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Optimisation of irrigation of substrate grown strawberry crops

Key external stakeholders:
Strawberry producers, other soft fruit producers, commercial horticultural researchers, commercial horticulture students.

Practical implications for stakeholders:
- Irrigation can be controlled effectively using an automated system
- Makes for more optimal irrigation control
- Good yields achieved using less water applied
- Cost savings by using less water and fertiliser
- Software needs to be more user friendly for grower operation.

Main results:
- FDR (SM150 Delta-T Devices) sensors can be used successfully to automate the irrigation of substrate grown strawberry crops.
- total yield of 10.15 kg/m^2 was obtained over the two growing seasons. This is a good yield for a two season strawberry crop in Irish growing conditions.
- There were no significant differences between any of the treatments over the two seasons.
- The difference in water used between the driest (T1) and wettest (T3) treatment was 16%.

Opportunity / Benefit:
Strawberry growers now have a technology available to successfully control the irrigation of substrate grown strawberry crops. This work can be used as a foundation for future sensor work in horticulture. The work can be accessed by all growers through the Teagasc Horticultural Development Unit (HDU). There is a economic benefit also in more uniform fruit yields and quality combined with savings in water use and fertiliser.

Collaborating Institutions:
U.C.D.

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1. Project background:

The strawberry business in Ireland continues to thrive. Over ninety percent of crops are now grown under protection. The season now runs from March to November. As the industry has expanded so has the demand for resources like water and nutrients etc. In the Netherlands for example, all water and nutrients from glasshouse grown horticultural crops must be recycled and re-used. This type of legislation may be introduced in Ireland in the not too distant future.

The main aim of this project is to automate the irrigation of substrate grown strawberry crops. At present in Ireland all of the substrate grown strawberry crops are irrigated manually or by timer. This takes very little account of changes in environmental conditions which drive plant demand for water and/ or nutrients. It is wasteful of water and fertilizer. Any method which may substantially reduce water and fertiliser use, would be greatly appreciated by the industry. Labour costs may also be reduced as growers will have to spend less time checking substrate water levels. Fruit quality may also be detrimentally affected by manual irrigation. This is more so when we experience prolonged wet weather conditions.

A number of studies have been undertaken using climate based models and tensiometers to control strawberry irrigation but these methods can be impractical for growers. In recent years the use of Frequency Domain Reflectometry (FDR) sensors to measure the volumetric content in situ have been used in a number of high value horticultural crops. The technology allows for the full control of irrigation with minimal grower intervention.

2. Questions addressed by the project:

- Would it be possible to control strawberry irrigation (cv.'Elsanta') using FDR sensors?
- Would it be possible to set an optimal irrigation level for the strawberry crop?
- Would the soil moisture level effect yield and or quality of the fruit crop?
- Will there be water savings?

3. The experimental studies:

Crops of strawberry (cv.'Elsanta') were grown in an unheated glasshouse. Bare root strawberry plants (26-28 mm in crown size) were used.

The plants were subsequently planted into black strawberry troughs containing a standard strawberry peat mix (11 litre Bato) at 6 plants per trough, giving a final density of 10 plants per m^2. These plants were fed using a standard liquid feed increased to an EC of 180 mSm^{-1} post flowering. There were three irrigation treatments with the volumetric water content being maintained between 40-45% (T1), 45-50% (T2) and 50-55% (T3) in the peat substrate. Two SM150 (Delta-T Devices Ltd.) soil moisture sensors were placed in two randomly selected sample troughs of each treatment. These were connected to GP1 data loggers (Delta-T Devices Ltd.). The GP1 data loggers were powered with nine volt (9V) dry cell batteries and were connected to a 24 volt solenoid valves powered with electric power.

The irrigation schedule for each treatment was fully controlled by the GP1 data loggers and irrigation was completely automated. Theoretically, when the moisture levels in the compost set by the GP1 data loggers were below and above the level set for each treatment the GP1 data loggers triggered the solenoid valves to open and close appropriately. Irrigation was supplied by two pressure compensated drippers for each growing trough. Irrigation continued throughout both growing seasons. Crops were harvested in the summers of both years. Fruit when harvested was measured for total fruit yield, marketable and non-marketable yield and fruit number.

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4. Main results:

- Strawberry crops performed well over the two seasons.
- The SM150 moisture sensors performed well. It was critical that the sensors were placed in uniformly in the growing troughs. Each sensor was also placed an equal distance from the irrigation source.
- A total yield of 10.15 kg/m^2 was obtained over the two growing seasons. This is a good yield for a spring and summer strawberry crop in Irish growing conditions.
- There were no significant differences between any of the treatments over the two seasons.
- The difference in water used between the driest (T1) and wettest (T3) treatment was 16%.
- Some slight symptoms of salinity did appear on the plants in the driest treatment. Strawberry crops need approximately 20% runoff at each irrigation cycle. This reduces the risk of damage from the build-up of salts in the substrate.
- The control software is designed for applied research. A more user friendly version would be very useful for industry adaptation.

5. Opportunity/Benefit:

The primary stakeholders for this research are the Irish strawberry producers and other soft fruit producers. The technology can be used by producers as part of an automated irrigation system. This system will remove the guess work involved in using a manual timer. Irrigation will therefore be optimised. This will result in excellent yields of Class 1 fruit, whilst also saving water and fertiliser use. Risk of poor fruit yield and quality (e.g. split fruit) will be reduced substantially as irrigation will be more optimal during wet and dry periods of weather.

6. Dissemination:

The results of this research have been presented at a number of National fruit growers meetings and at Teagasc seminars (http://www.teagasc.ie/publications) Growers have also visited the facility at Teagasc Kinsealy and further advice is given through the advisory-research service. Results have also been reported through some National and International media channels.

Main publications:

Popular publications:

Kehoe, E. (2015) Precision irrigation for strawberries. T-Research 10 (3) 26-27.
Kehoe, E. (2016) Ireland's thriving soft fruit sector. Horticulture Connected. Summer 2016. 38-39.
Kehoe, E. (2014). Proceedings of the Teagasc National Berry Seminar and Trade Show. www.teagasc.ie/publications

7. Compiled by:

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