Precision irrigation for strawberries

Dr Eamonn Kehoe, a soft fruit specialist based at Teagasc, Johnstown Castle, Co.Wexford, describes an ongoing project at Kinsealy Research Centre aimed at controlling strawberry irrigation using a sensor-driven control system.

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The Irish soft fruit industry continues to boom

The Irish berry sector continues to be one of the most challenging, rewarding and profitable sectors of Irish horticulture. High-quality berries, very favourable trends in population growth and healthy eating habits should help to drive the sector forward. The shining star continues to be the strawberry, which dominates approximately 92% of the Irish-grown berry market.

As the strawberry industry has expanded, so has the demand for resources like water and nutrients. In the future, it is possible that all water and nutrients used in glasshouse and tunnel-grown crops may have to be recycled and reused. This type of legislation already exists in the Netherlands for example. Most strawberry crops are now grown under protection, in peat substrates in modules (bags) or containers. In this system there is a small reservoir of water available to the plant, thus making irrigation necessary. On most farms this is provided by way of a drip-line irrigation system. Most of these systems are automated with a timer being used. Growers still have to monitor a number of crop-growing factors and anticipate weather conditions and set the controls accordingly. Results, therefore, depend on the grower's experience, attention to detail and intuition, which can often be misleading.

Precision irrigation systems

The current method of irrigation in strawberry crops (and many other horticultural crops) does not give optimal control. There are two approaches that can be used to improve the situation. One is that of direct measurement, where some type of sensor is used to measure the moisture status of the growing substrate. This then sends a signal, which controls the irrigation system. The other method of control is indirect, where the water used by the crop is calculated using a mathematical model of evaporation with the input of climate data, such as solar radiation, temperature, wind speed and humidity.

Currently, we are investigating the direct measurement approach in research trials at Kinsealy. Soil-moisture sensors (SM 150's- Delta-T Devices) were selected as the moisture-status sensor. The sensor measures the percentage volumetric water content *in situ* using Frequency Domain Reflectometry (FDR) and it consists of two short probes, which can be easily placed into the growing substrate (peat or coir etc.). Each sensor is wired back to a data logging unit (GP1 Data Logger-Delta-T Devices) and a portable PC, running a data interface, is used to connect to the data logger(s). This allows the user to set up the sensor control parameters and the overall irrigation control parameters.

Strawberry trial in Kinsealy research centre.

SM 150 moisture sensor *in situ* in growing trough.

There are three irrigation threshold treatments in the current experiment. Each threshold is based on the percentage volumetric water contents as read by the sensors. Irrigation is kept between a lower and a higher setpoint. The three thresholds used were as follows: 40-45%, 45-50% and 50-55%. These levels correspond to a below-average, average and above-average irrigation treatment (control).

How do the moisture sensors work?

When the plant takes up water or water is lost by evapotranspiration, the substrate dries out. Moisture levels are continuously recorded by the sensors. The software control programme (Delta-T), tests the moisture status of the sensors every 15 minutes. Taking the 40-45% irrigation treatment as an example, the sensor calls for irrigation once the moisture level in the substrate drops to the 40% setpoint. It does this by triggering an electrical relay (switch) through the GP1 data logger. This, in turn, controls the irrigation pump and solenoid valves, thus starting the irrigation cycle When the water level reaches the 45% setpoint the sensor detects this, the irrigation is stopped and the cycle begins again. The 45-50% and 50-55% treatments operate in a similar fashion, giving a more precise control of the irrigation of the crop.

Expected benefits

The main aim of the project is to develop an automated irrigation control system for substrate-grown strawberry crops. So far in the experiment the control system has worked very well. The sensors cover a wide measurement range and they are fast, reliable and user friendly. They are also very affordable. It is envisaged that this irrigation control system will be used on commercial farms in Ireland and growers are encouraged to adopt the system on a small scale to begin with.

The use of a precise irrigation control system also has many other benefits. These include a saving in water use and consequently fertilizer use, which will reduce costs. The percentage of Class 1 fruit quality should improve as growers are not trying to determine irrigation levels themselves, especially in rapidly changing weather conditions. There should also be fewer incidences of plant diseases due to a more optimal growing environment. Ultimately, the system should lead to improvements in efficiency and productivity on the farm (e.g. input costs and labour costs reduced).

This is one of a number of control systems that could be used in protected strawberry production and could also potentially be used in many other areas of horticultural production. The industry is continually searching for innovative ways to improve efficiency and productivity on the farm and more precise control systems are being developed with this in mind. The use of more powerful algorithms in control systems and the use of artificial intelligence (AI) in such systems could become more commonplace in the future.

The aim is to have increased productivity and efficiency on the farm by the scientific control of difficult daily operations, at the same time using less human input.

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Strawberry picking in progress. Black drip line irrigation tubing is also visible.