Horticultural
Development
Company

Grower summary

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

Annual Report 2008

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Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

- Irrigation scheduling will save water, improve fruit quality and increase berry shelf-life.

Background and expected deliverables

This Horticulture LINK project is exploring the potential to increase water use efficiency (WUE) in UK field-grown strawberry production by 40% thereby saving water and improving fruit quality.

Irrigation of the UK crop is now essential to ensure the yields and quality demanded by retailers and consumers. However, strawberry growers, Defra and the Environment Agency are all becoming increasingly concerned about the future availability of abstracted water for trickle irrigation. Current abstraction rates in the major strawberry-growing regions are unsustainable and growers must now comply with legislation designed to safeguard these resources (The Water Act 2003). Recent research at EMR and elsewhere has provided major opportunities to use water more efficiently while continuing to meet consumer demand for sweet fruit with good flavour and shelf-life.

There are 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.

Expected deliverables from this work include:

- Increased WUE and improved fruit quality that will, in turn, increase sustainability and profitability of this sector.

- Practical ways to use water more efficiently that will enable growers to comply with new legislation while continuing to meet consumer demand for high quality, healthy fruit with good shelf-life potential.

- Reduced water usage (by 30-40%), waste and diffuse pollution.

Summary of the project and main conclusions

The progress made to date in relation to individual milestones of this LINK project is summarised below.

Set up field trials at EMR to test effectiveness of different irrigation scheduling strategies (month 1).

- Beds were prepared and fumigated in autumn 2006 so that field trials could begin promptly at the beginning of the project.

- Cold-stored, bare-root strawberry plants (cv. 'Elsanta' – supplied by RW Walpole Strawberry Plants Ltd) were planted on 27 April 2007.

- Three different approaches to irrigation scheduling were compared (depicted in Figure GS1): scheduling using an Evaposensor to estimate crop evaporative demands; scheduling in response to

Figure GS 1. The middle polytunnel of the experimental field plot at EMR with the irrigation control centre in the background.

changes in the vertical profile of soil moisture content measured by EnviroSCAN probes; scheduling in response to changes in soil moisture integrated horizontally across the rooting zone using ECH2O probes (the closed loop system).

- Two treatments where irrigation was set for fixed times each day (30 and 60 min) were chosen to represent the arbitrary approach to irrigation used by some growers.

Complete physiological measurements and determine marketable yields and WUE associated with each irrigation scheduling strategy on 60-day plants (month 6).

- Measurements of pre-dawn and midday leaf water potential, stomatal conductance and leaf area development suggested that plants in the EnviroSCAN regime were under mild stress during the first two weeks of cropping.

- Yields of Class 1 fruit averaged between 80-90g fresh weight and were less than 50% of those expected from 60-day 'Elsanta' plants.

- Yields of marketable fruit were not significantly affected by the irrigation regimes.

- Scheduling irrigation by any means resulted in substantial improvements in WUE compared to the arbitrary irrigation regimes (Table GS 1).

- The highest WUE was achieved by scheduling using estimates of crop evaporative demand.

Table GS 1. Water use efficiencies, expressed as the percentage of the volume of water used in the Arbitrary-30 regime. WUE were calculated from the total irrigation volume applied during each regime between 23 June and 27 July 2007.

Scheduling regime	WUE (% of Arbitrary- 30 regime)
Evaposensor	279
EnviroSCAN	186
Closed loop	193
Arbitrary-30	100
Arbitrary-60	57

Set up experiments in GroDome and refine techniques to quantify root-derived, xylem borne signals in strawberry plants exposed to moderate soil water deficits (month 9).

- Detailed time-courses of the leaf physiological responses to Partial Rootzone Drying (PRD) and Regulated Deficit Irrigation (RDI) have been determined in GroDome experiments.

- Stomata began to close seven days after the beginning of the PRD and RDI treatments.

- Xylem delivery of the hormone Abscisic acid (ABA) from roots to shoots of deficit irrigated plants was increased 3.4-fold and 2.5-fold in PRD- and RDI-treated plants, respectively, within eight days.
- Changes in the output of other putative root-to-shoot signals (*e.g.* cytokinins) that may regulate adaptive responses to the deficit regimes are currently being quantified.

- Young fully expanded leaves have been used to develop detached leaf bioassays to help test the involvement of the xylem-borne chemical signals in the regulation of stomatal apertures in deficit-grown plants.

Complete sensory and analytical tests to determine effects of different irrigation scheduling strategies on fruit quality and shelf-life of 60-day plants (month 11).

- Fruit firmness and skin colour were not affected by the different irrigation scheduling regimes.

- Shelf-life tests indicated that rots developed first in fruit from the Arbitrary-30 and Arbitrary-60 regimes during storage at 20 ^{0}C. No treatment effects on shelf-life potential were detected after berries from each scheduling regime were stored for six days at 5 ^{0}C.

- BRIX values of tertiary fruit were highest in the EnviroSCAN and closed loop regimes and were lowest in the Arbitrary-30 and Arbitrary-60 treatments.

- A tasting panel at EMR found that fruit from the closed loop treatment were the most flavoursome and fruit from the two arbitrary treatments were the least flavoursome.

- The production of several key flavour volatiles was reduced in plants in which irrigation was scheduled using EnviroSCAN probes.

- The fruit organic acid profile was unaffected by scheduling regime and was not altered after 6 days storage at 5 ^{0}C.

- Berry sugar and bioactive content were not altered by the different scheduling regimes.

- Fruit sampled from two grower sites had higher BRIX values, greater concentrations of sugars, lower concentrations of organic acids and a higher sugar:acid ratio than fruit sampled from the trial at EMR.

- The total anti-oxidant capacity of fruit from grower sites was similar to fruit sampled from the different scheduling regimes

Conclusions

- All 60-day plants were slow to establish and subsequent development was poor, irrespective of the irrigation scheduling regimes. Poor initial plant quality, poor planting and the development of a compacted surface layer meant that the limited number of new roots that were produced were restricted to the top 10 cm of soil. Shoot canopy area was correspondingly small. The poor development was not due to water deficits or to nutrient deficiencies.

- Although there was adequate soil water available at depth, the soil moisture content in the rooting zone (top 10 cm of soil) became limiting during the first two weeks of cropping in beds where irrigation was scheduled using EnviroSCAN probes.

- WUE was improved by between two- and five-fold where some form of irrigation scheduling was used.

- Flavour volatile production was improved by some scheduling regimes. However, moderate shoot water deficits that developed under one regime during cropping reduced flavour volatile production.

- In taste tests, fruit flavour was found to be improved by irrigation scheduling.

- Berry sugar and acid contents were not altered by irrigation scheduling.

- Shelf-life was improved by scheduling.

- Berry antioxidant capacity and bioactive content were not altered by irrigation scheduling.

- The Evaposensor, the EnviroSCAN and the closed loop system all performed satisfactorily.

- The 60-day plants were grubbed after cropping and replaced with misted tips to try to ensure commercial yields of Class 1 fruit in 2008.

Financial benefits

A full cost-benefit analysis will, in due course, enable growers to make informed decisions about the financial benefits to be gained from irrigation scheduling and deficit irrigation.

Action points for growers

- Adopting some form of irrigation scheduling strategy will improve WUE, fruit flavour and shelf-life potential.