 10 pre-weighed container-pail assemblies were placed on 61-cm centers in an equidistant, offset pattern ***(See Figure One)***.

Containers were irrigated for 30 min applying 0.7 cm of water.

After irrigation, each container-pail assembly was weighed and the difference in weight before and after irrigation was used to calculate water use based on the specific gravity of water according to grams per cubic centimeter *(g•cm-3)*. The irrigation capture test was conducted three times for each plant species-container size resulting in a total of 21 measurements per plant species and container size.

The amount of water captured without a plant, was determined by placing empty pails in the same spacing pattern as plant irrigation capture tests and collecting irrigation water during three thirty minute irrigation runs.

The experiment was analyzed as a randomized complete block design with 10 blocks *(locations in test area)*, 11 plant species, and three options used for separating CF means at the acceptable 5% confidence level.

Test Two: Plant size and container spacing

In order to evaluate the effect of plant size and container spacing on CF, three plant species from test one were selected, according to a criteria that exhibited different growth habits and water-capturing abilities.

These plant varieties were:

- Parsonii juniper (Juniperus chinensis)
- India Hawthorn (Rhapheolepis indicia)
- Japanese privet (Ligustrum japonicum)

Three general plant size groups *(small,medium, large)* of each of the three plant species and two container sizes *(16 cm and 27 cm diameter)* were used.

Depending on the plant species, plant size, and container size, CF was measured at four container spacings ranging from canopies placed close together to canopies placed as far apart as 22.9 cms. ***(See Table Two)***.

CF was measured using the same methods explained in Test One with plant height and width determined for each test plant.

Twelve border plants were placed around the seven test plants in the same spacing arrangement as the test plants to maintain the same canopy interaction effects for all test plants ***(See Figure One)***.
The effect of spacing was evaluated with analysis of

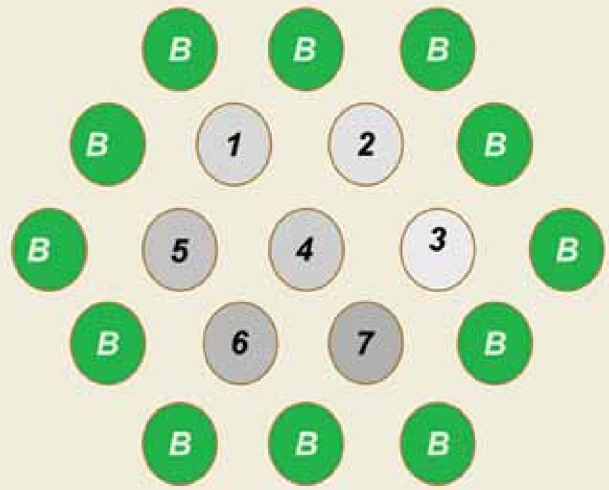


Figure One. *Arrangement of test plants used to measure the effect of plant size, container size, and container spacing on the capture of sprinkler irrigation . (Seven test plants surrounded by 12 border (B) plants.)*

Plant Nursery

variance *(Anova)* conducted separately for each species, container size, and plant size group.

For each plant species and container size, linear regression was used to relate plant height, plant width, and plant size index to CF measured at the widest spacing.

Test Three: Sprinkler head type-Wobbler versus impact
In order to gauge the most effective method of sprinkler irrigation, Wobbler sprinklers were compared with impact sprinklers for their effect on the irrigation water capture, Irrigation uniformity and application rate were measured for both sprinkler types by collecting irrigation water in

Table Two: Effect of container spacing on the capture of sprinkler irrigation by three plant size groups according to container size. (Experiment Two)

			CF						
			Equidistant spacing (cms between containers)						
Plant Size group	Plant Height (cms)	Plant Width (cms)	0.0	3.8	5.1	7.6	10.2	15.2	22.9
Parsonii juniper									
Small	20	25	1.09	1.15	1.14	-	1.10	-	-
Medium	25	36	-	1.43	1.68	-	1.88	1.96	-
Large	28	43	-	-	1.98	-	2.41	2.72	2.79
India hawthorn									
Small	18	25	1.25	1.41		1.37	-	1.32	-
Medium	20	30	-	1.57		1.81	-	1.85	1.80
Large	25	38	-	1.62		1.84	-	2.46	2.41
Japanese privet									
Small	30	30	1.30	1.60	-	1.87	-	2.04	-
Medium	36	38	-	1.85	-	2.24	-	2.60	2.62
Large	46	51	-	1.84	-	2.06	-	2.88	3.34

The capture factor (CF) is classed as the volume of irrigation water captured by a specific container containing a palnt, divided by the volume of water captured by the same container which does not contain a plant.

20 16-cm diameter pails placed within a 4.6 m • 4.6-m area inside the irrigation wind shelter.

Irrigation run time for irrigation uniformity tests was 45 minutes, with the tests were repeated four times for each sprinkler type.

For CF testing, seven marketable-sized plants in 16-cm- or 27-cm-diameter containers were placed in an offset pattern with one container diameter spacing between rims of adjacent containers.

Twelve border plants were placed around the seven test plants in the same spacing arrangement as the test plants.

The irrigation run time for CF testing was set at 30 minutes for impact sprinklers and 35 minutes for Wobblers. CF was measured for each of the seven test plants as described in the first test and three irrigation test applications for each sprinkler type and container Size were carried out. Plant height and width for all test plants was as described in the Test One.

Results and Discussion

Test Two: Plant species comparison

Plant species exhibited a wide range of water-capturing abilities ***(See Table One)***.

CF values for marketable-sized plants ranged from 1.2 to 4.2 depending on container size and plant species.

Based on results, it was ascertained that plants classified as groundcover or globose exhibite the lowest CF values, while semi broad spreading, broad spreading, and spreading vine habits were seen to exhibit moderate CF values. Upright spreading Habits were observed to enjoy have moderate to high CFs.

In general, it was observed that large-leafed plant species and species with greater height-to-width ratios tended to have higher CFs than plant species with smaller leaves and more spreading growth.

Test Two Plant size and container spacing

CF was seen to increase as plant size of each plant species increased ***(See Table Two)***, while container spacing was seen as significant factor in affecting CF.

Container spacing imposes a physical limitation on potential water capture because each plant, on average, can only capture water within the area allotted the container.

Test Three: Sprinkler type-Wobbler versus impact
Warbler sprinklers resulted in improved irrigation water capture by in 27-cm diameter containers, but not in 16-cm containers.
For 27-cm containers, wobbler sprinklers increased CF 7% compared with impact sprinklers.

The ability of wobbler sprinklers to deliver water uniformly at a lower pressure than impact sprinklers was estimated to have reduced the force of impact of water on the plant canopy, with the reduced force of impact as such may have increased retention of the water and enhanced subsequent channeling down leaves and stems to the container substrate.

Conclusions

Results of the tests have provided a clear indication that CF can be classed as a dynamic value, which can be ascertained by plant species, plant size, container size, container spacing, and nozzle type.

Growth habit and canopy characteristics can also determine to what extent a plant species can affect the capture of sprinkler irrigation water.

Container size and spacing were shown to affect CF by imposing a physical limitation to the amount of water available for capture.

CF can play a critical role in adjusting irrigation run times to apply a required amount of water to plant containers.

The overall findings of these tests were that grouping plants with similar irrigation requirements within container nurseries can readily be adopted as a best management practice. ■

Show Preview

Aquatech China 2015

10 - 12 JUNE 2015 SHANGHAI • CN

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AQUATECH CHINA

Aquatech China 2015 will take place at the newly built (Shanghai) Center for Exhibition and Convention. Aquatech China will bring together the worlds of water technology and water management, aiming to present integrated solutions and a holistic approach to the water challenges facing Asia. It features the best possible range of new and proven products on process, drinking and waste water. Come and find out about unique new novelties and advanced technological findings and make sure to attend the Aquatech Conference and the AquaStages, where you learn about best practices and progressive solutions. Undoubtedly, Aquatech China has become the most professional and the biggest international water show in China.

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- Wednesday 10 June 09.00-17.00 hours
- Thursday 11 June 09.00-17.00 hours
- Friday 12 June 09.00-15.00 hours

Shanghai Center for Exhibition and Convention

Aquatech China 2015 will be held in the newly built,Shanghai Center for Exhibition and Convention. he Exhibition Complex is projected to edge itself as the world's largest and most competitive MICE venue of our age, with half million square meters of exhibition space consisting of 400,000 square meters of indoors and 100,000 square meters of outdoors. The China Expo Complex, based in the booming Yangtze River Delta region, aims to serve China and the world with its cutting-edge design and multiple facilities.

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Influence of silicon fertilization on pest control of mango trees

Introduction

The mango tree *(Mangifera indica L.)* is an Asian fruit bearer, a member of the Anacardiaceae family, capable of reaching a height of 100 feet, *(30 meters)*. With an average circumference of around fourteen feet, *(4.25 meters)* although it can reach a width of around twenty feet *(six meters)* the Mango rated as the largest fruit-tree in the world

Originally found in the wild in India, cultivated varieties of the Mango tree have been introduced to other warm regions of the world, and is currently being commercially cultivated in East Asia, Africa and South America, particularly Brazil as well as other warm regions of the world. It is the largest fruit-tree in the world, capable of a height of one-hundred feet and an average circumference of twelve to fourteen feet, sometimes reaching a much as twenty.

applying silicon to the tree's roots through irrigation has become a pular alternative among growers, as a form of effective pest management

The Mango tree has adapted particularly well to the Brazilian climate, and the high quality tropical fruit that it produces is very much in demand both for local consumption as well as for export.

In recent years the Brazilian farming community have been increasingly planting mango trees on the 'Palmer' cultivar, a large, late-season mango cultivar that originated originally in Southern Florida in the United States.

The 'Palmer' cultivar, an elongated semi-dwarf variety with sweet, almost fibreless apricot colored flesh and larger than average fruit size, has become a major favorite among Mango cultivators Palmer Mangos are easily recognized by its brightly colored red-purple tinged skin, a combination which brings with it in increased demand and excellent prices. Like many trees grown in tropical regions of the World, the Mango tree, with the Palmer variety being no exception, can be susceptible to fungal pathogens, as well as a number of insect and mammalian herbivores.

To counteract this problem, applying silicon to the tree's roots through irrigation has become a popular alternative among growers, as a form of effective pest management. This method has proven to be an environmentally friendly and sustainable technology, with a decided potential to decrease the frequency and use of insecticides.

Although Silicon *(Si)* is not, in itself, an essential plant nutrient, the material is reportedly capable of increasing the photosynthesis rate, as well as the upright appearance and mechanical strength of plants, whilst reducing the tree's transpiration rate.

Previously held studies on the subject of silicon mechanism have suggested that this chemical element is capable of inducing plant defense mechanisms, as well as acting as a physical barrier through the silicification of leaf cells.

To further investigate the most efficient method of introducing silicon to mango trees as well as evaluating the influence of different silicon quantities on 'Palmer' mango tree cultivation a series of studies were recently carried out in Brazil.

Materials and methods

This study was carried out over a period of slightly more than twelve months in a 'Palmer' mango orchard situated in the municipality of Matias Cardoso, in the Minas Gerais (MG) state of Brazil.

The study was based around twenty-five mange trees planted in a uniform spacing of six by eight meters. The trees were all irrigated regularly through micro-sprinklers.

For the purposes of the study, a randomized block design was used with five treatments and five replicates, each with one plant per experimental unity.

The applied treatment levels were 0, 400, 800, 1600 and 3200 kilograms per hectare ha-1 of Agra-silicon *(calcium*

palmer mango

silicate and magnesium) composed of 25% Ca, 6.0% Mg and 11% SiO_2 which is estimated at a relative total neutralizing power *(TNP)* of 85%.
The Agro-silicon was applied under tree canopy projections and superficially incorporated into the soil.

During the trial, diseases, pest and natural enemies were monitored with the particular diseases under inspection being vegetative malformation, floral malformation and anthracnose while the plant pest monitored was Thrips.

The nutritional characteristics of soil and plants *(leaves and fruits)* and the vegetation, production and fruit quality characteristics were also under evaluation, with an analysis of their variance according to the various levels of Silicon being applied used to study these characteristics, as well as regression levels.

Table One: Physicio-chemical characteristics of "Palmer" Mango Fruit as found in the Minor Gerais region of Brazil

Maturity Stage	Soluble Solids (°Brix)	Firmness (N)	Acidity %	pH
Green	6.33	39.67	0.67	3.48
Ripe	15.10	2.53	0.13	4.53
Average	10.72	21.10	0.40	4.01
CV(%)	8.21	15.05	27.91	4.14

Results and discussion

The trial results showed that overall disease incidence levels were below 5%, regardless of the silicon quantities fertilized to each of three three 'Palmer' mango trees, meaning that under normal circumstances they would not require any chemical control.

A low incidence of Thrips *(less than 0.1% in the inflorescence)* was also recorded as well as the presence of natural predators, which reached its peak during the month of May, a time in which Mango trees are at full bloom.

A factor that became increasingly apparent as the trials progresses was that thecombination of healthy nutrition and precise micro-sprinkler irrigation, alongside the relatively low rainfall and humidity in this semiarid region may have combined to contribute to the low pest and disease incidence.

A general trend of increasing pH, calcium and magnesium levels in the soil around the trees were recorded as the quantity of Agro-silicon increased, indicating a corrective effect on soil acidity in the soil chemical characteristics at depths of 0-20

While silicon may take an active role in plant defense responses, it may have a more effective passive role in improving tolerance of stresses such as drought cm and 20-40 cm. However, at a soil depth of 0-20 cm, the mean pH, calcium and magnesium values were 6.13, 3.66 centimoles per cubic decimeter *(cmolc dm-3)* and 1.96 cmolc dm-3, respectively, whereas at a depth of 20-40 cm, the pH value was recorded at 5.74 and the calcium content was 2.59 cmolc dm-3 and the magnesium content was 0.82 cmolc dm-3.

The soil silicon content was recorded at an average level of 6.07 and 4.21% at depths of 0-20 and 20-40 cm, respectively, a finding that may be explained by low mobility of Si in the soil profile, a factor which confirms previous research that suggested that the lack of significant effect can be explained by slower translocation, uantity and speed of reaction of the silicon source applied due to what has been described as " soil buffer capacity", the ability of soil to replenish the soil solution of a particular solute as it will be removed by plant uptake or any other process.

During the trial it was observed that the silicon was absorbed by the root system via mass flow in the form of silicic acid *(H4SiO4)*, with the absorption occurring at a steady pace. It has been previously obseved that in grasses, silicon absorption can be even more rapid than that of water, which results in a reduction in the silicon concentration.

In the case of the 'Palmer' mango trees tested in this study, it was observed that the silicon absorption occurred at a much slower paste, at roughly the same rate to that of water, a factor which indicate that mango trees may be potential silicon accumulators.

Calcium and magnesium contents were statistically equal with averages of 29 g 230 kg-1 and 2.0 g kg-1, respectively, values which are within acceptable standards for the cultivation of mango trees.

Production characteristics, including the number of fruits per plant, average fruit weight, fruit length, production and productivity were also unaffected by the silicon quantities.

The 'Palmer' mango trees bore an average of 374 fruits, each weighing an average of 439 grams and measuring 138 mm in length. Total production was 163 Kilos per tree, averaging around 34 tons per hectare. Within the mango cultivation community, fruits average weight of fruits fluctuate around

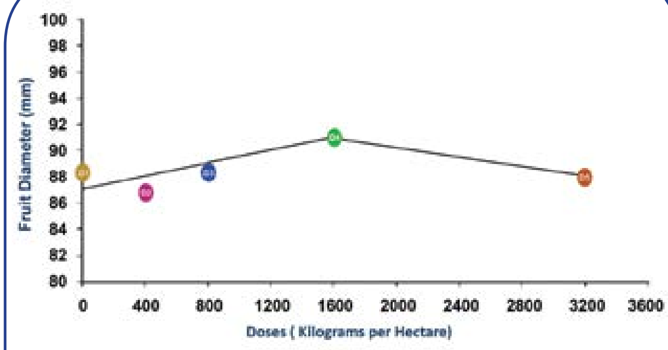

Figure One: . Fruit diameter from 'Palmer' mango trees in trial
Doses of calcium silicate and magnesium:
D1 - 0 kg ha-1
D2 - 400 kg ha-1,
D3 - 800 kg ha-1,
D4 - 1600 kg ha-1,
D5 - 3200 kg ha-1.

426 grams and 119 mm in length, with yields of between 18.5 and 26 tons per hectare being the norm.

The 'Palmer' fruit diameters were also found to be significantly different among the different silicon applications ***(See Fig. One)***.

Conclusions

The tests showed that Agro-silicon soil applications had little or no influence on levels of disease or pest incidence or the silicon, calcium and magnesium content of 'Palmer' mango-associated soil and leaves, indicating that Mango trees may be potential silicon accumulators.

While silicon may take an active role in plant defense responses, it may have a more effective passive role in improving tolerance of stresses such as drought, because during water uptake by the plant, silicic acid forms solid amorphous, hydrated silica *(silica gel)* layers which are thought to act as a form of physical barriers, to evaporation and other stresses. Similar research in corn and rice have shown that when supplemented with silicon, these plants displayed marked increases in drought and heat tolerance compared to unamended plants.

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