# Grower Summary

## SF 083 (HL 0187)

Improving water use efficiency and fruit quality in field-grown strawberry

Final year

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## Further information

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| **Project Number:** | SF 083 |
| **Project Title:** | Improving water use efficiency and fruit quality in field-grown strawberry |
| **Project Leader:** | Mark Else |
| **Report:** | Final Report 2012 |
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## Headline

This project developed new irrigation strategies for field-grown Elsanta and when applied on commercial sites, achieved both water and fertiliser savings.

### Background and expected deliverables

The project aimed to provide the potential to increase water use efficiency (WUE) in UK field-grown strawberry production by 40% thereby saving water and improving fruit quality.

Most soft fruit produced commercially in the UK is now grown under cover and so irrigation is essential to ensure that quality at market date matches the specifications demanded by retailers and consumers. Soft fruit cropped areas have increased by 22% in the last 10 years with UK production now worth an estimated £441 million. This rapid expansion has led to a sustained increase in the demand for irrigation. However, the major soft fruit growing areas in England are in the south east, east and west midlands where public, industrial and agricultural demands on water supplies are already high (Figure 1). Less water is available per capita in the south east of England than in parts of the Mediterranean and the predicted rise in summer temperatures and extended growing seasons will exacerbate the situation. Similar issues face many growers overseas and improving the consistency of supply and product quality whilst optimising the use of natural resources is a global challenge.

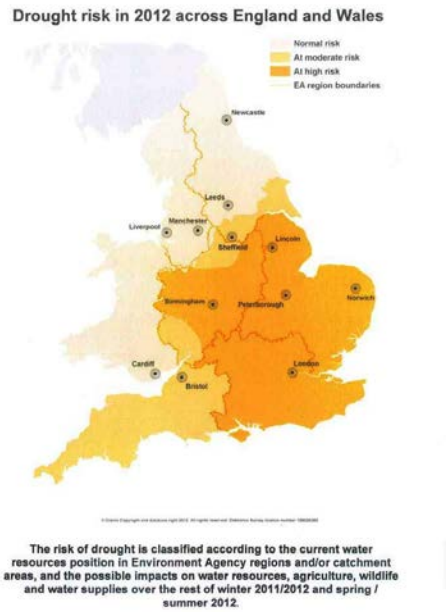


**Figure 1.** Assessment of drought risk across England and Wales for 2012. Source: the Environment Agency.

At the outset, it was recognised that there were no scientifically-derived guidelines for strawberry growers on how best to schedule irrigation. Matching demand with supply can be difficult in the changeable UK climate and due to the high economic value of soft fruit, some growers have tended to over-irrigate as an insurance policy. However, this can lead to excessive vegetative growth, increased disease pressure, and fruit with reduced consumer health benefits and shelf-life along with associated increases in waste fruit. Berry flavour profiles (eating quality) can also be reduced because these key compounds are diluted by the high water content. The leaching of nitrates and other nutrients can also increase diffuse pollution, which is particularly important in environmentally sensitive areas (e.g. Nitrate Vulnerable Zones). If growers are to maintain or increase yields against a backdrop of increasing summer temperatures, dwindling water supplies, and government demands for greater environmental protection, new production methods that improve water use efficiency (WUE) and utilise 'best practice' are needed.

Strategic research at EMR with substrate-grown strawberry has shown that if an irrigation scheduling regime is used so that plant demand is matched with supply, water savings of up to 30% can be achieved compared to current commercial recommendations, without affecting yield or quality of class 1 fruit. We have shown that further water savings can be achieved by applying deficit irrigation which involves applying less water than the plant needs at each irrigation event so that some roots are gradually exposed to drying soil and lower soil water (matric) potentials. These roots produce chemical signals, such as abscisic acid (ABA) that are transported to the shoots where they invoke several physiological responses, such as reducing leaf canopy area and closing stomatal pores to limit plant water loss. Manipulating *in planta* signalling in this way can deliver significant water savings and the concomitant reductions in vegetative growth can lead to improvements in fruit quality. However, it is vital, economically, that yields of marketable fruit are maintained under deficit regimes and, in the past, others have not achieved this when attempting to develop novel irrigation approaches.

There were two aims to this project:

1) To devise irrigation scheduling tools to deliver irrigation water when and where it is needed.
2) To use the improved irrigation scheduling tool to implement deficit irrigation techniques that deliver further water savings whilst maintaining yields, improving fruit quality and reducing waste.

## Summary of the project and main conclusions

A scientifically-based irrigation scheduling regime was developed for field-grown strawberries. The approach was to use the plant to detect when soil water availability had become limiting for various important physiological processes that have an impact on fruit yield and quality. Setting the lower irrigation set point at a soil matric potential above the value at which stress responses were first triggered ensured that significant water savings were achieved without reducing marketable yields or fruit quality. The frequency and duration of irrigation events were then adjusted to maintain soil matric potential within the rooting zone between upper and lower set points. In field experiments at EMR, water inputs were reduced by 80% (Figure 2) without reducing class 1 yields or quality.

**Figure 2.** The volume of water used to produce one class 1 fruit with a WP value of 78 $m^3$/t (large cylinder) and 10 $m^3$/t (small cylinder).

To test whether these improvements could be achieved in commercial production systems, trials on grower's farms were carried out in 2010 and 2011. The technology package needed to deliver this approach into commercial production systems was developed during the course of the project and utilised newly available soil matric potential probes and data loggers with telemetry to enable remote access to 'real-time' data from each of the grower trial sites.

In 2010, Class 1 yield increases of 18% and water savings of 36% were achieved under the new Grower Test Regime (GTR). Improvements in berry eating quality (firmness and flavour) were also apparent, compared to the Commercial Control (CC). The GTR was tested in 2011 on four grower sites to determine how the approach coped with differences in soil type. Water savings of between 3 and 36% were achieved and fertiliser savings of between 3 and 19% were also delivered. Yields of Class 1 fruit were increased under the GTR by 5-

15% and berry flavour, assessed by professional taste panels, was also improved under the GTR. Aspects of fruit quality including berry firmness and shelf-life potential were also improved.

The results from these grower trials are particularly encouraging since the grower partners in the HortLINK consortium are already 'water conscious' and use considerably less water than the industry average. Values of Water Productivity (cubic metres of water used to produce 1 tonne class 1 fruit) in the grower trials ranged from 30-37 under the commercial irrigation regimes and from 25-28 under the GTR. In 2008, the average industry WP value was 78; the WP industry average value for 2011 is being calculated at the time of writing. This new irrigation scheduling regime will be integrated into commercial production in 2012.

The approaches described above are readily transferable to other crops and the potential to use these techniques to reduce water inputs and improve product quality has been demonstrated in substrate-grown strawberry and raspberry, orchard-grown pears, field-grown potatoes, potted living herbs and containerised ornamental crops such as roses and poinsettia. Advances in scientific understanding of how crops respond to environmental stresses have also enabled EMR scientists to develop novel irrigation regimes to impose 'beneficial stresses' that deliver more robust crops and promote quality traits which have an impact on consumer health and product shelf-life.

## Conclusions

- In scientific field experiments, irrigation scheduling strategies for field-grown 'Elsanta' were developed that delivered water savings of 80% without reducing Class 1 yields and aspects of fruit quality were improved.
- In grower trials in 2010 and 2011, water savings of between 3 and 36% were achieved and fertiliser savings of between 3 and 19% were delivered by the GTR.
- Yields of class 1 fruit were increased under the GTR by 5-18% and berry flavour, assessed by professional taste panels, was also improved under the GTR.
- Values of Water Productivity (litres of water used to produce 1 Kg Class 1 fruit) in grower trials ranged from 30-37 under the commercial irrigation regimes and from 25-28 under the GTR. In 2008, the average industry WP value was 78.
- Over the two years of grower trials, on-farm water savings of up to 36% are particularly encouraging since the grower partners in the HortLINK consortium are already 'water conscious' and use considerably less water than the industry average.
- The project outcomes are challenging the soft fruit industry's preconceptions about how wet the soil needs to be to sustain high yields of good quality Class 1 fruit.

- The innovative approach to irrigation scheduling is being rolled out commercially in 2012 to help improve the environmental sustainability of soft fruit production. On-farm water savings of between 40 and 50% are anticipated.

**Financial benefits**

The increases in Class 1 yield achieved under the GTR were between 5 and 18%. Assuming increases in Class 1 yield of 5%, 10% or 15%, the net gain in gross income profit would be £1,750, £3,500 or £5,250/ha/annum.

The reduction in fertiliser use of 20% achieved by one of the participating growers under the GTR could be expected to save around £300/ha/annum. The Rural Business Research (RBR) 2008/2009 Farm Business Survey for Horticulture Production in England reported average annual fertiliser costs (across all specialist glass businesses including soft fruit) of £3,250-£4,500/ha. On this basis, a 20% reduction in fertiliser used, could on average save £650-£900/ha.

The RBR 2008/2009 survey reported average annual water costs (across all specialist glass businesses including soft fruit) of £530-£630. This confirms that on average the savings in expenditure on water do not justify expenditure on irrigation scheduling tools. Growers using mains water would be expected to pay significantly more for water and there may then be a significant financial benefit to using less water. The growers involved in this project do not use mains water.

**Action points for growers**

- Setting up systems to record the volumes of water applied to 60-day, main season and everbearer crops will help growers to establish their irrigation water requirements throughout the year.
- The water use data would also help to determine baseline water use efficiencies for each grower; this information will be required by the EA to support future abstraction license applications for drip / trickle irrigation.
- Ensure that the irrigation system is efficient and appropriate for the size of blocks being irrigated.
- Ensure that the correct operating pressures are being achieved so that dripper output is consistent along the bed.
- Monitor changes in soil water content or availability within the rooting zone to inform irrigation decisions.
- Avoid over-wet soils by scheduling irrigation effectively; fruit quality in the cvs

‘Elsanta’ and ‘Cordelia’ can be improved with subsequent increase in Class 1 grade out.

- Scheduling irrigation effectively will also help to reduce fertiliser inputs; savings up to 40% of current fertiliser costs are also possible without reducing yields or quality.
- Fertigation regimes may need to be adjusted under water-saving irrigation regimes to ensure that soil nutrient availabilities do not become limiting during fruit development and cropping.