



FERTINNOWA

**International Conference:**

**Sharing fertigation best practices across Europe**



**Almeria, Spain , 3-5 October 2018**

A conference on the cutting edge of science, management and policy for best practice and new technologies in fertigated horticulture



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# Programme

*3 October*



8:30	Registration
9:00	Welcoming: “Sharing good fertigation practices in Europe” IFAPA president: Jerónimo J. Pérez Parra
9:30	Introduction to FERTINNOWA project. Objectives and main results Els Berckmoes
10:00	Gaps in Technology and Legislation to Reach Sustainable Water Use Carlos Campillo
10:30	Business Models for Innovative Water Treatment Technologies Wilfred Appelman
11:00	Transfer of Innovation for Sustainable Agriculture Wim Voogt/ Teodoro Moreno
11:30	Coffee - Poster Session
12:00	Presentation of Fertigation Bible Rodney Thompson
12:20	Fertigation Equipment Juan José Magán
13:10	Fertigation Management Wim Voogt/Rodney Thompson
14:00	Break/ Lunch
15:00	Exchange of Knowledge and Technology Transfer Elisa M. Suárez-Rey
15:20	Technologies to Improve Water Use Efficiency Evangalina Medrano/ Teresa Lao/ Marine Guerret
16:10	Technologies to Improve Nutrient Use Efficiency Juan José Magán/ Rafael Álvarez/ Diego Intrigliolo
17:00	Technology Market

# Programme

*4 October*



8:30	Policy Session
9:00	Institutional Implication and Governance <a href="#">Carles Sanchis-Ibor</a>
9:30	Round Table (Moderator: Cesar Marcos) MARKET. <a href="#">Antonio Marhuenda/ Gary Spratt</a> USERS. <a href="#">Juan V de Palma/Luc Peeters</a> RULERS. <a href="#">Josefina Maestu</a> EXPERTS. <a href="#">Abel Lacalle/ Julia Martínez/ Julio Berbel</a>
11:30	Coffee - Poster Session
12:00	<b>Scarcity of Qualitative Fresh Water</b> Introduction Outcomes Related to Water Scarcity and Quality <a href="#">Els Berckmoes</a> Impact Climate Change on Water Quality and Quantity <a href="#">Matjaz Glavan</a> Alternative Water Sources, the Use of Disinfected Wastewater <a href="#">Rafael Casielles</a>
13:10	<b>Environmental Impact</b> Influence of Grape Cultivation on the Management and Quality of Groundwater in Val Tidone <a href="#">Ettore Capri</a> Nutrient Removal and Recovery from Drainage Water <a href="#">Els Pauwels</a>
14:00	Break/ Lunch
15:00	Technologies for Improving Water Quality <a href="#">Oockie van Niekerk/ Peter Prins/ Raúl Cano</a>
16:00	Reduction of Emissions from Agricultural Activity <a href="#">Peter Melis/ Ilse Delcour/ José Miguel de Paz.</a>
17:00	Technology Market

## Welcome note

In European countries, the cultivation of fertigated crops frequently suffers from a scarcity of water, and the intensity of cultivation poses significant potential risks to water quality.

The main objective of the FERTINNOWA thematic network is to create a meta-knowledge database of innovative technologies and practices for the fertigation of horticultural crops. FERTINNOWA has built a knowledge exchange platform to evaluate existing and novel technologies (innovation potential, synergies, gaps, barriers) for fertigated crops and ensure wide dissemination to all stakeholders involved of the most promising technologies and best practices.

By the end of the project we are expecting to:

- Close the gap between knowledge and growers with regards to fertigated crops through the gathering of knowledge, state-of-the-art, and innovative solutions, sharing of this knowledge, best technologies and practices, and the continuous involvement of the growers
- Support to action: including water reuse and recycling, water and waste-water treatment with recovery of resources, water governance, and decision support systems and monitoring
- Harmonise horticulture with essential natural resources on which farming depends and ameliorate the management of natural resources – in line with environmental requirements – to increase horticultural productivity and output sustainability
- Increase the application of water-related solutions and validation of at least 8 innovative technologies and best practices which will result in the further development of sustainable water solutions for fertigated crops
- Showcase of relevant exchanged technologies by consortium partners to local growers during field visits
- Provide growers with effective informative and dissemination tools in the different languages on how to implement and use the appointed technologies

This conference provides the European horticulture sector with a unique forum where academia, growers and associations, industry, policy makers and local authorities will have the opportunity to learn, exchange experiences and identify growers' needs for optimal irrigation and fertigation management and to learn of FERTINNOWA's results. More than 250 participants from all over Europe are expected.

What is FERTINNOWA's spirit? To encourage communication. There will be active participation of growers, companies, experts and policy makers.

This is an opportunity to interact!!!!

## KEYNOTE SPEAKERS



## Technology transfer of fertigation. The Dutch experience

Voogt W.

Wageningen Plant research

The application of fertilisers via fertigation rather than broadcasting started in the late '50s. This development was 'borrowed' from the application for soilless culture systems, which have been experimented in those days. The main driver for this development was labour saving as well as the issue of being more flexible in the adaptation of the fertilisation. This development went parallel to venture suction pumps and EC meters becoming available as well as soil sampling and analysis methods. A real boost was given by the introduction of mini-sprinklers and drip-irrigation. In the '70s and '80s the dosing systems became more advanced as well as better insight in the soil-specific requirements, crops-specific needs and the dynamics of the nutrient demand throughout the cropping cycle. This led to the development of the Dutch fertigation recommendation system. The initial transfer of the technology went almost automatically by mouth to mouth advertisements, as Dutch growers were organised regionally as members of the auctions and considered each other as colleagues rather than competitors, making sharing of knowledge and experience quite common sense. This was also enhanced by the support given by the governmental extension service system, which together with the Research and Experimental stations and the Agricultural school system formed a strong triangle. This system lasted until the early '90s. From the late 80s the pressure from the society to reduce environmental pollution of surface- and groundwater led to the necessity to reduce nutrient and PPP leaching from greenhouses. In succession growers were initially encouraged and later on enforced by regulations to recycle drainwater (soilless culture) or tune irrigation and fertilisation to crop demand (soil grown crops). Since these measures did not lead to higher yields or better produce quality, though to higher costs there was no incentive for growers to adopt these methodologies. Moreover, all initiatives to create special "brands" of sustainable products as well as all kind of emerging local initiatives in which new coalitions cooperate towards the common goal of sustainable production have not been very successful. As a solution regional collection and purification of drain water to irrigation water has been proposed, as well as alternative solutions like the redesign of production systems with no-emission as a primary design rule. This, however, requires a transition towards new sustainable agricultural production systems. Integrated projects to develop such social, economic and environmental sustainable production systems have been initiated with all stakeholders involved in the innovation process. However, despite all attempts to tempt growers to adopt sustainable fertigation methods, this has only been successful in some cases. Yet, the surveys on concentration of PPP's and nutrients in surface waters reveal that these have hardly decreased in the last decade in the concentrated glasshouse areas, which obliged the Dutch government to more drastic regulations recently. Eventually it must be concluded that law enforcement accompanied with strong penalties seems to be the only effective way for the implementation of sustainable fertigation methodologies.



## **Transfer of innovation for sustainable fertigation in Mediterranean horticulture: the Almeria case**

Moreno T.

Ing. Téc. Agrícola

In the fifties of the last century began the irrigation of the large wastelands of the fields of Dalías and Níjar, an initiative of the then called National Institute of Colonization. The lands that the colonists receive are irrigated by gravity and the technique of sand mulching is applied to them to reduce evapotranspiration so intense that this arid climate favours. Due to the continuity and intensity of the winds, outdoor crops also need the construction of windbreak hedges, using cane as the most suitable material for its easy availability. These two ways of doing things, sanding and windbreak hedges, demonstrate the wisdom and adaptability of these farmers to combat adversity and get the most out of this precious asset, water, which has been made available to them.

In 1970, there were 7 000 ha of open-air sand mulched crops and there were already 100 ha of vine greenhouses, a structure derived from the supports that hold the vines grown in the Alpujarra area of Almería. Around 1975 the first drip irrigation installations appeared. These two innovations led to significant water savings, with consumption rising from 7 000 m<sup>3</sup>/ha to 5 500 in 2006.

At the beginning of the decade of the 90's there is already a greenhouse area of 16 000 ha. 60% of this area is irrigated by drip irrigation. The rural area is very little electrified and the automation of the fertirrigation shines by its absence. Fertilizers are applied through the traditional fertilizer derivation. The crops in substrate, or without soil, have made their appearance and 200 has. have already been implanted in these dates.

In 2000, there were 25 000 ha of greenhouses in Almería and practically all of them were drip irrigated. The area dedicated to the soilless cultivation is 5 000 ha. and the need to automate the fertigation facilities for soilless crops has been a revulsive for the whole sector and this year, in addition to the 5 000 ha. soilless crops soil that have programmers for fertigation, there are also another 1 300 ha. of soilbound crops that have this innovation incorporated.

There are currently 30 500 ha of greenhouses in production. The surface area for soilless crops has stabilised at 5 000 ha. and is even suffering a slight setback. The irrigation facilities that have programmers for fertirrigation is around 60% remaining the rest of the surface with manual systems for incorporating fertilizers such as venturi, fertilizer diversion, open tank connected to the aspiration of the irrigation pump, etc..

Starting from the premise that in order to fertilize well you first have to irrigate well, the most interesting innovation that remains to be incorporated in Almeria is the improvement in the management of the irrigation operation. The physical element necessary, and I dare say essential for this, is the tensiometer. Another factor that needs to be improved in order to achieve this objective is the dissemination of the knowledge that we currently have, which has been developed at a local level by the different institutions and which is easily available to farmers and technicians. This dissemination, which is already being done but which needs to be intensified, should be aimed primarily at the field technicians of the marketing companies who are directly in contact with the farmers. The incorporation of suction probes to control the electrical conductivity of the soil and sporadically analyse the nutritional state of the soil would complete an important advance in the management of fertigation allowing better management of water and better control of pollution of aquifers from which water is extracted for irrigation.

## Presentation of the Fertigation Bible

Thompson R.

University of Almeria

The Fertigation Bible is an 800+ page book that provides useful practical information, to the horticultural sector in the European Union, of the diverse technologies available for all aspects of fertigation. It can be freely downloaded at: <https://www.fertinnova.com/the-fertigation-bible/>. A total of 124 different technologies, relating to diverse aspects of fertigation throughout the complete process of fertigation, from the provision of water through to reducing the environmental impact of drainage water, are presented.

This presentation will provide an introduction to The Fertigation Bible. The contents and structure will be briefly described, so that the audience will understand what type of information is presented and how they can quickly obtain it.

The structure used to describe each of the 124 technologies will be presented; two examples of different technologies will be presented as examples.

The 124 technologies described in The Fertigation Bible are organised into the following chapters:

Chapter 1. General Introduction

Chapter 2. Providing water

Chapter 3. Optimising water quality - chemical composition

Chapter 4. Optimising water quality - particle removal

Chapter 5. Optimising water quality - control of algae

Chapter 6. Optimising water quality - disinfection

Chapter 7. Fertigation equipment - irrigation

Chapter 8. Fertigation equipment - nutrient addition

Chapter 9. Fertigation equipment - soilless systems

Chapter 10. Fertigation management - irrigation

Chapter 11. Fertigation management - nutrients and salinity

Chapter 12. Reducing environmental impact- Nutrient removal and recovery

Additionally, the process of how The Fertigation Bible was produced will be described.



## **Fertigation management for optimal nutrient and water use efficiency of soil-grown crops in Almeria greenhouses**

Thompson R.

University of Almeria

This presentation will focus on two aspects of fertigation management of soil-grown crops in Almeria greenhouses. Firstly, it will address, in general terms, the management practices used in commercial production, and general tendencies with time of changes in management practices. Secondly, it will describe research lines and relevant technological developments that have been introduced or have promise to improve nutrient and irrigation efficiency.

Traditionally, within the greenhouse production systems of Almeria, nutrient and irrigation management were perceived as being lower priority issues compared to other issues, such as disease and pest management and climate control. There were three reasons for this, 1) the established methods seemed to work well, in terms of production, 2) fertiliser and water costs were a small part of the variable costs of production, and 3) on-farm nutrition and irrigation management were not life or death issues in which the entire crop, and the year's income, was threatened as with disease and pest issues.

The established methods for nutrient and irrigation management were based on fixed programs and recipes, that were adjusted depending on crop appearance and climatic conditions. The fixed programs and recipes, and the responses to appearance and climate, were based on the collective experience of growers and technical advisers. In Almeria, most growers are associated with cooperatives or auction houses that have teams of technical advisers; suppliers also have teams of technical advisers. Consequently, growers have access to the cumulative experience of the region from several different sources; they then may make their own modifications. During the first decades of this system, there was a production-based philosophy, and with regard to nutrient and irrigation management, the approach was "if it is not broken, do not fix it".

In the last 15 years or so, there has been increasing awareness of the limited water supplies and contamination of water resources, and the sensitivity of important markets to these issues. Appreciable research has been and is being conducted on irrigation management and nutrient management, particularly with N. The most promising of these research lines will be described, and information will be given on adoption.

## Transferencia de innovación para una agricultura sostenible

Moreno T.

Ing. Téc. Agrícola

En los años cincuenta del siglo pasado comienzan las actuaciones de puesta en riego de los grandes eriales de los campos de Dalías y Níjar, una iniciativa del entonces denominado Instituto Nacional de Colonización. Las tierras que los colonos reciben se riegan por gravedad y se les aplica la técnica del enarenado para disminuir la evapotranspiración tan intensa que este árido clima propicia. Debido a la continuidad e intensidad de los vientos los cultivos al aire libre necesitan, además, de la construcción de setos cortavientos, utilizándose la caña como material más idóneo por su fácil disponibilidad. Estas dos formas de hacer, el enarenado y los setos cortavientos, demuestran el ingenio y la adaptabilidad de estos agricultores para luchar contra las adversidades y sacar el máximo rendimiento de ese bien tan preciado, el agua, que se ha puesto a su disposición.

En el año 1970 hay 7 000 ha de cultivos enarenados al aire libre y ya se contabilizan una 100 ha de invernadero tipo parral, estructura que deriva de los soportes que sujetan las parras que se cultivan en la zona de la Alpujarra almeriense. Sobre el año 1975 aparecen las primeras instalaciones de riego por goteo. Estas dos innovaciones propician un importante ahorro de agua pasando el consumo de 7 000 m<sup>3</sup>/ha a 5 500 en el año 2006.

A principios de la década de los años 90 ya se cuenta con una superficie invernada de 16 000 ha. Un 60 % de esta superficie se riega por goteo. La zona rural está muy poco electrificada y la automatización de la fertirrigación brilla por su ausencia. Los abonos se aplican a través de la tradicional abonadora en derivación. Los cultivos en sustrato, o sin suelo, han hecho su aparición y 200 ha ya se han implantado en estas fechas.

En el año 2000 hay en Almería 25 000 ha de invernaderos y prácticamente todos ellos se riegan por goteo. La superficie dedicada al cultivo sin suelo es de 5.000 Ha y la necesidad de automatizar las instalaciones de fertirriego para los cultivos sin suelo ha sido un revulsivo para todo el sector y en este año, además de las 5 000 ha d cultivo sin suelo que cuentan con programadores para la fertirrigación, hay también otras 1 300 ha de cultivo en suelo que tienen esta innovación incorporada.

Actualmente hay 30 500 ha de invernaderos en cultivo. La superficie para los cultivos en sustrato se ha estabilizado en las 5 000 ha, incluso está sufriendo un pequeño retroceso. Las instalaciones de riego que cuentan con programadores para la fertirrigación está en torno al 60% permaneciendo el resto de la superficie con sistemas manuales de incorporación de los abonos tales como venturi, abonadora en derivación, depósito abierto conectado a la aspiración de la bomba de riego, etc.

Partiendo de la premisa de que para abonar bien primero hay que regar bien, la innovación más interesante que queda por incorporar en Almería es la mejora en la gestión de la operación de riego. El elemento físico necesario, y me atrevo a decir que imprescindible para ello, es el tensiómetro. Otro de los factores que han de mejorarse para la consecución de este objetivo es la difusión de los conocimientos que actualmente se tienen, que han sido desarrollados a nivel local por las distintas instituciones y que están fácilmente disponibles para agricultores y técnicos. Esta difusión, que ya se hace pero que ha de intensificarse, debe ir dirigida fundamentalmente a los técnicos de campo de las empresas de comercialización que están directamente en contactos con los agricultores. La incorporación de las sondas de succión para controlar la conductividad eléctrica del suelo y analizar esporádicamente el estado nutricional del mismo completaría un avance importante en el manejo de la fertirrigación permitiendo una mejor gestión del agua y un mejor control de la contaminación de los acuíferos de los que se extraen las aguas para el riego.

## **Fertigation management for optimal nutrient and water use efficiency of soil-grown crops in Dutch greenhouses**

Voogt W.

Wageningen Plant research

Irrigation in protected cultivation is indispensable for to the absence of natural precipitation and the high evapotranspiration which is due to the high temperatures and the prolonged cropping period, therefore it requires ample an adequate supply of water. Since the water supply is solely carried out by irrigation it enables full control over the water management of the greenhouse soil. Salinity is a constant thread and should be avoided through the use of water sources of good quality and through proper fertilisation management. Therefore rainwater collection and storage is strongly recommended or requested for operation sites situated in climatic suitable areas. The irrigation management should take the heterogeneities due to irregular water delivery of the irrigation system as well as site variations in soil and plants into account. Minimizing leaching should be one of the main drivers for optimization of irrigation. For soils with groundwater within reach of the root zone, capillary rise may add to the water supply of crops. However irrigation strategies aiming at deficit irrigation, in other words relying on capillary rise, can be used for the short term only. Given the presence of a surplus of ions in groundwater not only salts like Na and Cl, but also Ca, Mg, SO<sub>4</sub> and even K, salinity problems will occur on the long run. Irrigation management tuned to crop requirements is an important issue for a sustainable greenhouse production system.

For the Dutch situation, all greenhouse crops should meet the target of zero emission of nutrients and plant protection products (PPPs). Closing the cycle is the ultimate solution and is now common practice for soil-less grown crops. However, for soil grown crops the irrigation surplus cannot be reused for various reasons. Therefore leaching should be diminished as much as possible so irrigation management and fertigation should be tuned to the crop demand. In common practice irrigation is usually based on growers experience, which result often in high losses of nutrients. To achieve this, the irrigation should be tuned to the demand of the crop, taking into account also the variations in climate, soil types, growing seasons, planting dates and cultivars.

In the last two decades several tools ( DSS) have been developed to support the growers in the operational control of fertigation. An overview of these DSS will be given, focussing on the DAC (DENAR Aqua Control), the Fertigation model, the EMMAN3G model. Also the pros and cons of using the soil moisture condition (tensiometers, FD-sensors) or the estimation of the crop water demand by ET-models will be discussed.

The main issues are the following:

State of the art:

- Growers tend to stick to their 'default' fertigation strategies and is difficult to make them change.
- Due to the heterogeneity of the irrigation system and local variations, diminishing irrigation easily led to heterogeneities in growth, which is unacceptable for growers.
- The irrigation as well as nutrient surplus in soil grown greenhouse crops is still significant despite all efforts.
- Fertigation tuned to crop demand for soil grown crops is a learning process and need time.
- The current transpiration models are too complicated for irrigation control, require calibrations, which is not possible for growers. Though uncomplicated transpiration models, that use parameters regularly measured by climate computers are usable.
- Using soil moisture sensors to estimate the absolute water is a wicked way, as complicated and need proper calibration. Though using the sensor for trends in soil moisture only is a way to go.
- The only possibility for realistic determination of leaching is using lysimeter, however is not accepted by growers due to its complication and price.

The system consists of three main components: 1) a robust lysimeter of 3.8 m<sup>2</sup> and 0.90 m depth with automatic irrigation and drainage measurement, 2) a set of FD soil moisture sensors positioned at three depths in the soil profile, both inside and outside the lysimeter, 3) crop and soil model calculations. With the aid of the measured and modelled data of crop water consumption, soil water content and real and potential drainage, growers are able to adjust and fine-tune the irrigation and match with crop demand, and so minimize emission of nutrients and PPPs.

Obviously, supplying the crop with sufficient water is an important precondition for optimum crop health and performance. In addition, sufficient soil moisture is required for optimal functioning of the soil biota to secure mineral delivery from the applied organic amendments. As well accumulation of undesired salts must be avoided. On the other hand, nutrient leaching should be avoided or limited to a minimum. The irrigation management should take heterogeneities due to irregular water delivery of the irrigation system as well as site variations in soil and plants into account. Minimizing leaching should be one of the main drivers for optimization of irrigation in OGH.

Since OGH in Europe are strictly soil bound cultures, leaching and nutrient emission to groundwater is a thread. For soils with groundwater within reach of the root zone, capillary rise may add to the water supply of crops. However irrigation strategies aiming at deficit irrigation, in other words relying on capillary rise, can be used for the short term only. Given the presence of a surplus of ions in groundwater not only salts like Na and Cl, but also Ca, Mg, SO<sub>4</sub> and even K, salinity problems will occur on the long run.

Irrigation management tuned to crop requirements is an important issue for sustainable organic greenhouse production. To achieve sustainable management of OGH production, irrigation should be tuned to the demand of the crop, taking into account also the variations in climatic zones, soil types, growing seasons, planting dates and cultivars. Consequently, tools are required for irrigation management with the flexibility to deal with such variation. This paper will review the important aspects of the crop water demand and tools for irrigation management in organic greenhouse vegetables.



## Fertigation equipment

van der Kruk K.

PRIVA, The Netherlands

Over the last decades, fertigation equipment and cultivation systems have been developed rapidly. Driven by the development of soilless cultivation systems, nutrient management became more and more important. Smart and accurate technologies were developed to control the nutrient availability and prevent shortage or overshoot.

The setup of the fertigation equipment is founded on some basic principles. Every situation demands a certain configuration in terms of dosing capacity, setup of the fertilizer stocks, mixing principles and sensors. Making the right design choices is essential to gain a stable, robust and well controlled fertigation system.

And there is still a lot to achieve. The water footprint can be improved by using technology and sensing to increase water efficiency in soil grown cultivations. Therefore, the existing equipment might be adapted to meet specific market requirements. The glasshouse industry is searching for new cultivation systems that can improve water and fertilizer efficiency, with a very specific focus on measuring and dosing(-control) of individual fertilizer elements.

**Keywords:** fertigation, equipment, water efficiency, technology



## **Inorganic waste in horticultural greenhouses farming: the state of the art in the Province of Almeria (S. Spain)**

Carles Sanchis Ibor

University of Valencia

In the years around the turn of the century, when most irrigation systems in the Mediterranean area were undergoing their transformation to drip irrigation, several scientific investigations began to question the efficiency of these irrigation technologies. These published works did not question the success of the technology at the plot scale, but they qualified their findings with reliable data on the water savings in some communities of irrigators and, more importantly, the effects at the basin scale. In many cases, counterproductive effects were observed. Recent research shows that, if the scale of analysis and the variables under consideration is increased, the utility of drip irrigation depends on numerous contextual factors, not just hydraulic or agronomic factors, but also territorial and socioeconomic ones. The expansion of this technology, generously subsidised by the State, has been too rapid and undertaken without much consideration. It is necessary to design a second-generation modernisation strategy, dedicated to correcting the defects and negative impacts of this first wave of transformation and maximising the potential of this technology, in line with mitigation strategies and adaptations to climate change scenarios.

## Agua, fertilizantes y eficiencia: una mirada integral

La Calle A. & Martínez J.

Fundación Nueva Cultura del Agua

La recuperación de costes, uno de los principios básicos de la Directiva Marco del Agua, es también una de las asignaturas pendientes en la aplicación de la misma. De acuerdo con dicha Directiva, se deben recuperar los costes de los servicios del agua, los del uso del recurso y los costes ambientales, entre los cuales se encuentran específicamente los relativos a la contaminación difusa generada por las actividades agrarias. En el caso de los usos agrarios, si la recuperación de costes por el uso del agua es particularmente deficiente, la relativa a la contaminación difusa en aplicación del principio quien contamina paga es prácticamente inexistente. Una mejora real del estado de los ecosistemas requiere exigir la recuperación de costes a todos los sectores y específicamente a los agrarios, de donde proceden buena parte de las principales presiones sobre las masas de agua, tanto en captaciones como en contaminación.

Otra cuestión fundamental es evaluar los efectos de los sistemas agrarios, incluyendo los tecnológicamente intensivos como los de fertirrigación, respecto a dos cuestiones clave: el estrés hídrico y la contaminación difusa agraria. Ahora bien, para que dicha evaluación sea completa, hemos de preguntarnos no sólo por la eficiencia a escala de parcela o explotación agraria, sino también, y sobre todo, por la eficacia a escala del sistema y del estado de los ecosistemas implicados. Se ha mostrado sobradamente que muchos sistemas tecnológicamente intensivos han sido incapaces de evitar un estrés hídrico agudo (por ejemplo manteniendo o agravando la sobreexplotación de los acuíferos), pese a contar con tecnologías muy eficientes en el uso del agua a escala de explotación agraria (bajos consumos por hectárea). De la misma forma, en muchos casos los sistemas eficientes de fertirrigación han sido incapaces de evitar procesos intensos y generalizados de contaminación difusa, pese a contar con tecnologías avanzadas de control de los fertilizantes y del uso de pesticidas.

El Campo de Cartagena, que constituye la cuenca vertiente a la laguna costera del Mar Menor, constituye un ejemplo emblemático de todo ello. Desde hace varias décadas esta cuenca agraria está dominada por un regadío intensivo en tecnología, que cuenta riego localizado, sistemas de fertirrigación y aplicación generalizada de la denominada agricultura integrada, en la que se optimiza el uso de fitosanitarios para minimizar la exportación de pesticidas. Pese a ello, la exportación de nutrientes de origen agrario por contaminación difusa ha provocado una aguda crisis eutrófica del Mar Menor y el colapso ambiental de este espacio protegido a nivel internacional, mientras que en torno a setenta contaminantes orgánicos alcanzan la laguna. Este caso confirma la necesidad de replantear los conceptos de eficiencia y eficacia, así como la escala a la que se evalúan los efectos de la agricultura, incluyendo los tecnológicamente avanzados como los de fertirrigación: no es suficiente con una elevada eficiencia a escala de explotación agraria: el objetivo a alcanzar es la eficacia a escala del sistema a la hora de impedir y revertir tanto la sobreexplotación como la contaminación de los ecosistemas.

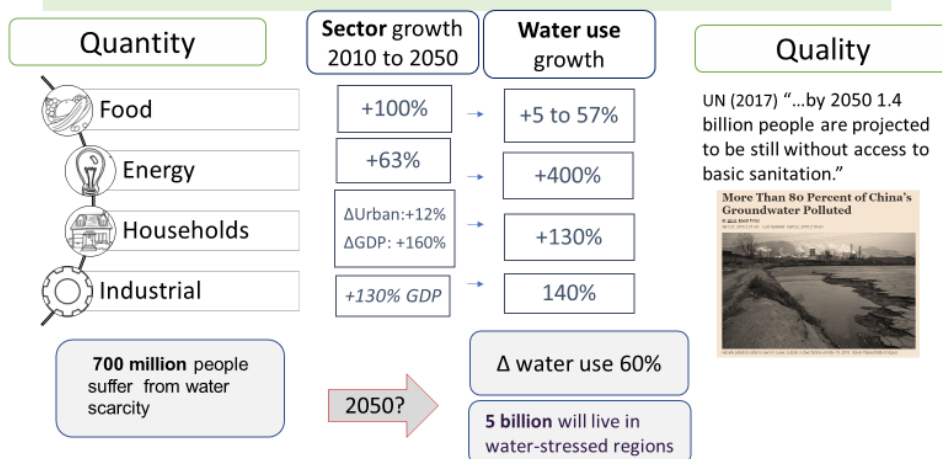
## Water use and economic efficiency

Berbel J.

University of Cordoba, Spain

- We will need around 60% more water for 2050
- Water rights are allocated today to historical uses. Some coalitions want to keep it locked to land/people (farmer lobbies, local politicians, eco-activist)
- Modernization does not produce real savings (they capture return flows).
- Modernization increases water value and productivity of factors (land, labor, water)
- Re-allocation to high value uses, better agronomy and 'open mind' are the way forward.

### Water demand 2010 to 2050



Source: OECD Environmental Outlook (Irrigation data from FAO), Water stress UN

### Closing the water gap

	How we are (2010)	The future is today (2050)
Wastewater reuse	20% wastewater is treated	Some regions (ISR, ESP) recycle 70-90% WW today
Desalination	Unit cost has reduced 10 fold since 1960	Cost will arrive to ≈ 0.40 €/m³
Water saving?	Return flows are reused at basin => No real savings	Water value & productivity growth (but no real savings)
Water pricing?	Inelastic demand (urban, high value crops...). Small savings.	Water price as a tool for financing & equity goals
Allocation	Allocation based on historical rights and 'rent seeking behaviour'	Water banks, market, water pricing, planning...
Governance	Failures, (e.g Cape town), ...	Up-down and user-group integrated policy, water accounts

"The mind is like a parachute it only works when it's open." A. Einstein

## Influence of grape cultivation on the management and quality of groundwater in Val Tidone

Suciu N.A.<sup>1</sup>, Zambito Marsala R.<sup>1</sup>, Calliera M.<sup>1</sup>, Marchis A.<sup>1</sup>, Russo E.<sup>2</sup>, Peroncini E.<sup>2</sup>, Decrema M.<sup>2</sup>, Bisagni M.<sup>3</sup>, Ferrari S.<sup>3</sup>, Colla R.<sup>4</sup>, Capri E.<sup>1</sup>

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More than 60% of the river and lake water bodies in Europe are reported to be in less than good ecological status and 26% of groundwater across Europe is in poor chemical status. Agriculture is the biggest source of plant protection products (PPPs) and nitrate pollution in European fresh waters. The WaterProtect Project, funded under the H2020 EU Programme, aims to create an integrative multi-actor participatory framework including innovative instruments that enable actors to monitor, to finance and to implement management practices and measures for the protection of water sources. Seven case studies are proposed, involving multiple actors in implementing good practices to ensure safe drinking water supply. One of the seven case studies is in the Tidone Valley, Piacenza Province, Italy. Tidone Valley is a hilly area with elevations ranging between 100 and 350 m above sea level, known for deeply rooted tradition and vocation to viticulture. The main culture is the vineyard, with 2 941 ha in 2016. Inhabitants of rural villages are mainly involved in grape and wine production, organised as private farms or as social wineries. Groundwater is used for drinking water production and zootechnical and agricultural practices. Monitoring results from the regional authority ARPAE revealed a non-adequate quality of the groundwater mainly due to the presence of pesticides and nutrients. Agriculture is the principal contributor to pollution from PPPs and nutrients even if the vineyards contribution to the general contamination is not well defined. WaterProtect in Tidone Valley aims to determine the real vineyards contribution to the general contamination of groundwater in Tidone Valley by nutrients and pesticides and increase uptake of measures. In this context, the study in Tidone Valley started with a deep analysis of the territory, in terms of (i) models and actors involved in the water governance, (ii) dimension of the viticulture sector and characterisation of agricultural practices used, (iii) historical monitoring data for PPPs and nitrates in groundwater and implementation of new monitoring plan and (iv) existence and level of application of best management practices and mitigation measures to avoid water contamination. Several survey campaigns were developed and six stakeholder categories were involved: farmers (175, farmers, 97 of them are members of social winery Vicobarone), farmers associations (Confagricoltura, Coldiretti and CIA), farmers advisory (Consorzio Fitosanitario Provinciale), reclamation authority (Consorzio di Bonifica di Piacenza), water supplier company (IRETI - gruppo IREN) and health local agency (AUSL). The results of the survey campaigns together with the implementation of the projects' activities on the territory for the achievements of the objectives will be presented during the conference.

**Keywords:** water governance, participatory monitoring, viticulture, stakeholders' engagement, pesticides, nitrates



# Interreg NSR-project: Nutrient Removal and Recovery from Drainage Water (NuReDrain)

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The NUREDRAIN project wants to tackle the problem of eutrophication linked to intensive farming activities by testing filter technologies which can remove and/or trap N and P before these nutrients reach receiving waters. NUREDRAIN aims to remove an average 50% of N and 70% of P on the test locations. Moreover, 20% recovery of P from the filter material is intended so that it can be reused as a fertilizer.

The NuReDrain consortium consists of universities and research institutes from Belgium, Denmark and Germany which have a large research expertise in both phosphate and nitrate removal from agricultural waters through filtration. Three agricultural and horticultural knowledge partners, with extended field experience in agriculture and horticulture, help to develop field tests for the different nutrient removal materials. The project aims to develop filter systems which effectively work and which allow to reuse the trapped nutrients as fertilizer. After both bench scale analyses and field scale demonstrations, a technical-economic evaluation will be made for the different filter systems. NuReDrain also consists of a Belgian and German drinking water company, both confronted with eutrophication in their water reservoirs due to nutrient losses through agricultural activities in their catchment area. The project partners will inform farmers and farmers' association as well as local, regional and national authorities to help develop mitigation measures and legislation in order to prevent eutrophication of our rivers, lakes, estuaries and coastal zones.

Several filter setups and filter materials are currently being tested during field demonstrations in Denmark, Germany and Belgium. With respect to N removal, 2 different mechanisms have been tested in lab and field conditions: a 'moving bed bioreactor' and a 'zero-valent-iron filter'. Both showed great potential. The moving bed bioreactor can be scaled up for field testing whereas the zero-valent-iron filter needs further modifications before the step from lab to field demonstrations can be made. Saturated filter materials are intended to be reused as fertilizers. This work is still in progress.

**Keywords:** nitrate, phosphorus, filter systems, eutrophication, recovery, water





## **Decision Support Systems for nitrogen pollution reduction in agricultural systems. A case from the Valencian Community (Spain)**

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The sustainability limits of three processes operating at Earth level have been transgressed by human activities. The disruption of the nitrogen cycle by agricultural activities is one of these. Soil nitrogen losses by  $\text{NO}_3^-$  leaching and  $\text{N}_2\text{O}$  emissions are the main responsible for the unsustainability of the global N management. This means low agricultural nitrogen use efficiency (NUE) and environmental nitrogen pollution (NP). Both NUE and NP are mainly caused by the high uncertainty in soil N contents and crop N requirements that farmers face when managing nitrogen fertilization. The high spatial variability in soil properties and the complex interactions among the main factors operating in agricultural systems are the main reasons behind this high uncertainty. Most of the recommendations followed by farmers are based on fixed fertilization rates which come from experimentation fields developed under specific conditions that are not translatable. Site specific nitrogen management (SSNM) is the key to increase NUE in agricultural systems while reducing NP. In this regard, simulation models arise as adequate tools, because they permit to take into account the main specific conditions of each farm in order to assess the nitrogen fertilization rates and thus reduce nitrate leaching and  $\text{N}_2\text{O}$  emissions. Nevertheless, the high complexity of these tools is the main reason whereby farmers are reluctant to use them. Particularly, in the Valencian Community (Spain) the extension of vulnerable zones to nitrate pollution (NVZ) has increased from 19% of the total area in 2000 to 35% in 2018, despite the nitrogen directive implementation since 2000. New technologies such as decision support systems (DSS) based on simulation models are promising technologies for the evaluation of potential nitrogen pollution and for implementing the SSNM in agricultural systems. In this regard, the NITIRSOIL model is an easy-to-use program written in visual studio 2012 .net and designed to be readily integrated in a DSS in a website or mobile app. Since this DSS will be user-friendly and 24/7 available, its use will easily expand to the farmers in the NVZs and, moreover, will support the implementation of the new Valencian order (10/2018) aimed at regulating the use of nitrogen fertilization materials.

## Inorganic waste in horticultural greenhouses farming: the state of the art in the Province of Almeria (S. Spain)

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The Innovation Strategy of Andalusia 2020 envisages a sustainable and efficient Andalusia with regards to the use of its resources, based on, among others, the recovery of waste, including everything related to the environment as a driver for socio-economic development and job creation, as well as to the green and blue economies.

Concretely, the information relating to the production of inorganic waste in rural areas is atomized or non-existent. In this study, in the context of the REINWASTE project, after analyzing the different activities in green houses horticultural production process with their respective inputs and production factors in the province of Almeria (Andalusia-Spain), we try to estimate the structure and the volume of the main residues produced, emphasizing in the contributing of the irrigation systems in the generation of the inorganics ones.

Finally, some innovative solutions for waste prevention have been defined to reduce, collect, recycle and recover waste along the value chain.

**Keywords:** Horticulture green houses, irrigation systems, inorganic waste, zero residues; Almeria Spain.

## Producing irrigation water and bioproducts from wastewater

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Aqualia, that has been managing water services in Almería for 25 years, knows the problematic of water scarcity under such a desert climate, where agriculture is the main economic sector and therefore water for irrigation is a valuable resource.

Considering the fact that this region is one of the most radiated areas of all Europe, the application of a technology that uses solar power to treat wastewater and, at the same time, produce reusable water for irrigation purposes and an organic fertilizer, appears to be ideal. Microalgae systems are an efficient wastewater treatment technology with a very low energy demand. On one hand, a high disinfection rate without need of tertiary treatment is reached, producing an effluent suitable for reuse for irrigation purposes under Spanish legislation RD1620. On the other hand, highly valuable biomass, such as biofertilizers and bioestimulants, can be obtained from the harvested algae, which is being studied in H2020 Sabana project. In El Toyo WWTP (Almería, Spain), a 3000 m<sup>2</sup> microalgae reactor demonstration plant has been built in the frame of both H2020 Incover and LIFE Biosolware projects. The system treats urban raw wastewater from 2,000 HA under real conditions and a biofertilizer product is being tested.

For areas where land availability is lower, Aqualia has developed another technology, based on the use of anaerobic membrane bioreactors, with much lower energy requirement and footprint than conventional aerobic processes. LIFE Memory Project aims to demonstrate at an industrial prototype scale the technical and economic feasibility of Submerged Anaerobic Membrane Bioreactor (SAnMBR) technology to treat urban wastewater. SAnMBR technology is based on the synergy between anaerobic treatment and membrane filtration process, reducing the sludge produced by 4 times. The biogas thus produced is converted into heat and electricity or refined as biomethane for use as biofuel. Simultaneously, the ultrafiltration process disinfects treated water, producing reusable water with a high nutrient content, making it very suitable for irrigation of farm land.

### Acknowledgements

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# ABSTRACTS



## Evaluation of water efficiency in farming: Empirical evidence from a semi-arid region

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Water scarcity in Spain is partly due to poor management of this resource in the agricultural sector. The main aim of this study is to present the major factors related to water usage efficiency in farming. It focuses on the Almería coast, southeast Spain, which is one of the most arid areas of the country, and in particular, on family farms as the main direct managers of water use in this zone. Many of these farms are among the most water efficient in Spanish agriculture but this efficiency is not generalized throughout the sector. This work conducts a comprehensive assessment of water performance in this area, using on-farm water-use, structural, socio-economic, and environmental information. Two statistical techniques are used: descriptive analysis and cluster analysis. Thus, two groups are identified: farms that are less and farms that are more efficient regarding water usage. By analyzing both the common characteristics within each group and the differences between the groups with a one-way ANOVA analysis, several conclusions can be reached. The main differences between the two clusters center on the extent to which innovation and new technologies are used in irrigation. The most water efficient farms are characterized by more educated farmers, a greater degree of innovation, new irrigation technology, and an awareness of water issues and environmental sustainability. The findings of this study can be extended to farms in similar arid and semi-arid areas and contribute to fostering appropriate policies to improve the efficiency of water usage in the agricultural sector.



## Efecto de la dosis de fertirriego sobre el cultivo ecológico de guisante (*Pisum sativum*) en invernadero

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El cultivo de leguminosas es un componente imprescindible en las rotaciones de cultivo dentro de la agricultura ecológica gracias a su papel mejorador de la fertilidad de los suelos, por la asociación simbiótica con bacterias fijadoras de nitrógeno atmosférico. Además, son una valiosa fuente de proteína para alimentación humana, con conocidos beneficios para la salud, siendo uno de los pilares de la dieta mediterránea.

Puesto que los principios fundamentales de la agricultura ecológica son la preservación de los recursos naturales y el aumento de la biodiversidad, el objetivo de este trabajo fue evaluar el efecto de la reducción de la dosis de fertirriego sobre la producción del cultivo de guisante bajo invernadero ecológico.

Para ello se ensayaron dos tratamientos diferentes, dotación usual de fertirriego (100% fertirrigación) y dotación restringida (50% fertirrigación). La programación del riego se llevó a cabo mediante el manejo de tensiómetros instalados a 15 centímetros de profundidad, siendo la consigna utilizada fertirrigar cada vez que el tensiómetro situado en la parcela del tratamiento de dotación usual de riego marcaba una tensión de 20 cb. Fertirrigando durante 30 minutos en el tratamiento de dotación usual de riego y 15 minutos en el tratamiento de dotación restringida de riego. El material vegetal ensayado consistió en 7 cultivares de guisante (*Pisum sativum*), concretamente fueron los cultivares comerciales Buddy, Ambassador, Altesse, Jumbo, Lincoln, Eddy, Zircon. Para estudiar los efectos de la dosis de fertirriego se cuantificó la producción comercial.

No se encontraron diferencias significativas entre el tratamiento 50% y 100% de fertirrigación en ninguno de los cultivares de guisante ensayados, encontrándose las producciones medias entre 1,35 kg m<sup>-2</sup> y 1,88 kg m<sup>-2</sup>.

Los resultados hacen pensar que en nuestras condiciones de cultivo se puede desarrollar, sin pérdidas de producción, el cultivo de guisante en producción ecológica con ahorro en agua y abono, mejorando de esta forma la sostenibilidad del sistema.

**Palabras clave:** Leguminosas, Diversificación, Riego, Fertilizantes.

# Experiences with cascade cropping systems

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## Introduction

The cascade cropping system is an advisable agricultural technique since it allows a saving of water and nutrients with similar yields and a reduction in the leachate discharge of horticultural and ornamental crops to the environment, and the consequently, pollution of surface and groundwaters. This system is based on the simultaneous growth of several crops with different degrees of salt tolerance where the drainage from irrigation of one crop could be used to fertirrigate other species in a sequential process. The first crop in this system is the most salt sensitive whereas the last crop is the most salt tolerant.

Aim. The aim of this work is to show two different experiences carried out with this cropping system in several crops. These experiences were based on the comparison of water and nutrients supplies and leachates between a traditional fertigation system and a cascade cropping system under greenhouse conditions in two experiments: 1) *Cucumis melo*/ *Rosmarinus officinalis*/ *Cactus* sp. (Garcia-Caparrós et al, 2018 a) and 2) *Ruscus aculeatus*/ *Maytenus senegalensis*/ *Juncus acutus* (Garcia-Caparrós et al, 2018 b).

## Methods

Throughout both experiments, nutrient supplies and leachates of each crop were computed and their chemical composition was determined using a high-performance liquid chromatography (HPLC). In addition, yield of each crop was also recorded.

## Results and Discussion

In both experiments, there were no significant differences in yield comparing the traditional fertigation system against the cascade cropping system. The results obtained showed that the cascade cropping system involved a water saving of 61 L per m<sup>2</sup> and 36 g of NO<sup>3-</sup> per m<sup>2</sup> in the first experiment and a water saving of 3 L per m<sup>2</sup> and 1.6 g of NO<sup>3-</sup> per m<sup>2</sup> in the second experiment. The establishment of cascade cropping systems resulted in water and nutrient saving and the pollutant runoff water harvesting making this system more sustainable from an environmental point of view.

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## “Cheaper Agrícola” a Nutrient Dosing Device

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Según “The Fertigation Bible”, publicación científica preparada por FERTINNOWA PROJECT, ([www.fertinnowa.com](http://www.fertinnowa.com)), cuyo principal objetivo fue el de proveer de información al sector hortícola sobre las diversas tecnologías disponibles para todos los aspectos de la fertirrigación, los enfoques generales de las tecnologías existentes para suplir las necesidades de dosificación de nutrientes se podrían organizar en las siguientes categorías:

### 1-Equipo controlado manualmente:

1.1- Tanque de fertilización simple (que incluye un tanque presurizado cerrado y/o un tanque de fertilización abierto conectado a la succión de la bomba)

1.2- Inyección Venturi

1.3- Bomba de inyección

### 2.-Equipo automático:

2.1- Equipo de inyección automática por efecto Venturi controlado por solenoides y basado en CE y pH

2.2- Equipo de inyección automática basado en Venturi con tanque de mezcla controlado por CE y pH

2.3- Equipo de inyección automático basado en la adición cuantitativa con bombas de desplazamiento positivo

En el siguiente resumen presentamos una forma novedosa de dosificar los nutrientes ya probada con éxito durante diez años de experimentación.

El Cheaper Agrícola es un dispositivo diseñado para la inyección de nutrientes a un sistema de riego. Sus principales características lo hacen un sistema sencillo, libre de mantenimiento, con bajo consumo de energía, adaptable prácticamente a cualquier sistema de riego. Su funcionamiento está basado en la teoría del “Orifice Meter”, según la cual, la cantidad de fluido que pasa por un orificio es directamente proporcional a la raíz cuadrada de la presión diferencial aguas arriba y aguas abajo del Orificio.

En los sistemas de riego, normalmente se genera una depresión en la línea de succión (NPSH). Esta depresión es utilizada por el Cheaper Agrícola para introducir los nutrientes en forma de solución concentrada en la línea de riego. Como quiera que la depresión generada en la línea de succión depende, entre otras variables, del caudal despachado por la bomba, igualmente el caudal aspirado por el Cheaper, dependerá de la depresión generada en la línea de succión, así que la relación entre estas dos variables se puede mantener relativamente constante dentro de un amplio rango de caudales.

Este sistema ha sido probado con éxito en algunas explotaciones de Fresas en Colombia entre ellas una de 10 hectáreas (Fresas Santa María) en cultivo hidropónico en sustrato de cascarilla de arroz y escoria de Carbón en mezcla 70/30 durante más de 10 años.

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**Keywords:** Nutrient dosing, Fertirrigation, Nutrient management.

# Investigation of hydraulic performance and irrigation uniformity under different layout for big gun sprinkler

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## Introduction

Sprinkler irrigation system has been widely employed due to the operational simplicity that this irrigation method offers. Big gun sprinkler is one of the most useful rotating sprinkler, and the most widely used type globally (Pascal, 2006; Osman et al, 2014). Water distribution uniformity is an important performance characteristic and the most relevant parameter of the sprinkler irrigation system and it can effect on important aspects such as water use efficiency, leaching of fertilizers and crop yield (Seginer et al, 1991). The purpose is to investigate the effect of the nozzle diameter, operating pressure, layout form, and overlapping distance on the hydraulic performance.

## Results and Discussion

The discharge coefficient ranged from 0.96 to 0.99. The application rate was lower near the sprinkler, and a peak value occurred under the radius of throw from 4 to 6 m for each water distribution pattern. The average application rate decreased with increase of operating pressure. The average application rate increased with the increase of nozzle diameter. The increased or decreased in magnitude of average application rate under small nozzle diameter was larger than large nozzle diameter within the same range of variation in operating pressure. The maximum Christensen uniformity (CU) values increased with the increase in operating pressure under different nozzle diameter or different layout. Equilateral triangle layout achieved higher uniformities compared with square layout. The optimal CU values and spacing coefficients of the big gun sprinkler with different layout forms, operating pressure and nozzle diameter were proposed.

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**Keywords:** irrigation equipment, sprinkler, hydraulic performance, water distribution uniformity



## Comparison of methods of irrigation scheduling in a pepper crop in Mediterranean greenhouse conditions

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Improving the efficiency of irrigation water use requires knowing accurately the amount of water to be apply in each plot or irrigation sector at a given time. The most widely used procedure to quantify the irrigation needs of each plot is the method developed by FAO (Doorenbos and Pruitt, 1977) and which has been calibrated for use in the greenhouses of southeastern Spain (Orgaz et al., 2005; Fernández et al., 2010). This approach is useful, but it generates some uncertainties associated mainly with the crop (variety, plant density, dimensions and shape of the vegetable canopy, etc.) and cultivation system (use of mulches, tunnels, mesh or greenhouses, etc.). An alternative is the irrigation control with sensors, but has the drawbacks of cost, risk of failure, sensor accuracy and lack of anticipation of irrigation needs in the medium term.

The objective of this study was to compare two methods of irrigation scheduling in a pepper crop with the conventional management used by the farmers (CM).

A simple automatic system for the activation of irrigation based on electro-tensiometers (IM) and a non-commercial web tool IRRIX (Casadesús et al., 2012), that combines the water balance and sensors, were used. To avoid the soil salts accumulation, an average leaching fraction of 16% was applied in IM and IRRIX modified the irrigation dose according to the soil electrical conductivity measured with GS3 sensors (Decagon Device).

The IM and IRRIX irrigation scheduling methods have allowed reduce 15% and 31% irrigation water volume, respectively in relation with CM, reducing by half drainage in IM (Table). The irrigation volume used in IRRIX method was slightly higher than the ET<sub>c</sub> measured in drainage lysimeters (320 mm) and similar to the ET<sub>c</sub> estimated with PrHo (Fernández et al., 2009), which was 330 mm. Production achieved with the irrigation scheduling methods were similar.

Determine doses irrigation from a water balance model and use the sensors to adjust the theoretical dose to the actual situation of each plot is the best way to improve irrigation water use efficiency in the future.

Table. Cumulative irrigation volumes, drainage volumes and yield.

Irrigation scheduling method	Irrigation (mm)	Drainage (mm)	Yield (Kg m <sup>-2</sup> )
CM	437	118	9.97
IM	380	60	10.47
IRRIX	332	Not measured	10.15

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**Keywords:** crop evapotranspiration, greenhouse, sensor, irrigation



## **Analysing different sources of potassium (K) for a better management of fertigation under conditions of water stress and / or salinity in fruit-tree crops**

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The salinization of agricultural soils is one of the most serious problems facing agriculture. In recent years, the increase in salinized cultivation areas has been dramatic due to the intensification of agriculture, the indiscriminate pumping of water for irrigation in areas near the sea together with the use of high saline index fertilizers. A high concentration of salts, apart from the specific toxicity due to the absorption of ions in high concentrations, results in a high osmotic potential of the soil solution obliging the plant to use more energy to uptake the water.

As for the nutrients, potassium (K) is one of the essential macronutrients for plants that is required in large quantities by them for proper vegetative and reproductive development. It is known as the "fruit quality nutrient". Moreover, this element regulates the opening and closing of stomata, therefore, playing an important role plant water uptake. Hence, it will be key for the greater or lesser crops water-stress tolerance.

The effect of different sources of potassium applied in fertigation on the absorption of nutrients, production, fruit quality and vegetative growth-stage of young clementine plants of Nules and kaki, bright red and on different soil parameters are being analysed. Young citrus plants of the Nules clementine variety grafted on citrange reed and kaki bright red on Lotus (salinity sensitive rootstock) are being cultivated on sandy loam soil. The following treatments have been carried out: CONTROL, Treatment 0 or control without contribution of potassium fertilizers; SK, fertigation with chloride-free liquid fertilizer based on potassium sulphate; ClK, fertigation with liquid fertilizer with chlorides based on potassium chloride; MultiKTM, fertigation with soluble solid fertilizers based on potassium nitrate.

The nutritional status of the plants was not affected by the different fertilizers. However, foliar concentration of chlorine was much higher in trees fertilized with chloride-based fertilizers. In addition, the plants fertilized with this form of K presented a greater fall of the fruit, possibly because they underwent a greater hydric stress (greater water potential) at critical moments of cultivation. As for the effects on soil, treatments fertilized with potassium chloride drove to EC values significantly higher than the rest of the treatments, with the potassium concentration in the saturation extract being higher than other treatments.

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**Keywords:** fertigation, fruit-trees, potassium, osmotic potential, yield.

## Evaluation of three sensors (GS3, CS655, WET) for soil water content and salinity estimations

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Affordable sensors based on different technologies such as capacitance-conductance (CC), Frequency Domain Reflectometry (FDR), and Time Domain Reflectometry (TDR) has been developed in recent years. These sensors measure soil bulk dielectric permittivity ( $\epsilon_b$ ) and electrical conductivity (EC<sub>b</sub>), and estimate soil volumetric water content (VWC) and salinity. However, few experiments compare sensor estimates of VWC and salinity to reference values of, respectively, soil gravimetric water content per bulk density (GWC x BD) and the saturation extract electrical conductivity (EC<sub>se</sub>). In this study, three current commercial sensors of different typology: GS3 (CC, Decagon Devices, Inc.), WET (FDR, Delta-T Devices Ltd.) and CS655 (TDR, Campbell Scientific, Inc.) were evaluated. Twenty-four pots were filled with a typical clay-loam soil and arranged combining four levels of VWC (45, 40, 35, 30%) with six levels of soil water electrical conductivity (EC<sub>w</sub>) (0.2, 1, 3, 5, 7, 9 dS m<sup>-1</sup>), and measurements of soil temperature,  $\epsilon_b$ , and EC<sub>b</sub> were carried out with the three sensors. The VWC was modelled with the equations recommended by the manufacturers, and also with the simplified dielectric mixing (SDM) equation. Fitting the parameters of the SDM equation for the WET and CS655 sensors, the R<sup>2</sup> and RMSE reached values of 0.5 and 0.022 m<sup>3</sup> m<sup>-3</sup>, and using the manufacturers' equation (Topp equation) for the GS3, a poorer model was found. High salinity affects differentially the VWC estimates for each sensor, and removing the two highest levels of EC<sub>w</sub>, the relations improved significantly, reaching R<sup>2</sup> = 0.75 and RMSE = 0.017 m<sup>3</sup> m<sup>-3</sup> for the CS655, and R<sup>2</sup> = 0.69 and RMSE = 0.082 m<sup>3</sup> m<sup>-3</sup> for the GS3, but improved only moderately for the WET sensor reaching R<sup>2</sup> = 0.71 and RMSE = 0.022 m<sup>3</sup> m<sup>-3</sup>. Therefore, for EC<sub>b</sub> values over 1.75 dS m<sup>-1</sup>, VWC estimates are quite affected by salinity for the GS3 and CS655 sensors. Regarding EC<sub>se</sub>, it was well predicted by the EC<sub>b</sub> measured with the CS655 and WET sensors, reaching R<sup>2</sup> of 0.96 and 0.87, respectively, but less accurately with the GS3 with R<sup>2</sup> of 0.80. Each sensor requires its own calibration considering the salinity level, and should be adapted to each soil typology.

**Keywords:** VWC, soil sensor, salinity, GS3, CS655, WET.

## Influence of application of microalgae hydrolysates (*Scenedesmus* sp) on *Petunia x hybrida* plants

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Microalgae contain active compounds such as free amino and organic acids, phytohormones, vitamins and enzymes which are known to play crucial roles in plant development. The aim of this work was to study the effect of foliar spraying with microalgae hydrolysates (*Scenedesmus* sp) on growth and flowering of *Petunia x hybrida*. The trial was carried out in a greenhouse. Single plants were transplanted in 1.5 L pots and the substrate used was a mixture of peat and perlite 80:20 (v/v). Fertigation was applied manually. The concentrations in the standard nutrient solution were: 0.40, 4.0, 1.0, 0.6, 2.5, 1.0 and 1.2 mmol L<sup>-1</sup> of H<sub>2</sub>PO<sub>4</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, SO<sub>4</sub><sup>2-</sup>, K<sup>+</sup>, Ca<sup>2+</sup> and Mg<sup>2+</sup>, respectively. The pH and EC were 6.5 and 2.6 dS m<sup>-1</sup>, respectively. Two treatments were performed: T1 (foliar application with water) and T2 (foliar application with *Scenedesmus*). Foliar spraying was applied 5 times (0, 14, 28, 35 and 42 days after transplanting). The results showed that the application of microalgae (*Scenedesmus*) increased number of flowers and leaves per plant. However no difference in shoots number per plant, internode length, leaf area, water content, leaf and stem+petiole and root dry matter was found. Based on the results, it is advisable to use *Scenedesmus* as biostimulant to improve flowering and leaf growth.

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**Keywords:** hormones, biostimulants, number of leaves, flowering

# Centralized fertigation and organic farming. Conflict and alternatives in València Region (Spain)

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## Introduction and objectives

During the last 20 years, drip irrigation systems technologies have been massively installed in water users' associations (WUA) of the València Region (Spain). Most of these associations have adopted centralized fertigation infrastructures in the citriculture areas, in order to reduce labour and fertigation costs, and to increase farmers' comfort. However, during the last decade, the crisis of the orange market has broken the homogeneity of this landscape of monoculture, and new crops and organic farming practices are emerging as an alternative to the traditional orange production systems. This new orientation, still minority, finds an obstacle in centralized fertigation, which hinders individual innovative fruit growing systems. The objective of this research is to analyze this conflict and the discourses of both groups, and to identify farmers' and WUAs' technological and management strategies to overcome this confrontation.

## Methodology

Field semi-structured interviews have been developed with members of the government board of the WUAs, technicians of the WUAs, farmers, farmers and experts from the administration and research centers.

## Results

Farmers and WUAs have agreed two kind of adaptations to make compatible the interests of a majority of farmers defending centralized fertigation, with a minority of users trying to consolidate organic farming business or fruit trees growing diversification strategies. Irrigation network adaptations lets farmers to connect (by their own economic means) their individual pressurized networks to the collective one. This is done upstream the fertigation injection point in order to get water without chemical fertilizer. Collective management adaptations consist in the integration of "clean" water irrigation turns at WUAs central management level. Such adapted water turns are addressed to one or few organic farmers on the irrigation scheme. Both strategies are not global neither sustainable solutions as do not completely satisfy any of these groups' needs, directly related with emerging agricultural choices. This confrontation reflects the complex cohabitation of two fruit growing models seeking to maximize their productive potential in a changing context.

**Keywords:** Centralized fertigation, organic farming, citriculture, water users' associations, drip irrigation, adaptation.



# Cucumber green mottle mosaic virus transmission in cucumber through irrigation in different soils and substrates

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*Cucumber green mottle mosaic virus* (CGMMV, Tobamovirus) was first detected in Spain in cucumber grown in the province of Almeria in the early 1990ies. During the following years, several small outbreaks took place which jeopardized greenhouse crops (Crespo et al., 2017). Primary infectious are introduced through infected seeds. Successful control of secondary spread through crop management is positively correlated with soil disinfection (Elorrieta et al., 2017). The high infectivity of the virus and its transmission by contact urged the need to investigate following two aspects of the epidemiology of CGMMV: i) the permanence of CGMMV in different growth substrates, and ii) the possibility of virus transmission by irrigation water. The former issue was addressed during the fall of 2013 (October-January 2014) and the spring of 2014 (March-June 2014), when cucumber cv. Estrada plants were grown in 5 different substrates: perlite, rockwool, coconut fiber, peat, and sand. Plants were inoculated manually and grown until the end of the cultivation period. The substrates were preserved in their original containers and used to plant a new crop at the start of the spring campaign (March-June 2014) in order to investigate the persistence of virus in the soil. To evaluate the transmission of the virus by potentially infected water, drainage liquid was collected during fall and spring campaigns from infected crops and used for irrigation on healthy cucumber plants. The drainage was analyzed by ELISA for CGMMV. Irrigation water has been considered to play a role in the epidemiology of CGMMV (Li et al., 2016). Our results suggested that in greenhouse crops from Almeria there was no risk of CGMMV contagion through irrigation water for cucumber under autumn campaign conditions. However in the spring campaign 5% of plants were affected when they were irrigated with this fluid. In the case of the persistence in soils, the percentage of plants infected during the spring campaign reached 100 % regardless of the type of soil substrate that was previously infected.

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**Keywords:** Tobamovirus, epidemiology, disease control, greenhouse



# Methodology for analysis, assessment and improvement of fertilizer distribution in pressurized irrigation networks

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Pressure distribution networks allow the efficient use of the available resources through the exhaustive control of water inputs to real demand. In particular, drip irrigation allows to apply fertilizers into the water (fertigation) in such a way that both water and nutrient requirements are met using the same distribution system. Fertigation has been a common practice in individual irrigation systems and it has been studied in terms of injector type (Bracy et al 2003) and injector and emitter type (Jiusheng et al 2007). In the last years the increasing number of collective pressure irrigation systems has allowed the use of collective filters and central fertigation systems.

For a better management of the fertilizer it is necessary to understand the processes that take place in the central fertigation system.

The only rational way of managing central fertigation processes in pressure irrigation networks is by grouping the intakes into sectors that operate on scheduled irrigation shifts or arranging the scheduling, in such a way that fertilizer concentrations to be injected are known beforehand. Fertilizer needs a travel time to flow from the injection point to consumption points. Travel time depends on the flow rate and distance to the consumption point. Therefore, it is necessary to know how the fertilizer can be distributed uniformly along the irrigation system. This will allow users to implement strategies that improve fertilizer distribution. In this work it is showed a methodology to improve fertilizer distribution uniformity (Jiménez Bello et al 2010). This methodology requires a calibrated mathematical model of the network coupled with genetic algorithms. By estimating the Effective Fertigation time for each irrigation intake (EFT), the model produces the optimal scheduling, opening and shutting of irrigation intakes, that maximizes the average EFT. It can also be combined to satisfy with the minimum energy consumption, in case pumps are used.

Moreover, it can be used to study how to empty the network of fertilizers as fast as possible and strategies for reducing the concentration that achieves some irrigation subunits in case they do not want receive fertilizers, like organic growers.

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**Keywords:** Fertigation, Irrigation network, hydraulic simulation.

## Internet Platform for supporting fertigation decisions

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### Introduction

Fertigation has become a common practice of fertilization in intensive irrigated agriculture. The Internet Platform for Supporting Irrigation Decisions has been created in the Research Institute of Horticulture, within the Multi-year Programme - [www.nawadnianie.inhort.pl](http://www.nawadnianie.inhort.pl) (Treder et al, 2013). The Platform consists of the following modules: a base containing weather data, a base containing scientific publications, popular science articles, lectures and methodic on irrigation and water management subjects as well as computing applications (calculators) which are the main components of the Platform. The calculators enable to estimate many important parameters related to planning and running irrigation and fertigation of horticultural plants, e.g.: choosing an optimal irrigation method, calculation of water needs, calculation of irrigation system hydraulics, calculation of soil water reserves, preparation of fertigation schedule, and many others.

### Methods

A user or an agricultural consultant can prepare a schedule of fertigation using the application: 'a fertigation schedule based on nitrogen doses' or 'a fertigation schedule based on fertilizer doses'. In the first stage, a database containing list of fertilizations used during the fertigation should be created by filling a template table with the names of fertilizers and their chemical composition. Next, a schedule template should be filled with a code assigned to the fertilizer, fertilizer dose or the dose of nitrogen (as a pure element).

### Results

The end result is a table containing the total amount of elements and relations among them, as well as a chart illustrating doses of the elements during the whole period of fertigation treatment. If necessary, it is possible to change types and doses of fertilizers. The completed schedule can be saved and printed, as well as a report (in pdf format) can be generated and printed out. The report contains a fertigation schedule and information about weekly as well as total fertilizer doses. Also the information about weekly and total doses of individual macroelements is included.

### Conclusions

Thanks to the option of importing and editing the schedule, the application provides a platform enabling to exchange fertigation schedules among farmers and consultants. There are also other useful applications related to fertigation: 'calculating the fertigation runtime', 'preparing fertilizer mixtures', 'calculating nitrogen concentration in a tank', 'calculating discharge of fertigation pump'.

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**Keywords:** DSS, irrigation, fertigation

# Introduction and improvement of drip Irrigation in vegetables and fruit in Flanders, Belgium

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## Irrigation in Flanders

The last years periods of drought are occurring more frequently in the Northern part of Belgium (Flanders). Combined with the fact that Flanders is a region with water scarcity (ca. 1500L/capita/year) urges for a more sustainable irrigation management. Today sprinklers and hose reel irrigation are common practice in Flanders in vegetables. However, some farmers want to improve their water efficiency by applying drip irrigation. Besides economical losses, water stress at plant level causes an inefficient uptake of nutrients, which ultimately leads to leaching of nutrients. This causes high pressure on the environment and sustainability of the growers.

## Introducing drip irrigation

In Flanders drip irrigation is a commonly used technique in fruit production but not in vegetable production. Based on the outcomes of a previous irrigation project in *Asparagus officinalis* subsp. *officinalis* and the project 'FERTINNOWA', researchers started to introduce this technique. Recently some demonstration projects are running in order to explore the possibilities, advantages and difficulties of drip irrigation for a broad range of horticulturists. These demo fields are carried out for water-invasive crops (*Apium graveolens*, *Asparagus officinalis* subsp. *officinalis*, *Foeniculum vulgare*, *Vaccinium corymbosum* etc.) at research stations and at privately owned or rented fields of some early adaptors. The main reasons why these farmers started with drip irrigation are: (1) a more accurate water supply at the plant root level, (2) less labour intensive in comparison with hose reel irrigation, (3) a reduced disease pressure, (4) a higher yield and (5) possibilities for a more fine-tuned fertigation. However some questions need more research in order to make a larger scale introduction of this innovative technique on farm level. Burning questions which are topic to the demonstrations are: positioning of the drip lines, the interval between and the amount of water gifts to the crop, the selection of most suitable drip lines and other practical questions are topic of these demonstrations. Furthermore, attention is given to data management and collecting data with sensors in order to measure humidity or water pressure in the soil. In these projects a selection in available sensors on the market is evaluated in close consultation with farmers. Another research topic is to test if wetting agents or surfactant can help to spread moisture in the soil better. To provide interested farmers with the complete drip irrigation experience a visit to South Europe is planned to visit farmers and research stations which have already a high experience with these techniques. Fresh market vegetables (asparagus, leek, fennel, celery), berry, apple and pear are the focus crops of this demonstrative research. First results are expected at the end of the season 2018. This project is supported by the European Agricultural Fund for Rural Development: Europe invests in its countryside ' Flanders, province Limburg and research stations.

**Keywords:** drip irrigation, outdoor vegetables, fruit growing, demonstration

# Calibración de sondas capacitivas mediante modelo para la programación del riego

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## Introducción

El ajuste de las necesidades de riego es un paso fundamental para lograr un adecuado manejo del agua en las explotaciones agrícolas. Cantidad, duración y frecuencia del riego pueden determinarse gracias al conocimiento del estado hídrico del suelo y de las plantas. La humedad del suelo se puede emplear como un parámetro para el control y la determinación del riego, para esto, es necesario partir de un dato ajustado a las características propias del suelo donde se desea emplear.

## Objetivos

El presente trabajo tiene como objetivo desarrollar y validar una metodología de extrapolación de un valor de humedad crítica definido para la programación del riego en parcelas de cítricos en condiciones mediterráneas. Se pretende calibrar sondas capacitivas para la medida directa de la humedad del suelo mediante diversos parámetros físicos del suelo y un modelo de simulación para realizar los ajustes correspondientes.

## Métodos

Para ello se ha realizado un ajuste en dos niveles. Por un lado, se ha establecido la relación entre las medidas de las sondas de humedad instaladas en parcela y los valores obtenidos mediante el modelo matemático Leachm que simula el balance de agua en suelos no saturados. Este paso permite obtener una primera corrección de lecturas de humedad que resuelve la inexistente calibración de sondas. Por otro lado, se han determinado las curvas que relacionan la humedad del suelo con el potencial matricial. De esta manera, tomando como valor de referencia el potencial matricial asociado a los datos de origen, se consigue extrapolar la humedad crítica a cada uno de los puntos deseados.

## Resultados y discusión

Con la metodología desarrollada, se ha conseguido la extrapolación de valores de referencia de humedad volumétrica para la programación del riego a otras parcelas de cítricos. Este estudio ha corroborado que la utilización directa de la información de las sondas FDR sin calibrar, puede conducir a decisiones de riego erróneas. Este problema se ha solucionado empleando como herramienta de calibración el programa de modelización de humedad del suelo. Este trabajo podría asentar las bases para futuras investigaciones, donde se analice la posibilidad de utilizar las humedades críticas extrapoladas directamente sobre las simulaciones.

**Palabras clave:** humedad volumétrica, curvas de retención, Leachm.



## Decision support system and weather forecast data for open field vegetable crops irrigation scheduling

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Usually, irrigation scheduling is based on a soil water balance approach that considers reference evapotranspiration and crop coefficients as inputs. However, these crop coefficients come from the literature and the whole approach does not take into account field variability in canopy vigour, among other factors. The current study compared a novel irrigation model (Riego-Asesor, RA), which determines soil evaporation and plant transpiration separately using crop characteristics and weather forecasts as inputs, with the standard irrigation farmer practices (F). Such comparison were performed on three open field vegetation seasons, two in endive and one in muskmelon, in south-eastern Spain. The irrigation volume applied, crop above-ground biomass, water content, relative chlorophyll content (SPAD) and yield were determined in both treatments.

Water savings up to 7.5% for RA when compared with the F treatment have been observed. Farmer's watering regime was already well adjusted to the crop water needs and this, combined with the leaching fraction applied due to the high salinity levels of the irrigation water employed in the area, impeded to attain greater water savings. No significant differences in aboveground biomass, water content, SPAD and yield were observed between treatments for all the crops studied.

In sight of the results obtained from the three field experiments, it can be concluded that the proposed model is able to mimic successfully the irrigation management performed by the farmer without the use of on-the-ground sensors. The main discrepancies observed between the two approaches were caused by the fact that the Riego Asesor model does not consider special management practices during specific moments of the growing season. Nevertheless, when no specific actions were adopted by the farmer, Riego Asesor tended to estimate lower irrigation volumes, resulting in water savings. The incorporation of weather forecasts allows for assessing crop water demands in advance. Therefore, it may be possible to anticipate the occurrence of extreme events and adapt irrigation volumes to future conditions. However, further studies are required to assess how the weather forecasts influence the estimated irrigation volumes and if it is worth to use these predictions instead of weather data already recorded in the days previous to the recommendations.

**Keywords:** crop water needs, model, salinity, soil water balance



# Verticillium dahliae introduction through irrigation system for verticillium wilt development in olive

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## Introduction

Irrigation waters of olive orchards in Andalusia, southern Spain, are sources of *Verticillium dahliae* inoculum which contribute to the spread of the Verticillium wilt. Modern irrigation technologies in combating the presence of *V. dahliae* in irrigation waters of olive orchard should be implemented. However, the impact that levels of pathogen through irrigation system could have on Verticillium wilt epidemics in olive is still unknown. Drip-irrigation procedures reproducing the Verticillium wilt symptoms successfully are required to evaluate the efficacy of some control measures directed to water.

## Aims

To determine the effectiveness of drip-irrigation with water infested with *V. dahliae* to Verticillium wilt in olive and to study the relationship between the level of pathogen into the water, the inoculum density in the soil and the disease.

## Methods

The Picual olive cultivar, susceptible to the Verticillium wilt, and a *V. dahliae* isolate representative of the defoliating pathotype of fungus were used. Trees (one per pot) were irrigated once per week with water infested with conidia or sclerotia of *V. dahliae* during ten weeks from winter to spring. Infested water contained in storage reservoirs was supplied through a surface drip irrigation system (three 1.3 L/h drippers per pot) to achieve either three inoculum concentrations (one reservoir and 32 trees per concentration) at each irrigation event. Equal number of trees remained irrigated with *V. dahliae*-free water as controls. The root system of half of the trees was injured. The disease, water inoculum levels at drippers (ILD) and soil inoculum density (ID) were monitored for a year.

## Results

Irrigation with  $1.5 \times 10^{10}$  conidia and  $3.7 \times 10^7$  or  $3.7 \times 10^5$  sclerotia per tree in each event caused a final disease incidence (DI) of 50 and 6.25 %, respectively, when their roots were injured. Linear or critically damped models described the ILD accumulated and the ID over time. A positive linear relationship was found between both parameters during the period of *V. dahliae*-irrigation, although the accumulation of propagules in the soil was lower than the inoculum incorporation per tree. The relation between ILD and ID with DI was explained by exponential equations which estimated a 100 % of DI for  $3.9 \times 10^{11}$  ufc provided per tree through irrigation system and  $1.77 \times 10^7$  ufc/g of soil.

## Discussion

Root injuring and inoculum concentration in irrigation water were likewise key factors increasing the precision (defined as the repeatability of visual symptoms) of Verticillium wilt symptoms under natural environmental conditions.

**Keywords** defoliating pathotype, sclerotia, inoculum density, *Olea europaea*.

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# Injection of chemical treatments into the irrigation system to deal with *Verticillium dahliae* in water

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## Introduction

Controlling *Verticillium dahliae* in irrigation systems is demanded to be integrated in the management of *Verticillium* wilt of olive in Andalusia (Spain). Water disinfectants containing hydrogen peroxide (OX-Virin® and OX-Agua AL25®) have shown a high in vitro effectiveness in reducing propagules of the fungus in water (Santos-Rufo & Rodríguez-Jurado, 2016; Gómez-Gálvez et al, 2018).

## Aims

In this present work, the disinfectants were tested under natural environmental conditions and under operational conditions of modern irrigated olive orchards. The disinfectants were evaluated for its capacity to prevent the arrival of viable *V. dahliae* through drip-irrigation system and to alter the pathogenicity of the viable inoculum that could reach the soil.

## Methods

Sterilized potted soil was drip-irrigated with conidia- (experiment 1) or sclerotia-containing water (experiment 2) that was pumped from a storage tank and distributed through an irrigation network consisting of 7 independent pipelines equipped with metering pumps incorporating either chemical treatments (6: 2 products x 3 concentrations) or water (untreated control) for 5 weeks under natural conditions of Córdoba (Spain). Treatments effect was evaluated by measuring the accumulated inoculum density in soil. Further assays were conducted to assess the capacity of the residual inoculum in soil to infect olive plants.

## Results and Discussion

Inoculum levels in soil were significantly decreased by disinfectant treatments in comparison with control, resulting in reductions between 83.7 and 100% or 51.8 and 100% in experiment 1 or 2, respectively, depending on the concentration and cumulative irrigation. At the end of both experiments, viable inoculum was not detected in soils subjected to treatments dispensing the highest concentrations. Expression of symptoms was not observed in olive plants grown in previously treated soils. The infectivity of the residual inoculum present in some treated soils was always lower than that observed in untreated soils. These results provide a novel, interesting and feasible approach in the management of the pathogen in drip-irrigation systems of Andalusian olive orchards.

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**Keywords:** *Verticillium* wilt, infested irrigation water, integrated pest management, chemical control, activated peroxide, quaternary ammonium compounds, metering pump

# TECHNOLOGY MARKET





AQUA4D is an electromagnetic water treatment technology that facilitates a better dissolution and distribution of minerals, promotes water retention in the soil and allows for absorption of minerals by the plants. AQUA4D also increases the natural resistance of plants against diseases, avoids nematode attacks in roots and prevents clogging and biofilm in pipes. What is more: AQUA4D brings all these advantages without changing the chemical composition of the water, it does not use any chemicals, it does not create any by-products, it consumes very little energy (can be powered with a small solar panel) and it does not require any maintenance. The overall result is an increase up to 20% in the production yield, using up to 25% less water, with a fast return on investment (payback between 6 and 24 months).



New technology to transform nutrients from effluents (Municipal wastewater, industrial residues and farming manures) into biofuels, using algae ponds and anaerobic digestion. A first industrial demo site of 2 ha of algae cultures is operational in Chiclana near Cadiz, producing biomethane for 40 vehicles, as well as disinfected wastewater for reuse, and biofertilizer. New technology to transform nutrients from effluents (Municipal wastewater, industrial residues and farming manures) into biofuels, using algae ponds and anaerobic digestion. A first industrial demo site of 2 ha of algae cultures is operational in Chiclana near Cadiz, producing biomethane for 40 vehicles, as well as disinfected wastewater for reuse, and biofertilizer.



Colegio Oficial de  
Ingenieros Técnicos  
Agrícolas de Almería

El Colegio Oficial de Ingenieros Técnicos Agrícolas de Almería (COITAAL) es una Corporación de derecho publico que agrupa a todos los Ingenieros Técnicos Agrícolas que ejerzan la profesión en la provincia de Almería. En el stand de Fertinnowa se pretende dar a conocer los servicios que prestan los Ingenieros Técnicos Agrícolas al sector almeriense y sobre todo en el ámbito de la fertirrigación.



CoRHIZE is an independent French company that has been providing since 2007 innovative and proven solutions to see fast and right, decide and act with relevance to secure yields and draw the best value added from crops.

In the characterization of the infield heterogeneity of soils, irrigation management, active supervision of crops and facilities, CoRHIZE values the fruit of a combination of know-how putting the most advanced technologies at the service of a concrete and realistic agronomy. We promote accessible Precision Framing with the sole aim of providing cost-effective solutions to real needs and bring value-added to actors of quality channels.

You are in search of economic performance, and you think that this one passes first by the technical performance. We have reliable answers and experience to help you.





DICSA, is a company dedicated to the distribution of laboratory equipment and scientific equipment, as well as equipment to help control fertigation.



The agricultural CHEAPER is a device designed for the injection of nutrients into an irrigation system. Its main characteristics make it a simple system, free of maintenance, with low energy consumption, adaptable practically to any irrigation system. Its operation is based on the theory of “Orifice Meter”, according to which, the amount of fluid passing through a hole is directly proportional to the square root of the differential pressure upstream and downstream of the orifice.

In irrigation systems, a suction line depression (NPSH) is usually generated. This depression is used by the agricultural cheaper to introduce nutrients in the form of a concentrated solution in the irrigation line. As you want the depression generated in the suction line depends, among other variables, on the flow delivered by the pump, equally the flow sucked by the cheaper, depends on the depression generated in the suction line, so the relationship between these two variables can be kept relatively constant within a wide range of flows.

This system has been successfully tested in some strawberry farms in Colombia including one of 10 hectares (Santa Maria strawberries) in hydroponic cultivation in rice husk substrate and coal slag in mixture 70/30 for more than 10 years.



The efficient and sustainable management of water in agriculture has become simpler. Since its market introduction in 2009, Irristrat™ has stood out as the most advanced intelligent irrigation management software, integrating monitoring equipment from leading manufacturers, processing field information in real time and providing accurate information to farmers, for more efficient irrigation with better results. The Irristrat™ platform is a complete system that integrates Irristrat™15 for operational management, Irristrat™ Mobile for greater access mobility and Irristrat™ BI for data exploration and cross-checking.

Projects are customised for each client, with remote support from agronomy and irrigation experts. Each project is broken down into Irrigation units with the following characteristics:

- Soil Parameters (type, layers, slopes);
- Crop Data (growth stages, root depth, water utilisation and stress rates);
- Irrigation Systems (characteristics and performance);
- Tools to collect information (weather stations, probes, flowmeters, dendrometers) and the weather forecast.

Irristrat™ works with all equipment from the leading brands.

After the initial characterisation, customers helped to define the irrigation strategy that best serves their overall objectives.





At INTA, we have over 25 years experience developing and installing advanced systems for fertigation control for all types of crops as well as climate control for greenhouses. This means that we can always offer the most reasonable and suitable solution for your crops.

We have implemented design and construction projects for irrigation head centres and climate control for greenhouses in over 30 countries, adapting to the crop requirements and the needs of those responsible for their management. This ability to change and respond is one of the basic principles in the operation of our company.

We aim to provide a direct and efficient service. We will always provide the necessary support at any time and at any location. Our basic objective is the success of our clients and that is what we are proud of.



ISPEMAR Natural Growing Solutions is a company born in Almería, established as a cooperative in October, 2001 and specialized in producing natural solutions for its appliance in Agriculture. ISPEMAR's philosophy is looking forward to the future to create the most advanced solutions environment-friendly. This target is the basis of our day by day work, we want to give you the most advanced products assuring quality in the food you produce and the generations to come.

Trutina system: PLant monitoring system focus into determinate the water needs of the plant on real time by weight.

With Trutina we can get information about irrigations, drenage, transpiration, plant weight and biomass.



ITC was set up in 1988 and is dedicated to manufacturing dosing pumps and dosing control equipment. The wide range of products developed by ITC, including dosing pumps from 1 to 3200 l/h, Mixers, controllers and sensors for water quality, allows meeting the needs for water treatment applications in wastewater treatment plants, drinking water treatment plants, industrial processes, food industry, landscaping and agriculture.



**METER**

METER GROUP PROFESSIONAL AGRICULTURE provides turn-key field monitoring stations to help consultants and technical staff adjusting Irrigation and crop management practices as well benchmarking their performance. METER GROUP also trains and provides support to consultants in order to ensure a meaningful use of the information to make decisions.

Naadnadjain will present a unique system based on a set of ground-breaking algorithms to analyze data collected from sensors: soil, climate and most importantly plant-based. The data collected is translated to a series of agriculture services:

- Growth-Based Irrigation<sup>TM</sup>, a unique closed-loop irrigation system, fully autonomous and reactive to plants needs in real time: already commercial in 14 of the worlds largest markets, showing constant results of 30% water savings and above 5% increase in yields on average, in a wide range of crops.
- Decision support tools; alerts and notifications generated from the field; accurate protocols for implementation of agro-chemicals based on real-time crop data; agronomic guidance.
- Data-driven services, among them dynamic irrigation regimes and instructions, based on real-time calculations of data.
- Turn-Key agriculture projects, built from the ground up to be fully integrated with SupPlant's data based autonomous technology.



We are a Spanish company that is a market leader in climate control and irrigation automation for greenhouses and outdoor facilities. Our primary goal is to enable producers to maximise the yield of their crops with the minimum personal effort. To achieve this we focus our efforts on the research and development of software and hardware specifically designed to control irrigation, fertigation and climate conditions.

Nutricontrol climate control systems are specifically designed to generate the optimum climatic conditions inside your greenhouse. The equipment reads the information it receives from the sensors and responds by entirely automatically operating the actuators inside the greenhouse, such as the windows. EWater is a key element in every agricultural facility. A lack of or excess water and its condition are factors that may adversely affect your yield and compromise the quality of your crop. Nutricontrol offers you a full range of products allowing you to take complete control over your landscape and to manage your irrigation effectively.

We define objectives and offer integral solutions, with special dedication to irrigation programming, salinity control and fertilization with management and data access on the internet. We collaborate in national and international projects with companies and institutions.



Van der Ende groep will showcase the Poseidon Sodium Extractor, which won the FERTINNOWA innovation award in 2017. The Poseidon is developed specially for growers who sluice off water to discharge sodium: a system that extracts sodium from drainage water with a maximum retention of nutrients. The Poseidon complies combines membrane filter technology and activated carbon. The water treatment system can optionally be expanded with a reverse osmosis system to concentrate the water to be discharged and, in doing so, reducing it by 80%. The greatest benefits of the Poseidon are: decreases the sodium content in the drain silo, unique retention of nutrients, 50% nutrient savings, 80% water savings, no pollution of the environment, easy to install, low operational costs due to low energy consumption, low maintenance and more than 95% rejection of crop protection products.

The paper belt filters can be used for various liquid flows in your greenhouse. Moor Filtertechniek supplies a specially selected line of products for greenhouse and other horticultural uses, divided into belt filters for low-flow (3 to 15 m<sup>3</sup>/h) and high-flow (15 to 100 m<sup>3</sup>/h) use. Moor Filtertechniek's paper belt filters are compact stainless-steel (304) models, complete with stainless-steel reservoir, pumps and switch box. A belt filter is suitable for various purposes, such as: discharge water from a sand filter, filtration of drain water, filtration of basin water, filtration of water from flood and drain (hydroponic) systems, pre-filtration for UV filters.



VISUAL 4.0 is an agricultural information management system with geolocation of the farms of the producers and agronomic management, it is based on an interactive map system and a continuous intelligent analysis of geo-referenced data. Among the most innovative aspects of VISUAL are:

- Automatic geolocation of fields.
- Calculation of occupied surface and SIGPAC references.
- Agronomic management: Records and creates automatically a log of the activities and treatments that have been carried in each field.
- Phytosanitary information: shows the phytosanitary products that can be used in crops for the pest or disease detected, containing the updated list of phytosanitary products authorized by the Ministry.
- Satellite images and drones: With VISUAL you can monitor the vigour of the crop every 15 days, follow the evolution of the plots by consulting the most current satellite images and the maps of NDVI or water stress.
- Sensors: Performing the monitoring of soil moisture content allows better irrigation management. VISUAL SENSORS: VISUAL sensors are CAPACITIVE SENSORS. Sensors that measure the dielectric constant of the soil. They are based on the fact that the dielectric constant of the soil undergoes important changes with the introduction of water in the ground.
- Advanced agroclimatics.

Wise solutions include a survey of the soil and the environment of the crop, the installation of a variety of sensors to control the irrigation, nutrition and climatic variables and a training process for the farmer.

We analyze the soil characteristics for determining it's "working range" and provide a reference frame to obtain the meaning of the sensors values

We measure by sensors a variety of variables

We train the farmer for the correct interpretation and implementation during the first few months

