Effect of Peat Grade, Irrigation System and Nutrition on the Production of Nursery Stock in Closed Systems

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Introduction

Containerised nursery stock plants in Ireland are almost exclusively produced in peat growing media using controlled release fertilisers and are irrigated by means of overhead spraylines with the drainage water going to waste. Concern about nutrient pollution and the need to use water and nutrients more efficiently may lead in the future to regulations about capturing and re-cycling drainage water. This would particularly apply where nutrients are incorporated in the irrigation as in liquid feeding or where hard water is being acidified to neutralise bicarbonate.

These experiments were started to study the performance of nursery stock plants in closed systems and to compare ebb and flood and capillary irrigation with overhead spraylines. A comparison of a liquid feeding regime as against the use of controlled release fertilisers was also included.

The use of fractionated peat allows peat substrates with a wide range of physical properties to be prepared by using graded fractions or blends. It was thought desirable to include these in the experiments as there may well be interactions between irrigation systems and substrate properties.

Methods

The experiments were conducted in 20 independent beds each measuring 5 x 2 m and plumbed back to an individual water reservoir in an adjacent glasshouse (Figure 1).The beds had wooden frames, were lined with butyl rubber.

Figure 1 : The nursery stock research beds at Kinsealy

Eight of the beds were capillary sand beds in which the bed was filled with a non-calcareous sand and a constant water level maintained in the sand, 2 cm below the surface, by means of a float valve. The pots containing the plants were placed on the moist sand and obtained water through capillary action. A pump maintained pressure in the supply line to the

float valve from the reservoir. Rain falling on the bed was conducted back to the reservoir via an overflow pipe.

Eight beds were ebb and flood irrigated. These beds were filled with a 10 cm layer of non-calcareous pea gravel. The pots were placed on the gravel and irrigation was carried out by flooding the bed, to a depth of 4 cm, using a submersible pump in the reservoir. A motorised valve in the return pipe was closed to prevent the water from flowing back to the reservoir during irrigation. Then the valve was opened and the water returned to the reservoir. It took 5 minutes for the water to reach the 4 cm level. This level was maintained for another 5 minutes and then the return valve was opened.

The remaining four beds were equipped with overhead spraylines with the water again being pumped from the reservoir. The spraylines were aligned along the sides of the beds at a height of 1 m. The water was directed onto the beds through 180o nozzles. Excess water flowed back to the reservoir through a return pipe. A 5 minute spray period was found to be sufficient to bring the pots back to container capacity.

Irrigation events on the flood and sprayline beds were set on a time basis and the operation of the pumps and valves were controlled by a computer. The software was written in Microsoft QuickBasic V5.

Half of the capillary beds and the ebb and flood beds were irrigated with a complete nutrient solution. The other beds, including the four sprayline beds, were irrigated with pure water and here the peat was base dressed with a controlled release fertiliser , 12-14 month Osmocote (15:9:11) , at 5 kg m^{-3}.

Peat was graded by sieve and the grades were used separately or in blends to provide five treatments with a range of air filled porosity (AFP) values as shown in Table 1

Table 1 : Peat grades used in the experiment and their corresponding AFP value

Peat grade	AFP
100% 0-3 mm	5
100% 0-10 mm	10
Nursery stock grade[1]	15
80% 6-12 mm, 20% 0-10 mm	20
80% 10-25 mm, 20% 0-10 mm	25

[1] A commercially available blend for the nursery stock industry.

In 1995, rooted cuttings of *Hebe* "Mrs. Winder" and *Lavandula steochas* (Lavender) were potted into the containers in May. In 1996, a third species, *Thuya placata* was included. In the first experiment the plants were overwintered and the final assessment was made in April. In the second year the experiment terminated in December.

Results

Plant health

Plants were monitored regularly for incidence of root disease which might be spread in a re-circulating system. In both years there was no incidence of *Phytophtora* or *Pythium* disease. This was an encouraging result as sterilisation of recycled water would be a significant additional cost. Plant size was much greater in the first experiment due to the fine summer and the longer growing season.

Peat grade

In the first experiment, plants in the coarsest peat (25% AFP) were the smallest and had the lowest fresh weights and root index. In the second year, the smallest plants were again produced in the coarsest peat grade (25% AFP). *Hebe* gave the heaviest plants at the middle grade (15% AFP) while *Thuya* did best at the finest grade. Both *Hebe* and *Lavandula* produced the most marketable plants at 15% AFP while the *Thuya* scored again best at the finest grade.

Irrigation system and nutrition

In the first year, plants in the ebb and flood beds being liquid fed were the most vigorous, tallest and heaviest. Those in the capillary beds were the smallest with no difference between those with controlled release fertilisers and those receiving liquid feed. Plants in the overhead

beds although smaller than those in the ebb and flood beds scored well for marketability because the shorter internodes combined with good colour made the plants look more attractive. Plants in the capillary beds scored badly on the root index because of the relative absence of roots in the bottom of the pot and again at the very top.

In the second year, the combination of ebb and flood irrigation with liquid feeding was again the outstanding treatment for plant fresh weight and vigour and marketability scores. This was especially the case with *Hebe* and *Lavandula*, differences between the irrigation treatments were less with *Thuya*.

Irrigation and nutrition interaction

In both experiments, however, there were significant interactions between peat grade and irrigation and feeding system. In 1995, the ebb and flood with liquid feed treatment was best at the 5, 10 and 15% AFP peat grades in the case of *Hebe* (Figure 2) and at the 5 and 10 % grades with *Lavandula.* At the coarse grades of peat results in this treatment were more similar to the other irrigation treatments. In the second experiment, the combination of ebb and flood irrigation with liquid feeding was outstanding at all peat grades. With *Hebe* (Figures 3). there was a quadratic response to peat AFP with the best results being obtained at 15%. There was a similar but less pronounced trend with *Lavandula*. *Thuya* showed a decline at the two coarsest grades

Figures 2 and 3 : Interaction between irrigation and nutrition system and peat grade on the fresh weight of *Hebe* 'Mrs. Winder' (E/F - ebb and flood irrigation, CRF - controlled release fertiliser, LF - liquid feed)

Figure 2 : Hebe, 1995/96

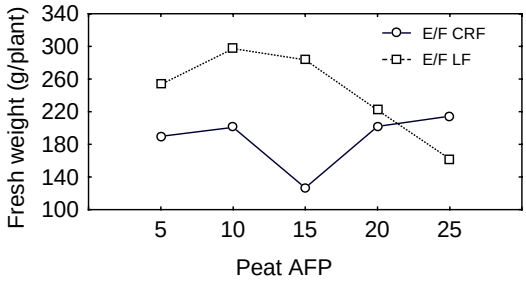
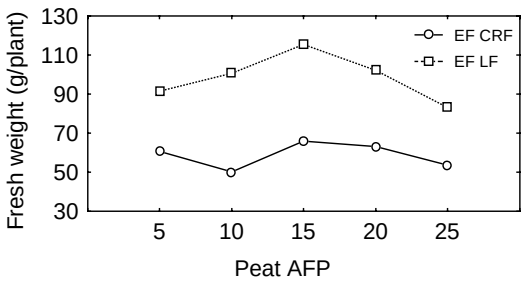


Figure 3 : Hebe, 1996



The interactions between the irrigation and feeding treatments and the peat grades suggest that in the warm dry summer of 1995, the two coarse peats did not have sufficient water holding capacity to sustain the production of large plants with a consequent large water and nutrient requirement. In 1996, a normal summer, plant weight was reduced and there was less fall off in plant performance with the coarse grades of peat.

The better growth achieved with liquid feeding in the ebb and flood beds over the controlled release fertiliser suggests that it may be easier to maintain optimum nutrient levels in the containers with a liquid feeding programme. However, better results may also have been obtained with increased rates of controlled release fertiliser. Nevertheless the size of the increase in plant weight and quality obtained from liquid feeding indicates that this approach should be further studied as a means of improving overall performance and quality in the nursery stock industry. It may also improve the chances of closed systems techniques being adopted if there are performance gains to be achieved.

The lower level of performance of the plants in the capillary beds in 1995/96 may be related to the build up of excess levels of salts as evidenced by high levels of conductivity measured. This experiment took place during an exceptionally warm and dry summer and consequently there was little or no leaching of salts from the pots by rainfall until after the growing season. In such conditions watering the pots from above on occasion may be advisable. Combining liquid feeding with the use of a capillary sand bed presents a number of problems. After heavy rainfall, nutrients will be leached from the pots and the solution in the sand bed itself will be much diluted and it may be difficult to introduce sufficient nutrients into the pots quickly. Nutrient accumulation in the pots occurs during dry periods necessitating overhead watering. Where sand beds are used therefore, the experience of these experiments indicates the use of controlled release fertilisers.

Conclusions

- The results suggest that for many species, an AFP of 15% is a reasonable compromise between the conflicting aims of good aeration and water holding capacity.
- No benefits were obtained by using peat grades coarser than that which provided an AFP value of 15%.

- Some vigorous rooting plants, e.g. *Thuya plicata*, may benefit from a higher water holding capacity.
- Over two seasons, nursery stock crops were successfully grown in closed re-circulating systems without incidence of serious disease problems.
- On ebb and flood irrigation beds the use of liquid feeding gave large increases in plant size and vigour compared with controlled release fertilisers.
- Controlled release fertilisers are preferable to using liquid feeding on capillary sand beds.
- Where controlled release fertilisers are used, differences in plant performance between ebb and flood beds, capillary sand bend and overhead sprayline beds were not large.

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