Evaposensor - controlled mist

A Demonstration of the Evaposensor in Commercial Propagation

Grower's Walks 2009

Boningale Nursery, Albrighton, Wolverhampton

Tuesday 13th October 2009, 3.30 pm

Micropropagation Services, Brookside Nurseries, East Leake, Loughborough

Wednesday 14th October 2009, 3.30 pm

Background: the whys and wherefores of Evaposensor control

Cutting water balance

Water stress from transpiration losses remains a common cause of failure when propagating cuttings. Of course, until rooted, the rate at which cuttings can take up water is very limited, so it is vital to limit the rate of transpiration from the leaves. Misting (or wet fogging) reduces leaf temperature through evaporative cooling, as well as maintaining high humidity – both of which slow down water loss from the cutting and maintain turgor.

Control of mist or fog

The 'evaporative demand' or rate of transpiration varies enormously with the time of day, weather, season, type of propagation facility etc. If we match the rate of misting to the evaporative demand we can minimise desiccation stress without over-wetting the leaves or the rooting media. Traditional mist controllers all have their weaknesses:

- *Timers* – while still very popular, growers can never adjust them frequently enough to adequately cope with the variable environment.
- *'Wet leaf' or 'Electronic leaf' sensors* – Unreliable and often over-wet. Conductivity between electrodes affected by salts and hard water deposits, and sensitivity controls often difficult to get right.
- *Light sum integrators* – Either stand-alone controllers such as 'Solarmist' or light sensors used with timer controllers. Often settings inadequately matched to cutting needs and light sensor location frequently remote from cutting environment.

The Evaposensor

The Evaposensor consists of two temperature sensing 'leaves'. One leaf remains wet via a wick and distilled water reservoir, and the other 'dry' leaf gets wetted periodically by bursts of mist or fog. Unlike conventional 'wet / dry hygrometers' in an aspirated screen for measuring relative humidity, the Evaposensor is placed just above cutting height. Here it is influenced by the mist, solar radiation, air temperature, humidity and air movement – i.e. *all* the factors affecting the rate of transpiration water loss from the cutting.

- Wet leaf remains cooler than dry leaf by evaporative cooling.
- Temperature difference is called the ***Wet Leaf Depression (WLD) - °C.***
- WLD is proportional to ***potential transpiration***. Hence to potential ***water stress*** on the cutting.
- During misting, 'dry' leaf becomes wet and WLD falls to near 0 °C, reflecting the effect of mist on transpiration.
- As dry leaf dries out, WLD rises until the ***set point*** is reached, and another burst of mist is triggered.

The Evaposensor is a good basis for controlling mist (or fog) in propagation, as it senses WLD in an analogous way to the 'transpiration stress' experienced by cuttings or a plant. Misting frequency is automatically adjusted along with the weather to accurately reflect changes in evaporative demand.

Think 'WLD set point' *not* 'How much mist?'

- ***WLD set point*** represents a ***level of cutting support*** that can be reproduced across different facilities, nurseries and seasons.
- Whatever the background environment, the system applies the amount of mist or fog needed to limit transpiration to the level set on the controller.
- Select a setting to suit cutting subject, rooting media and drainage. E.g. Low WLD (1.0 – 1.5 °C) ~ soft cuttings or stress sensitive subjects. High WLD (4.0 – 5.0 °C) ~ stress tolerant or quick rooting subjects, or if drainage limiting.
- Raise WLD in stages for e.g. difficult to wean material such as microprop.

The Evaposensor Mist Controller

ETS Ltd developed a controller in project HNS 159, to replace the now obsolete Nobel humidity controller that was used in the earlier research at East Malling. The ETS controller determines the WLD from the Evaposensor, and enables the user to adjust the amount of misting applied using a 'maximum WLD' set point.

Connection options and modes of use

The ETS controller can be used as a stand-alone device for single solenoid operation, or can be connected and integrated with existing timer controllers for multi-bed use from a single Evaposensor. Two common options are described below:

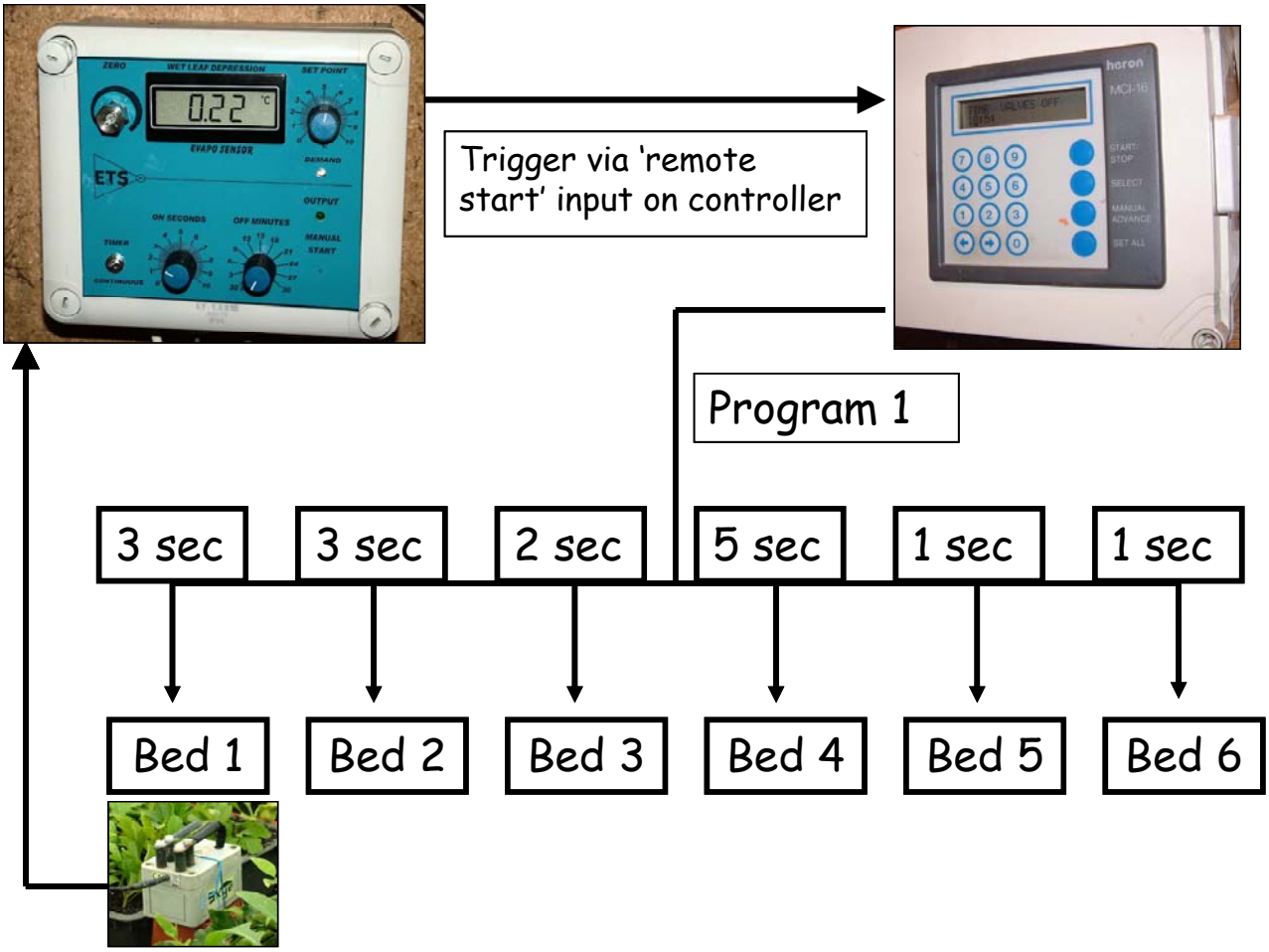
A. Independent controller mode

The Evaposensor is located on the bed being controlled ensuring that it is receiving a typical amount of mist for the bed, and that it is free from shading by cutting foliage or other obstacles such as mist riser pipes. It is connected to the ETS controller where it gives a continuous display of WLD or evaporative demand. This also serves as a useful check that all is operating correctly.

The solenoid valve is wired into the controller which provides a 24 VAC power supply. The timer controls on the ETS are used to set the mist burst length ('On seconds') and the *minimum* interval possible between bursts ('Off minutes'). Some interval is required to allow the mist to reach the sensor and the WLD to respond. Normally this is set to a low setting (e.g. 1 min), but the *actual* interval between bursts will normally be much longer and will automatically adjust according to the conditions affecting evaporation / transpiration rate.

This arrangement is most suitable for propagation units with a small number (1 to ~4) of independently controlled beds.

B. Multiple bed control



An economical way of providing control to multiple beds is to integrate the ETS with a multi-station controller. The example above illustrates a relay output from the ETS being connected to a Heron control panel, although other controllers are available that will work similarly. Six propagation beds are allocated to Program 1 on the Heron, with the Evaposensor placed on Bed 1. The mist duration / minimum interval settings on the ETS are not used, but replaced by the settings in the Heron program. When the WLD on Bed 1 reaches the set point, Program 1 runs, supplying mist to each bed sequentially. Some adjustment to the amount of wetting given to different beds can be achieved by varying the burst durations in the Program 1, thus enabling some water-sensitive subjects to receive less leaf wetting for example, or giving some weaning. The *frequency* of misting will, however, be determined by the conditions on Bed 1.

If very different misting regimes are required on different beds, flexibility can be further increased by using an additional ETS + Evaposensor and connecting both to a multiple-remote-start input card on e.g. a Heron controller. This means that two sets of beds could be controlled independently with one set at a low WLD set point (wetter or more supportive) and the other at a higher WLD (drier – e.g. for weaning and subjects that dislike too much wetting). This arrangement allows flexibility for switching any bed between the wet and dry regimes, switching it off completely or even switching it to a timer controlled regime.

C. Other uses

The Evaposensor + ETS controller can also be used to automate irrigation scheduling to growing crops. In this mode, a signal from the ETS is fed to an integrator card in a sequential irrigation controller, and irrigation doses are applied based on accumulated 'evapotranspiration-sum'. This has been successfully demonstrated at Hillier Nurseries in 2009 as part of the HNS 97a 'Water LINK 2' project, and HDC should be contacted for further details and reports if interested. The evapotranspiration-sum approach can also be applied in propagation and may have advantages in some situations. Contact Chris Burgess or Richard Harrison-Murray for advice.

Maintenance

- Keep Evaposensor reservoir topped up with distilled water (weekly routine).
- Occasionally clean off any serious accumulation of algae etc. on the wick with an old toothbrush. Reverse or replace wick if it becomes very faded or torn (e.g. annually).
- Clean off lime or other deposits from dry leaf annually, and touch up with matt black paint if necessary.
- Check zero adjust annually, or if the display deviates more than 0.3 °C from zero in cool conditions at night. With both probes immersed in a pot of water for 5 min, the WLD can be zeroed.

Summary of trial results from HNS 159 & 159a

During 2007 – 2009, trials were undertaken at:

- New Place Nurseries, Pulborough, W. Sussex
- Binsted Nursery, Arundel, W. Sussex
- Lowaters Nursery, Warsash, Southampton

Over this period, the ETS controller was developed and compared against the now obsolete Nobel controller. The ETS device gave as good control as the Nobel controller. Refinements were incorporated and the production model as described above was developed.

Control of cutting environment under mist

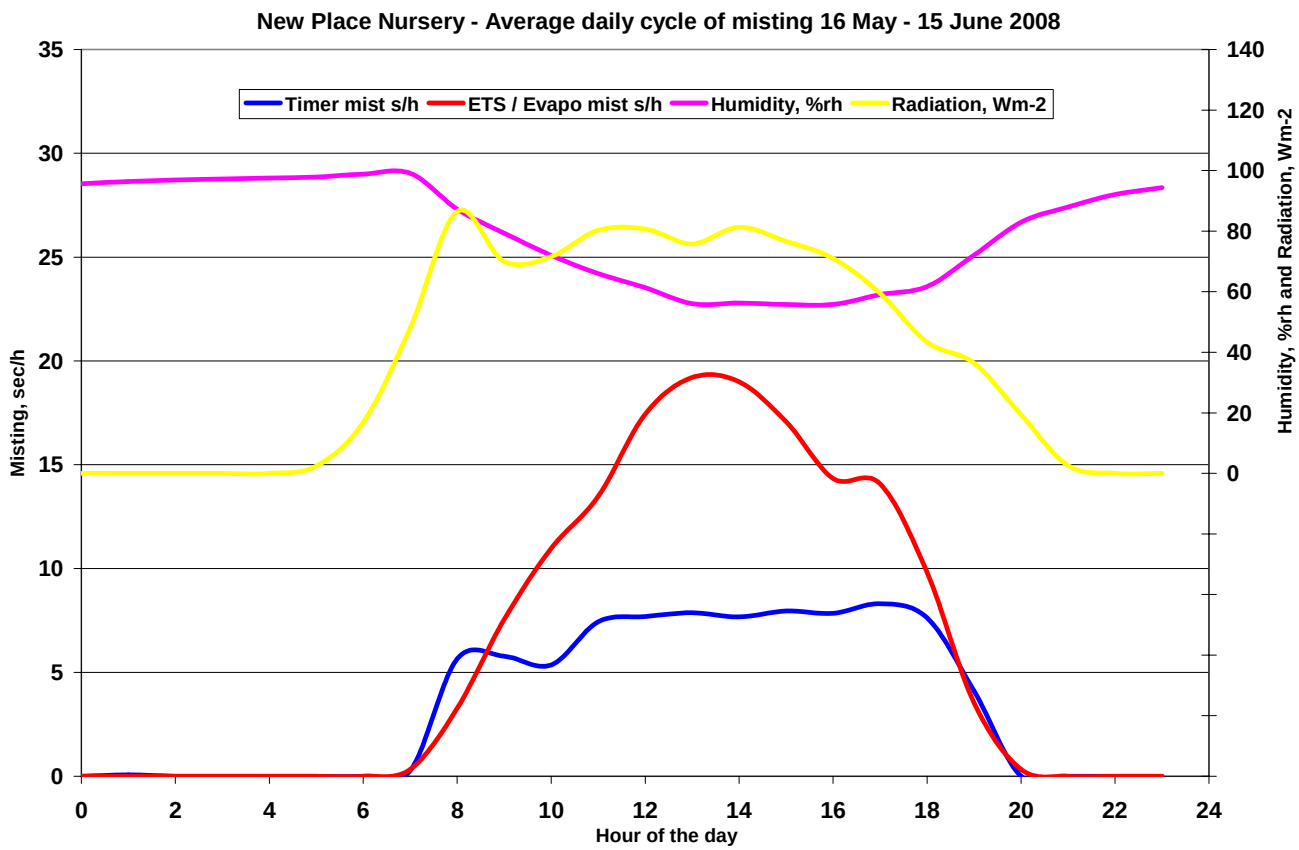


Fig 1. Comparison of average day / night misting patterns for Evaposensor vs. Timer control and ambient environment over a one month summer period at New Place Nursery.

Fig 1 (above) and Fig 2 (below) illustrate how the Evaposensor control of misting responds closely to environmental conditions, applying more mist under conditions of high evaporative demand (e.g. on bright days when humidity is low), whereas it applied much less mist on dull and cool days. Where nurseries were using Timer control, adjustments could not be altered to suit the variable weather conditions, and frequently either too much mist was being applied when not needed (e.g. at night or during cool and dull conditions), or insufficient during warm bright periods, especially in the middle hours of the day.

Where the standard system was a Timer but with extra mist triggered according to external light levels there was some additional misting when bright. However, the system did not respond adequately under high stress conditions, and a better environment for the cuttings was again provided by the Evaposensor.

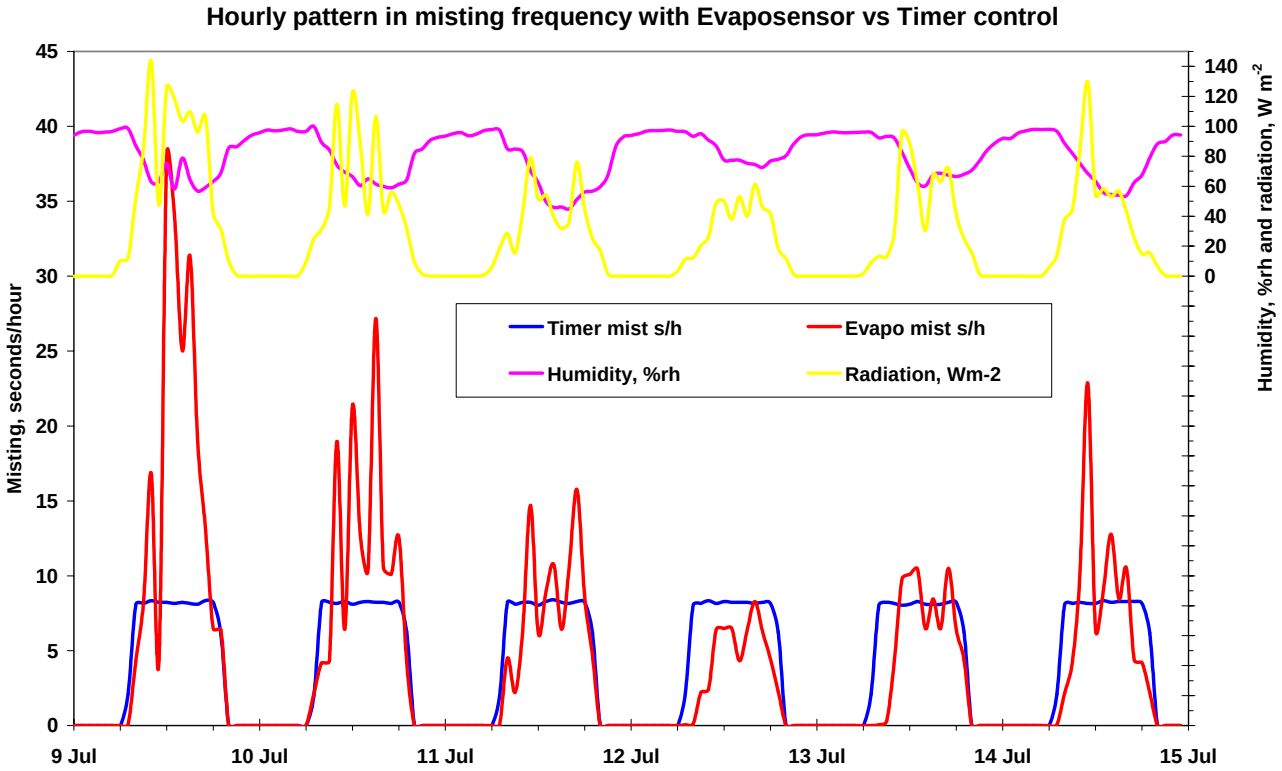


Fig 2. Misting pattern under Evaposensor control automatically adjusts with the weather compared to a static pattern under Timer control.

During 2009, under the demonstration project HNS 159a, three additional nurseries were used to trial the Evaposensor:

- Boningale Nursery, Albrighton, Wolverhampton
- Barrow Nursery, Living Landscapes Ltd, Great Barrow, Chester
- Brookside Nurseries, Micropropagation Services, East Leake, Loughborough

At Boningale and Barrow Nurseries, the Evaposensor was compared with an 'electronic leaf' (or 'wet leaf') control system. Both nurseries have found the wet leaf system tends to apply *too much* mist, and either there is no sensitivity control or it is unreliable. Fig 3, below, illustrates how excessive mist was being applied late afternoon and overnight by the wet leaf at Barrow Nursery. At Boningale Nursery, a time clock was being used to limit power to the wet leaf controller to the daytime in an attempt to overcome this, but the Evaposensor still gave better and more responsive control. Both nurseries found management of mist using the Evaposensor much easier and more convenient.

At Brookside Nurseries, the Evaposensor control of mist has been compared to light-sum control for weaning micropropagated material and also rooting mini-cuttings. The Evaposensor system has again proved easier and more convenient to manage. It has automatically adjusted for ventilation and shade screen effects on the glasshouse environment, whereas the light-sum system requires frequent adjustment of the trigger point.

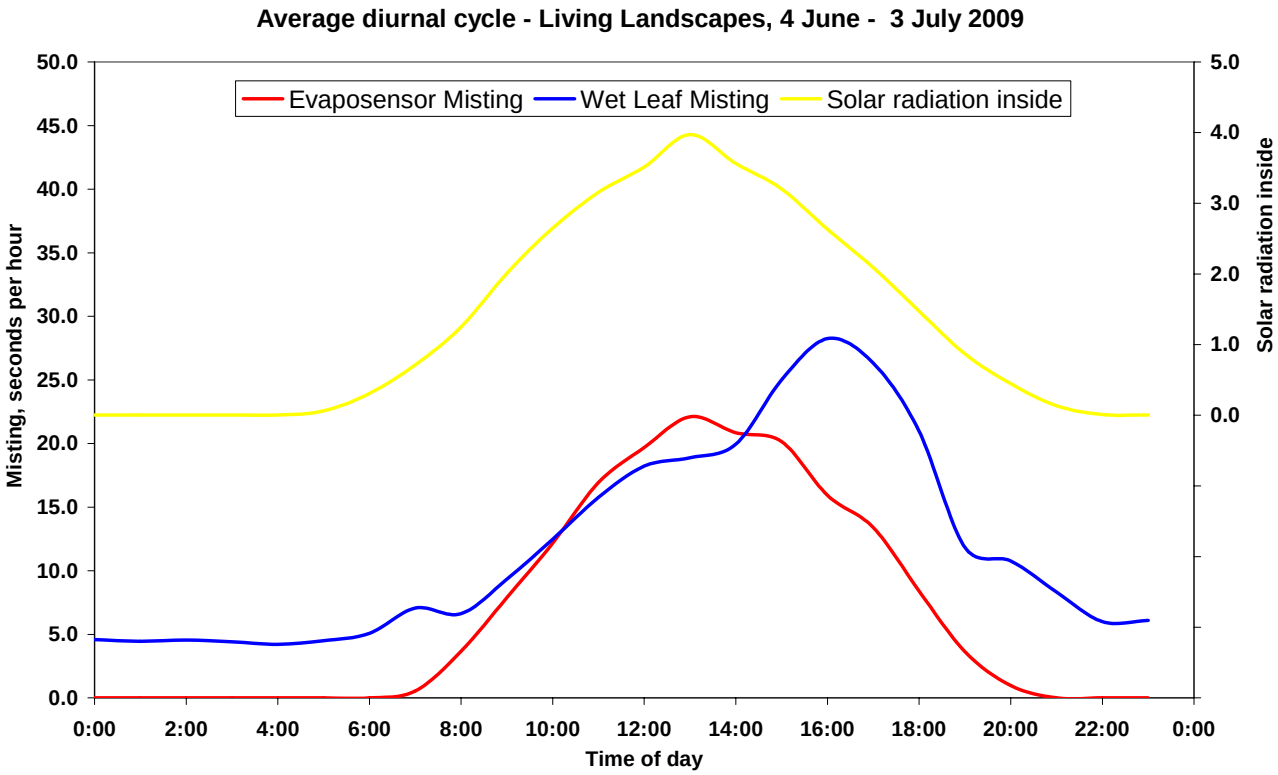


Fig 3. Average day / night misting pattern at Living Landscapes Nursery showing Evaposensor control responding closely to daytime demand vs. Wet Leaf control where unwanted misting occurs late pm and during the night.

Effects on rooting of cuttings

Table 1 summarises the rooting responses from the growers' standard vs Evaposensor mist control treatments at two of the nurseries in the HNS 159 project. Please see the HDC project reports for details of species.

Table 1. Summary of rooting results 2007 – 2009 at New Place and Lowaters Nurseries

New Place Nursery			
Batches compared	% rooting Evaposensor	% rooting Standard	Mean difference in % rooting
55	78.1%	73.7%	+ 4.4
Number of batches where rooting under evaposensor control was:			
Better	Similar	Worse	
23	22	10	

Lowaters Nursery			
Batches compared	% rooting Evaposensor	% rooting Standard	Mean difference in % rooting
69	72.7%	61%	+ 11.7
Number of batches where rooting under evaposensor control was:			
Better	Similar	Worse	
37	18	14	

At New Place Nurseries, the Evaposensor gave a mean overall rooting improvement of 4.4 percentage points. However 82% of the 55 batches compared gave similar or better rooting with some such as *Berberis darwinii, Hydrangea petiolaris, Spiraea* Arguta, and *Viburnum sargentii* giving significant improvements up to 20 – 30 percentage points. The mist facility at New Place was more shaded than the other two nurseries, and both treatments run relatively wet with the Evaposensor WLD set point at 1.3 – 1.5 °C during the project. The 'positive drainage' from a sand bed standing base was effective in preventing rooting media from getting waterlogged during heavy misting.

At Lowaters Nursery (shrubs and perennials), a larger mean rooting benefit of 11.7 percentage points was achieved, with 80% of the 69 batches compared giving similar or better rooting. Species showing the greatest benefits included *Choisya ternata, Cistus cvs., Coleonema cvs., Coprosma cvs., Escallonia cvs., Fuchsia genii, Halimium spp., Myrtus romana compacta, Olearia cvs., Phygelius x rectus cvs., Polygala myrtifolia, Ulmus procera and Vinca minor cvs.* with improvements from 20 – 70 percentage points. At Lowaters, less heavy shading was used, but the very heavy misting that would be required to achieve minimal cutting stress in bright conditions had to be tempered to avoid water logging the rooting medium. At Lowaters, the sand beds were covered by a layer of old, partially blocked Mypex which may have been impeding good drainage. Consequently, a higher WLD of 4 – 5 °C was used during the summer. The Evaposensor still achieved very good results, but highlighted the conflict that can occur between supplying sufficient mist to minimise stress on leaves and shoots, and over wetting rooting media if good drainage is in any way restricted.

This was also highlighted at Binsted Nursery where trays were stood on capillary matting over polythene on a concrete base. The nursery used a very light misting regime to

minimise over wetting of the trays. While the type of subjects being propagated were relatively stress tolerant and would root under this regime, the potential benefits of the Evaposensor control system could not be demonstrated here because of the limits on misting that had to be imposed.

In general, the biggest rooting benefits from the Evaposensor have occurred where the standard system has failed to apply sufficient mist under high evaporation demand periods, and cuttings have been stressed. However, at Barrow Nurseries in 2009, an estimated 5 – 10% improvement in rooting was found with the Evaposensor for subjects susceptible to the over wetting that was occurring under their standard wet leaf control.

At Boningale Nursery, at least 29 subjects have been compared under the Evaposensor (WLD set point about 1.5 °C) vs wet leaf systems during summer 2009. Percentage rooting has been high under both systems for nearly all subjects, with little difference between treatments, although some subjects on the Evaposensor beds have shown faster root development and development of new top growth. The main benefit from the Evaposensor has been the ease of management and the automatic adjustment of mist, though the nursery feels that improvements in propagation of more difficult and sensitive subjects may well be possible in future, if they fully convert to this system, given the better environmental control they are now able to achieve.

New Place Nursery:

Lowaters Nursery:

Grower comments about Evaposensor mist control

‘It has been an easy system to adapt to and change from the conventional leaf system. Very quickly I found I could leave the sensor to totally control the misting, the beds did not become too wet or too dry making a very good rooting environment… I am very keen to have the entire mist house at Boningale changed to the Evaposystem…’

Nerys Arch, Propagation manager, Boningale Nursery

‘We have been very pleased by the simplicity of management of the device… there has been little training required to understand the system and the user interface is friendly and easy to understand with 2 simple adjustments controlling the whole unit…
The other benefit is that the Evaposensor beds continue to perform at their optimum without regular manual intervention, therefore at weekends and spring and autumn periods when weather can rapidly change we are not using valuable skilled staff time in making regular tweaks to the system which are sometimes missed…
The average [rooting] improvement was 12% across a range of genera including some unusual and often difficult plants…if we could reduce… labour by 12% this would [be worth] close to £800 pounds a year saving…’

Charles Carr, Nursery manager, Lowaters Nursery

‘I have found that the Evaposensor to be a very useful controller. It is more controllable on our system and keeps the mist beds drier at night than our wet leaf system.
I have found for subjects susceptible to over wetting the rooting is approximately 5 – 10% better than on the wet leaf beds. We should seriously consider controlling the whole system with an Evaposensor’.

David Crabtree, Manager, Barrow Nursery, Living Landscapes

‘The advantage of the Evaposensor system is that it automatically takes care of day-to-day weather changes which in the main do not happen [with the timer based system]… I think the principle is very sound since its WLD illustrates what is going on around the cuttings. The fact that we have already installed two Evaposensors underlines our commitment towards further expansion of the system. I am particularly keen to look at it in polytunnels.’

John Hedger, Managing Director, New Place Nurseries

Summary of Evaposensor Mist Control Benefits

- Responds to *all* environmental factors affecting water loss.
- Matches mist to cuttings’ needs. Defines level of cutting support.
- Automatic mist adjustment with weather and environment.
- Versatile and simple to use for rooting and weaning.
- Offers easier management and potential for faster and better rooting.
- Affordable retrofit to existing systems.

Acknowledgments

Thanks to Boningale Nursery and Brookside Nurseries for hosting these Grower's Walks, and also the co-operation of the staff at all the six nurseries in involved in Projects HNS 159 and HNS 159a for looking after the trials at their sites and the recording of rooting results.

Project Team

Chris Burgess, CB Consultant Agronomist – Project leader
Richard Harrison-Murray – Research and technical consultant
Olga Grant, EMR Researcher – Supply of logging equipment
Jill England, ADAS Horticultural consultant – Assistance with logger downloading and recording
Neal Wright, Micropropagation Services Ltd – Grower co-ordinator for HDC project
John Walker, ETS Ltd – Development and supply of new controller for Evaposensor
Skye Instruments Ltd, - Supplier of Evaposensor (Model SKTS 500/PT100)

Useful contacts:

ETS Evaposensor controller:
Electronic & Technical Services Ltd
40 Acreville Road
Bebington
Wirral
CH63 2HY
Tel: 0151 645 8491
www.ets-controls.co.uk
email: john@ets-controls.co.uk

Evaposensor *(specify type SKTS 500/PT100/4)**:***
Skye Instruments Ltd
21 Ddole Enterprise Park
Llandrindod Wells
Powys LD1 6DF
Tel: 01597 824811
www.skyeinstruments.com

Further advice and consultancy on optimising use:
Chris Burgess
CB Consultant Agronomist
Tel: 01202 470435
email: home.burgess@ntlworld.com

Richard Harrison-Murray
RHM Science
Tel: 01732 847403
email: richard@rhmscience.co.uk