Grower Summary

HNS 182

Developing optimum irrigation guidelines for reduced peat, peat-free and industry standard substrates

Annual 2012

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

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.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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HDC is a division of the Agriculture and Horticulture Development Board.

Project Number:	HNS 182
Project Title:	Developing optimum irrigation guidelines for reduced peat, peat-free and industry standard substrates
Project Leader:	Mark Else
Contractor:	East Malling Research
Industry Representatives:	John Adlam (Dove Associates) Malcolm Dick, John Woods Nurseries Dr Bill Godfrey (W. Godfrey & Sons) Alastair Hazell (Darby Nursery Stock Ltd) Susie Holmes (Consultant)
Report:	Annual, March 2012
Previous report/(s):	Annual, March 2011
Start Date:	1 April 2010
End Date:	31 March 2013
Project Cost:	£56,897

Headline

- Irrigation was scheduled successfully to three HNS crops using the optimum range of substrate water contents developed for reduced peat, peat-free and industry standard media
- Irrigation frequencies and durations that maintained optimum substrate water contents were identified for each substrate
- An automated irrigation scheduling tool was developed for use on commercial nurseries
- Plant quality in the different substrates was similar

Background and expected deliverables

The HNS sector is the largest user of peat in the UK horticultural industry. Around 450,000 m^3 of growing medium, of which about 80% is peat, is used annually for hardy nursery stock production in the UK. Although some customers request peat-free production (*e.g*. The National Trust), the majority do not, and so at the moment there is little commercial pressure to reduce peat use. Following a consultation period (ending 11th March 2011), Defra has outlined plans to reduce the horticultural use of peat in England in the Natural Environment White Paper published June 2011. This includes a voluntary phase-out target of 2030 for professional growers of fruit, vegetables and plants. The proposed withdrawal of peat from the UK horticulture industry is of great concern to many HNS growers.

Most growers acknowledge that irrigation and nutrient regimes will need to be modified when using reduced peat and peat-free substrates. The relatively poor water-holding capacity of most peat-free alternatives will necessitate more frequent irrigation events but over-watering must be avoided to minimise run-through of water and dissolved fertilisers and limit environmental pollution. To help facilitate the development of 'best' or 'better' grower practice during the transition to peat-free production, new scientifically-derived irrigation set points are needed that maintain an optimum substrate moisture content for reduced peat and peat-free media likely to be used by HNS growers in the future.

In this project, the 'optimum' substrate moisture content is defined as one that supports good, healthy plant growth while avoiding over-wet conditions so that leaching of irrigation water and fertilisers is minimised or eliminated. Irrigation set points have been identified for each substrate, which will be used to develop new guidelines to help growers overcome problems associated with over-watering reduced peat and peat-free alternatives.

The overall aim of the project is to develop and implement improved irrigation scheduling guidelines for reduced peat, peat-free and industry standard media that will help growers to comply with legislation, optimise plant quality, reduce costs and gain confidence in growing HNS in peat alternatives.

Summary of the project and main conclusions

Experimental plant species and commercially available reduced peat, peat-free and industry standard substrates were selected after consultation with members of the Project Steering Group. The following widely-produced crops were chosen for 2011 experiments as they were considered moderately resilient to substrate drying and therefore a good choice of 'indicator' species:

- *Ribes sanguineum* 'Koja'
- *Escallonia rubra* 'Crimson Spire'
- *Sidalcea* 'William Smith'

The following substrates were chosen (for use in years 1 and 2) since they are considered to be good quality brands that are (or are becoming) widely used by UK growers:

- **Industry standard:** substrate based on 25% bark, 75% peat supplied by Sinclair
- **Reduced peat:** substrate based on 25% wood fibre, 25% bark, 50% peat supplied by Bulrush
- **Peat free:** substrate based on peat-free materials (composted green waste and bark) supplied by Vital Earth

Specification details were obtained for each substrate; additionally each was analysed for air-filled porosity, particle size distribution, pH, density, dry matter, dry density, Ca, Cl, Mg, P, K, Na, N, EC and trace elements[8].

Nine centimetre liners were potted in to 3 L pots containing one of the three substrates. The bottom 20 mm of compost was gently removed to leave a root ball of about 60 mm. Controlled release fertiliser (Osmocote Pro 12-14 month, 18+9+10 +2 MgO + trace elements) was incorporated at 3 kg per 1000 L for *Sidalcea* and 5 kg per 1000 L for *Escallonia* and *Ribes*. All plants were established under cover in an unheated mesh-walled polytunnel and were hand-watered during establishment.

Plants were then placed on a mypex bed (mypex over polythene) on the East Malling Water Centre (EMWC) (Figure GS1). *Sidalcea* plants were cut back to approximately 5 cm above soil level; *Ribes* were cut back to just above the height at which the stems had previously been pinched, *i.e.* between 18 cm and 26 cm, and *Escallonia* were trimmed to approximately 22 cm. *Sidalcea* and *Escallonia* plants were cut back once more during the experiment and *Sidalcea* plants were cut back at the end of the growing season.

Figure GS1. Experimental plots of *Sidalcea*, *Ribes* and *Escallonia*, East Malling Water Centre, July 2011.

One aim of this project is to develop a practical irrigation scheduling tool for use on commercial nurseries. Delta-T Devices, (Cambridge, UK) supply a data logger capable of switching solenoid valves on and off when a soil moisture probe detects changes in volumetric soil moisture content (VSMC). In HortLINK project 97b, water savings of 80% were delivered over the season at Hillier Nurseries Ltd when irrigation was scheduled using

Delta-T SM200 soil moisture probes connected to a GP1 data loggers, compared to plants where irrigation frequency and duration were decided by Hillier staff. Savings in staff time were also achieved by reducing the time taken deciding whether or not to irrigate. This system has also been used to schedule irrigation and deficit irrigation regimes to poinsettia crops on a commercial nursery. Since the Delta-T GP1/SM200 system has already been implemented successfully on commercial nurseries, it was chosen to schedule irrigation to each species in each of the substrates in experiments on the EMWC during the 2011 growing season. This system may be particularly suited to reduced-peat and peat-free substrates since positioning the probe below the layer that tends to dry out would ensure that irrigation is triggered in response to changes in the VSMC in the rooting zone, rather than the top layer of the substrate. Due to the different water-holding capacity of reduced peat and peat-free substrates, the VSMCs at which irrigation should be triggered will differ from those already established for 100% peat. Straightforward plant-and-pot weighing could also be used to schedule irrigation effectively on smaller to medium size nurseries. The frequency and duration of irrigation events will also need to be adjusted to limit run-through when using more freely draining peat alternatives.

Water was sourced from the mains and irrigation to each pot was supplied *via* a dripper stake and bootlace connected to a pressure compensated 2 L h^{-1} emitter. For each crop the timing and duration of irrigation events was controlled using three Galcon DC-4S units (supplied by City Irrigation Ltd, Bromley, UK) connected to manifolds housing three DC-4S ¾" valves. To maintain VSMC and plant-and-pot weights within the optimal range identified in year 1 for each crop and substrate, the GP1 irrigation set points were adjusted frequently to ensure that average VSMC and average plant-and-pot weights were maintained in the experimental plants. The duration of each irrigation event was adjusted to ensure that run-through was minimised.

Experiments in year 1 were carried out using 2 L pots but the Project Steering Group recommended that 3 L pots were used in 2011. Therefore, the optimum range of plant-and-pot weights for 3 L pots was determined for each substrate, along with corresponding VSMC values (Table GS1).

Table GS1. The ranges of average values for VSMC and corresponding plant-and-pot weights used for scheduling irrigation of *Sidalcea*, *Ribes* and *Escallonia* plants grown in each of the three substrates in 3 L pots. Data are means of eight replicate plants.

A) *Sidalcea*

Substrate	**Optimum plant-and-pot weights and VSMCs for each substrate**			
	Pot weight (g)		**VSMC (m^3 m^{-3})**	
	Pot capacity	**Irrigation set point**	**Pot capacity**	**Irrigation set point**
Sinclair	2052	1420	0.46	0.23
Bulrush	2096	1540	0.49	0.34
Vital Earth	2106	1680	0.41	0.29

B) *Ribes*

Substrate	**Optimum plant-and-pot weights and VSMCs for each substrate**			
	Pot weight (g)		**VSMC (m^3 m^{-3})**	
	Pot capacity	**Irrigation set point**	**Pot capacity**	**Irrigation set point**
Sinclair	1998	1400	0.48	0.29
Bulrush	2010	1230	0.46	0.22
Vital Earth	2069	1620	0.41	0.3

C) *Escallonia*

Substrate	**Optimum plant-and-pot weights and VSMCs for each substrate**			
	Pot weight (g)		**VSMC (m^3 m^{-3})**	
	Pot capacity	**Irrigation set point**	**Pot capacity**	**Irrigation set point**
Sinclair	1995	1471	0.44	0.25
Bulrush	2041	1450	0.44	0.24
Vital Earth	1955	1545	0.41	0.25

Rates of substrate drying were low in *Ribes*, and so to enable a comparison of irrigation frequency and duration to be made between substrates, the VSMC irrigation set points were raised for Sinclair and Bulrush substrates.

Table GS2. Frequency of irrigation and total irrigation volumes applied between 27 September 2011 and 1 October 2011, over 430 accumulated degree hours (*Sidalcea*), 369 accumulated degree hours (*Ribes*) and 335 accumulated degree hours (*Escallonia*), for plants grown in each of the three substrates. For *Sidalcea, Ribes* and *Escallonia* plants growing in Vital Earth substrate values are means of eight replicate plants; for *Ribes* plants growing Bulrush and Sinclair substrates, values are means of seven and four replicate plants, respectively. Volume of run through has been deducted to derive values for total volume applied.

A) *Sidalcea*

Substrate	Lower pot weight	Irrigation volume giving ≤5% run-through	Number of irrigation events	Mean total volume applied (ml)
Sinclair	1420	207	2	409
Bulrush	1540	205	2	402
Vital Earth	1680	134	4	539

B) *Ribes*

Substrate	Lower pot weight	Irrigation volume giving ≤5% run-through	Number of irrigation events	Total volume applied (ml)
Sinclair	1400	192	2	370
Bulrush	1230	102	2	200
Vital Earth	1620	94	4	367

C) *Escallonia*

Substrate	Lower pot weight	Irrigation volume giving ≤5% run-through	Number of irrigation events	Total volume applied (ml)
Sinclair	1580	202	3	585
Bulrush	1450	189	3	537

Vital Earth	1545	90	6	529

The water holding capacity for each substrate was estimated by measuring the irrigation duration that resulted in less than 5% run-through when the plant-and-pot weight was at the lower irrigation set point. As anticipated, water-holding capacity was 30-50% less in peat-free substrate than industry standard substrate (Table GS2).

Water-holding capacity was consistent between crops for industry standard substrate, but varied with crop for plants growing in reduced peat and peat-free substrates. This may have been due to differences in root development in the different crops resulting in more open, more freely draining substrates. For each crop, plants growing in peat-free substrate required more frequent irrigation then those growing in industry standard and peat-reduced substrates.

To help ensure that the optimum ranges identified for each substrate did not affect plant growth and quality, plant physiological and growth measurements were made during the growing season. Transpirational water loss, stomatal conductance and leaf growth were monitored frequently at regular intervals, as these were shown in year 1 to be sensitive indicators of substrate drying. For each crop, no significant differences were detected between substrates in stomatal conductance and leaf growth, indicating that the plants were transpiring freely and that the upper and lower irrigation set points were optimal. Although significant differences in transpiration and evapo-transpiration between substrates were seen in all crops on some dates (Figure GS2), the absence of significant differences in stomatal conductances imply that differences in plant canopy leaf area were the cause. When significant differences were noted, rates of evapo-transpiration per degree hour of *Sidalcea* plants were often greater in the reduced-peat and peat-free substrates than in the industry standard substrate. In contrast, rates of evapotranspiration per degree hour were reduced for *Escallonia* plants growing in peat-free substrate during September 2012.

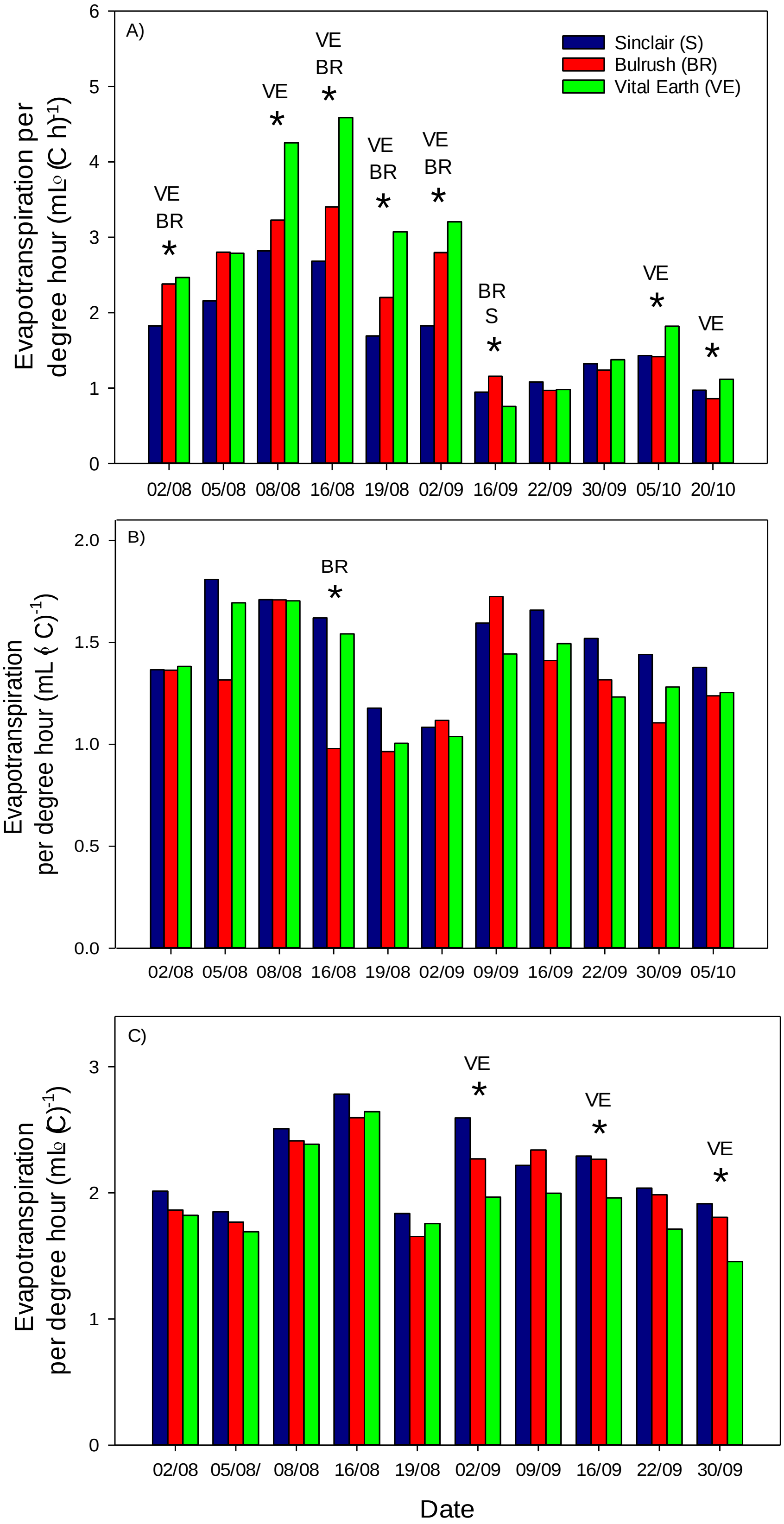

Figure GS2. Statistically significant differences in evapotranspiration rates of A) *Sidalcea* B) *Ribes* and C) *Escallonia* grown in industry standard (Sinclair), reduced peat (Bulrush) and peat-free (Vital Earth) substrates

Average plant grade-out at simulated dates of sale was similar for *Sidalcea* plants growing in peat-free, reduced peat substrates, and industry standard substrates (Figure GS3). This suggests that the upper and lower irrigation set points derived for the three substrates would be suitable for the commercial production of *Sidalcea*. The quality of *Sidalcea, Ribes* and *Escallonia* in each of the three substrates will be determined in Spring 2012 and the results will be presented in the Final Report.

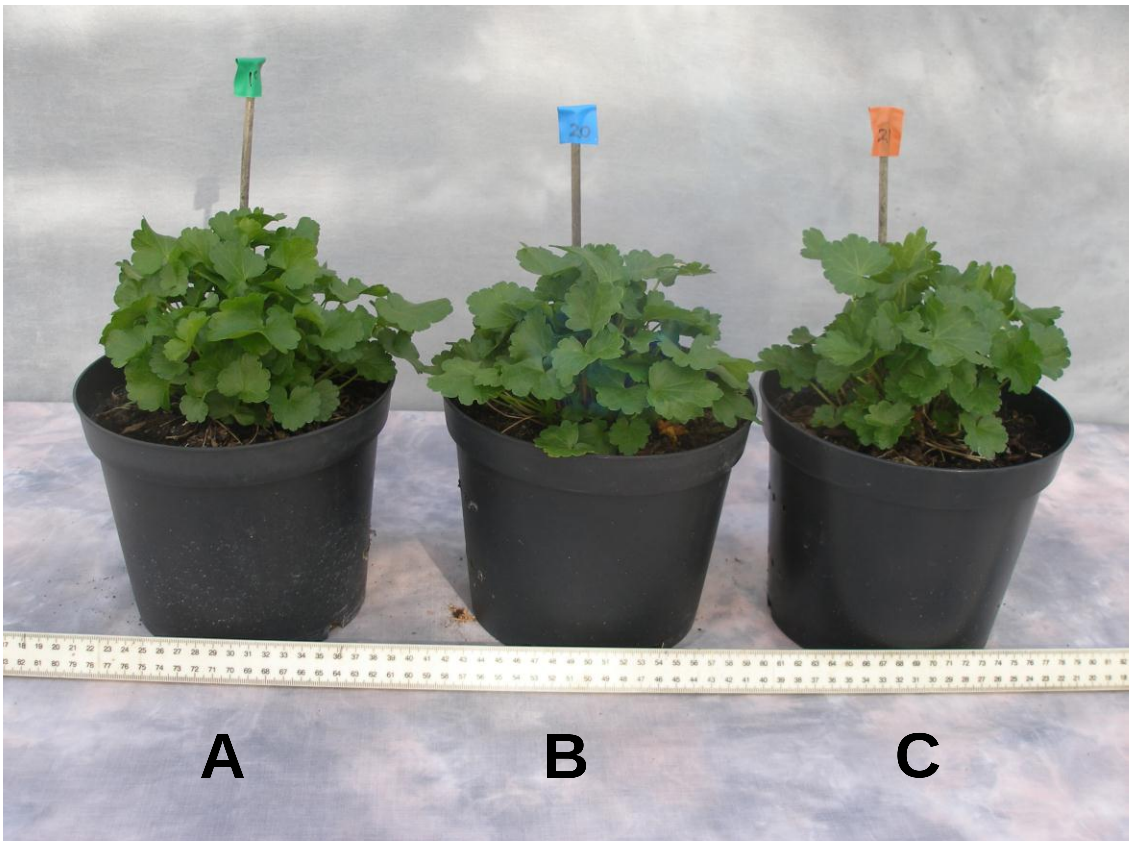

Figure GS3. *Sidalcea* plants graded as saleable at simulated date of sale, growing in A) peat-free (Vital Earth); B) industry standard (Sinclair) and C) peat-reduced (Bulrush) substrates.

Plants on the EMWC were over-wintered and measurements of pot weights and VSMC were made to determine whether the more freely draining reduced peat and peat-free substrates were less prone to waterlogging. In March 2012, samples were taken of each substrate from over-wintered pots of each crop, and values for air filled porosity obtained; these values will be published in the Final Report. Visual inspections of root and canopy health will be carried out in Spring 2012 to determine whether plant vigour is improved in the more freely-draining substrates.

The same range of crops and substrates will be used in experiments on the EMWC during 2012 but instead of drip irrigation, irrigation schedules will be developed that optimise substrate moisture contents under conventional overhead or sub-surface irrigation (capillary matting). The effects of the different irrigation systems on plant growth and quality in the three substrates will be determined. The irrigation schedules developed for industry standard, peat-reduced and peat-free substrates will be demonstrated at an Irrigation Workshop to be held at the EMWC in Summer 2012 and opportunities to implement these schedules in commercial production systems will be discussed. An article summarising project aims, objectives and results to date will be submitted to HDC News at the end of March 2012.

Financial Benefits

Full cost-benefit analyses at commercial nurseries would be required to quantify precisely the potential financial benefits arising from this project. However, significant cost savings are anticipated due to lowered production costs, more efficient use of resources and reduced plant wastage. A preliminary cost benefit analysis was included in the First Annual Report for HNS 182.

Action points for growers

- Consider scheduling irrigation to all substrates using measurements of plant-and-pot weights or VSMC
- Begin to measure volumes of water delivered over a set time by different nozzles used on the nursery (see Factsheet 16/05)
- Install water meters so that the volumes of water applied over the season to different crops can be measured
- Identify the upper and lower target plant-and-pot weights for reduced peat and peat-free substrates
- Measure the duration of irrigation needed to achieve less than 5% run-through at the lower irrigation set point for each substrate
- Irrigation duration for peat-free substrates should be reduced by approximately 30-50% compared to industry-standard substrates to prevent over-watering
- Irrigation duration for substrates with reduced peat can be similar to industry-standard peat-based substrates but with some crops may need to be reduced in order to minimise run-through