Grower Summary

HNS 182

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

Final 2013

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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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Project Number:	HNS 182
Project Title:	Developing optimum irrigation guidelines for reduced peat, peat-free and industry standard substrates
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Headline

- Plant quality in each of the three substrates was similar when substrate moisture contents were optimised
- The automated irrigation scheduling tool prevented over-irrigation following the frequent and heavy rain showers during the summer of 2012
- Irrigation scheduling regimes that reduced or eliminated run-through were developed for drip, overhead and sub-surface irrigation to industry standard, reduced peat and peat-free substrates

Background and expected deliverables

Following a consultation period (ending 11th March 2011), Defra outlined plans to reduce the horticultural use of peat in England in the Natural Environment White Paper published in June 2011. The White Paper included an ambition to reduce horticultural peat use to zero in England by 2030, setting the following milestones: a progressive 2015 target for new contracts in the public sector, a 2020 voluntary target for amateur gardeners and a 2030 voluntary target for commercial growers. The Sustainable Growing Media Task Force was established in June 2011 and has since adjusted its remit to that of putting the horticultural sector on a long-term sustainable footing by ensuring that all choices of growing media (or substrate) used for amateur gardening and horticulture are sustainable. The HNS industry's views on peat replacement and peat alternatives are set out in the HDC News Growing Media Review.

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. Growers will face increasing pressure to use water more efficiently, due to restrictions on future water use and drip/trickle irrigation is to be brought under legislation in April 2014. Improved irrigation scheduling guidelines for HNS media 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

Substrates

The following substrates were selected after consultation with members of the Project Steering Group; the substrates are considered to be good quality brands that are (or are

becoming) widely used by UK growers:

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

Plant species

The following widely-produced crops were chosen for experiments after consultation with members of the Project Steering Group; these species were considered moderately resilient to substrate drying and therefore a good choice of 'indicator' species:

- *Ribes sanguineum* 'Koja'
- *Escallonia rubra* 'Red Dream'
- *Sidalcea* 'Party Girl'

Experimental site

All experiments were conducted on the East Malling Water Centre (EMWC) (Figure GS1). Plants were placed either on 10 m x 5 m gravel beds with overhead irrigation or on 1 m^2 square plots of mypex overlaying outdoor capillary matting and polythene, on a sand bed measuring 10 m x 5 m on the EMWC.

Figure GS1. Experimental plots of *Sidalcea*, *Ribes*, and *Escallonia* plants potted in industry standard, reduced peat or peat-free substrates. Sub-surface irrigation bed, EMWC, July 2012.

Irrigation delivery

Overhead irrigation was applied by six MP rotator 2000 overhead sprinklers spaced 2.5 m apart along the west and east edges of each bed. Sub-surface irrigation was applied using T-tape irrigation tubing supplied via a 3/4" low flow pressure regulator. Each plot was irrigated by two lines of T-tape tubing spaced 60 cm apart, each with six emitters at 15 cm spacing. Water was sourced from the mains and the timing and duration of irrigation events was controlled using Galcon DC-4S controllers.

Irrigation scheduling

Irrigation was scheduled automatically using Delta-T SM200 moisture probes connected to Delta-T GP1 data loggers. The moisture probes were inserted through holes drilled through the side of the plastic pot 6 cm below the substrate surface and were located in a representative experimental pot for each substrate. To maintain volumetric substrate moisture content (VSMC) and plant-and-pot weights within the optimal range identified in Year 1 for each crop and substrate, irrigation set points were adjusted when necessary. Irrigation was scheduled according to the requirements of the crop with the highest transpiration rate; in each substrate this was *Escallonia*. Plant-and-pot weights were measured before and after irrigation during the growing season and the duration of irrigation events were then adjusted to minimise run-through and wastage of water.

Plant growth and physiology

Routine measurements of plant-and-pot weights for plants given overhead irrigation, and plant physiological responses under both irrigation treatments were made weekly during the growing season to determine whether the irrigation regimes imposed to maintain the 'optimal' moisture contents for each substrate promoted strong, healthy plant growth, or resulted in plant stress during periods of high evaporative demand.

Plant quality

Plant quality in each of the three HNS species in each substrate was assessed by members of the Project Steering Group in May 2013. A score of 5 represented excellent quality, 3 was deemed to be marketable and a score of 1 indicated very poor quality.

Results

Substrate volumetric moisture contents

For most substrate / species combinations receiving overhead irrigation or sub-surface irrigation, average plant-and-pot weights or VSMCs were maintained within the optimal ranges identified earlier in the project. The exception was *Escallonia* plants in reduced peat

substrate where the average plant-and-pot weight fell below the lower irrigation set point at the end of August and the beginning of September 2012. Further investigation revealed that the pot in which the SM200 probe was located was no longer representative of the *Escallonia* crop and so the probe was re-located to another experimental pot within the same plot. A similar issue resulted in the VSMC being temporarily below the lower set point for *Escallonia* in peat-free substrate in mid-September.

Irrigation scheduling during periods of heavy rainfall

Scheduling irrigation to uncovered crops following rainfall events can be difficult for HNS growers due to the uncertainty over how much of the rain fell onto the substrate surface, or how much was intercepted by the canopy and channelled into the pot. In the HNS industry, 5 mm of rainfall or more is generally considered to be 'effective rainfall' i.e. sufficient to raise VSMCs. However, it is difficult for growers to decide when to resume irrigation following 'effective rainfall', especially if the weather continues to be changeable. The automated irrigation system used in conjunction with the lower irrigation set points developed in this project effectively removes the uncertainty following rainfall events; this system prevented over-irrigation of the HNS crops during the very wet summer of 2012 (Figure GS 2).

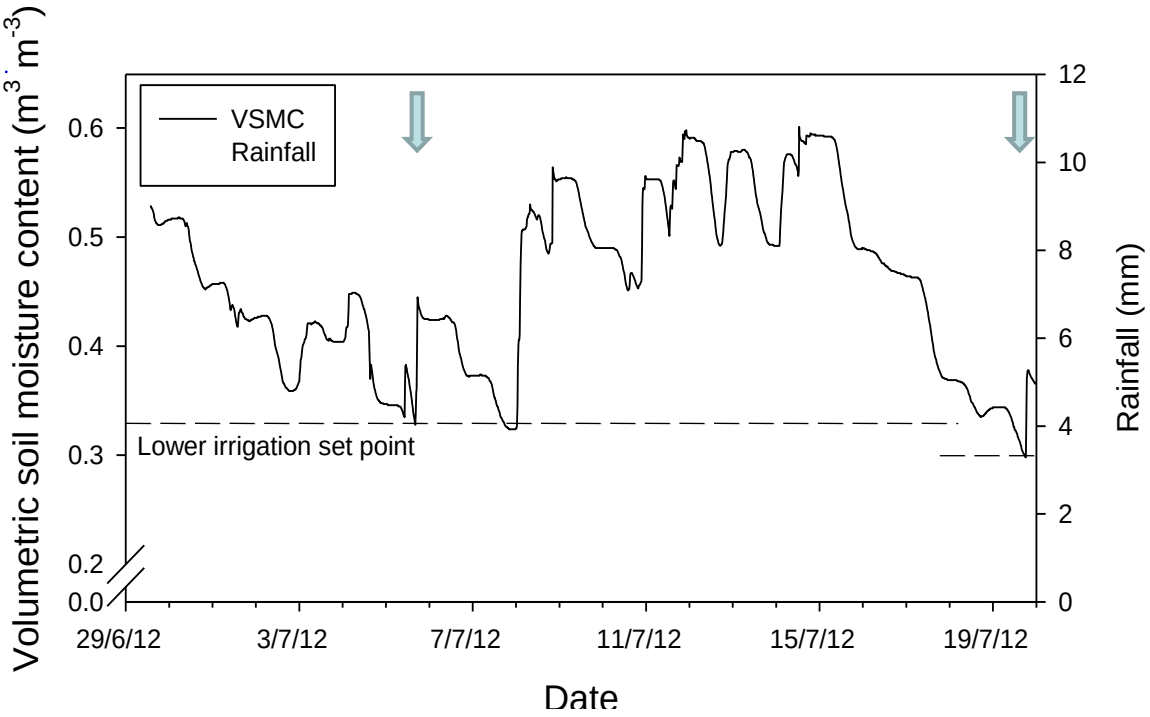

Figure GS2. Automated irrigation scheduling prevented over-irrigation of *Escallonia* plants during the wet summer of 2012. Irrigation was triggered automatically on two occasions between 29 June and 19 July 2013 (indicated by the arrows), otherwise, VSMC was

maintained above the lower irrigation set points (dashed lines) by frequent and heavy rainfall (blue bars).

Plant growth and physiology

Measurements of whole-plant transpiration were made at intervals throughout the season to establish whether the 'optimum' substrate moisture contents allowed plants to transpire freely and avoided stress associated with limited substrate water availability under conditions of high evaporative demand. For plants given overhead irrigation, transpiration was measured throughout the experiment; *Escallonia* and *Ribes* had higher rates of transpiration than *Sidalcea* and these differences were significant on some dates.

For plants receiving sub-surface irrigation, transpiration was measured during July and early August 2012. Significant differences were seen on some dates between substrates when transpiration rates of *Escallonia* and *Ribes* were significantly higher than those of *Sidalcea*. These measurements confirmed that plants were transpiring freely and that substrate water availability was not limiting under the irrigation regimes imposed.

Plant quality

At the end of June 2012, following a cold and wet period, plants in the peat-free substrate were exhibiting signs of chlorosis. Analysis of the substrate indicated that insufficient nitrogen mineralisation had taken place, probably due to the weather conditions. Therefore, plants in peat-free substrate were each given 100 mg nitrogen (applied as 100 mL 6.45 g L^{-1} $CaNO_3$ solution to each pot) on 25 June 2012.

Estimates of overall plant quality made by members of the Project Steering Group in May 2013 indicated that there were no significant effects of the three substrates on plant quality in the overhead irrigation treatment. However, when sub-surface irrigation was applied (*via* capillary matting), plant quality of *Escallonia* grown in the reduced peat substrate was reduced compared to plants in the industry standard and peat-free substrates, although this effect was just outside statistical significance. The quality of *Sidalcea* and *Ribes* was similar in each of the three substrates.

In plants receiving overhead irrigation, moss coverage was significantly higher in pots of *Sidalcea* and on the surface of the peat-free substrate. Moss coverage was, unsurprisingly, lower in pots receiving sub-surface irrigation than those receiving irrigation overhead. Levels of liverwort were significantly higher in pots of *Sidalcea* receiving overhead irrigation but there were no significant differences in the levels of liverworts on each of the three

substrates. Under the sub-surface irrigation regime, the incidence of liverworts was very low and there were no significant differences between species or substrates.

Main Conclusions

- VSMC values at which plant physiological responses are triggered were identified for *Sidalcea*, *Ribes* and *Escallonia* grown in industry standard, reduced peat and peat-free substrates.
- The 'optimum' range of VSMC and plant-and-pot weights in each substrate were determined for *Sidalcea, Ribes and Escallonia* and maintained throughout two growing seasons using drip irrigation, overhead irrigation and sub-surface irrigation.
- Water holding capacity of substrates was 30-50% less in peat-free substrate than industry standard substrate and the water holding capacity in peat-reduced and peat-free substrates varied with crop.
- Irrigation frequency was higher for crops growing in peat-free substrate compared to plants growing in industry standard and reduced peat substrates.
- Plant growth and quality in peat-free and reduced peat substrates were similar to those in industry standard substrate, when irrigation scheduling was optimised.
- The occurrence of mosses and liverworts on the surface of the substrate was greatest for *Sidalcea* receiving overhead irrigation.
- Moss coverage was greatest on the surface of the peat-free substrate under overhead irrigation.
- An automated irrigation scheduling tool that has previously been tested on commercial nurseries in HortLINK 97b experiments was used to maintain 'optimum' VSMCs under drip, overhead and sub-surface irrigation.
- The automated irrigation scheduling tool prevented over-irrigation of plants during the heavy and frequent rainfall in 2012.
- The approaches developed in this project could be used to identify the optimum range of substrate moisture contents in a range of sustainable growing media.

Financial Benefits

A preliminary cost benefit analysis was included in the First Annual Report for HNS 182. Figures provided by Will George (ADAS consultant), from the Horticultural Trade Association's Nursery Business Improvement Scheme (NBIS) suggest that the average value of plant waste from five nurseries during the period 2002 – 2004 was between £21,000 - £27,000 per annum or between 7 and 10% of turnover. Poor watering of peat-based growing media accounted for 3.2% of the waste, which equates to a loss of approximately

£1,000 for each nursery per year. This project aims to minimise losses through poor watering during the transition to reduced-peat and peat-free substrates which could be much more substantial than those reported for peat-based media.

Action points for growers

- Consider scheduling irrigation to all substrates using measurements of plant-and-pot weights using an electronic balance, VSMC using a soil moisture probe or estimates of evapotranspiration in combination with crop coefficients using an evapometer.
- 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 each substrate.
- 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 reduced peat substrates can be similar to industry-standard peat-based substrates but may need to be reduced with some crops in order to minimise run-through.