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Improved Water Saving in Nursery Production Using *Sphagnum* Peat

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Abstract

Reducing irrigation in nursery production has become a major issue due to environmental concerns. Different irrigation systems are proposed to increase irrigation efficiency. These systems required growing media with specific properties to optimize their utilization. Substrates commonly used are often too coarse resulting in frequent watering and poor capillarity properties required for sub-irrigation systems. Addition of *Sphagnum* peat could enhance water holding capacity and reduce water use. An experiment was conducted to evaluate water-saving potential of *Sphagnum* peat (30 to 60%) in a bark mix (30 to 60% bark/10% sand) compared to sedge peat (30%) commonly used in Florida. The setup included both overhead irrigation and capillary mat system (Aquamat) in nursery production of *Ligustrum* and *Viburnum*. Plant growth was improved using *Sphagnum* peat in high proportion reducing production time (13 to 28%) and water use (15 to 38%) with both irrigation systems. The best combination tested was capillary mat used with the substrate containing 60% *Sphagnum* peat which provided an adequate capillary rise. An economic analysis showed the profitability of this solution and definitely justified the additional investments required.

INTRODUCTION

Reducing irrigation in nursery production has become a major issue due to environmental concerns. Commonly used coarse growing media provide a high air-filled porosity, but require frequent irrigation. An easy way to reduce irrigation is to improve the water holding capacity of the mixes by adding fine particle material. In the Southern region of the United States, sedge peat is often added to the media. However water-holding capacity could be further increased by changing the peat type. *Sphagnum* peat has adapted structures for holding and transferring water, resulting in a large water holding capacity and improved capillary rise properties. To maintain adequate aeration properties and avoid root asphyxia affecting crop growth rates, the proportion of *Sphagnum* peat added to the mix must be optimized.

The objective of this study was to compare *Sphagnum* peat with sedge peat in different proportions, as substrate components in nursery growing media by evaluating

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their cultural performances, water-saving potential and profitability with overhead and sub-irrigation systems.

MATERIALS AND METHODS

Substrate Characteristics

Se30
- 30% sedge peat (Florida Potting Soil)
- 60% composted pine bark fines (Florida Potting Soil)
- 10% coarse sand

Sp30
- 30% *Sphagnum* peat (Premier Horticulture)
- 60% composted pine bark fines (Florida Potting Soil)
- 10% coarse sand

Sp60
- 60% *Sphagnum* peat (Premier Horticulture)
- 30% composted pine bark fines (Florida Potting Soil)
- 10% coarse sand

Initial physical properties were measured on three replicates of each substrate potted into 5 L containers. Water desorption curves were established using tension tables and gravimetric water content determinations. Air-filled porosity was estimated by the difference between total porosity and the volumetric water content at container capacity. Easily available water was calculated from the difference between the volumetric water content at container capacity and at -50 cm of matric head. The Laval tension disc technique was used to determine the saturated and unsaturated hydraulic conductivity. Gas relative diffusivity was estimated using the water flow and multiple points from the water desorption curve. More details on physical properties measurements can be found in Caron et al. (2005) and Caron and Elrick (2005).

Experimental Setup and Cultural Practices

Liners were transplanted in April 2001 into 5 L plastic containers (#1) placed in a randomized split block design with the two irrigation system as the main plot and the three substrates as the subplots. Treatments were replicated in 3 blocks of 6 plants replicates.

Plants Species
- *Ligustrum japonicum*
- *Viburnum odoratissimum*

Irrigation Systems
- Aquamat (Soleno Textiles)
- Overhead supplied through sprinklers

Canopy growth measurements, irrigation volumes applied and production periods were evaluated when 92% of the plants had reached a commercially acceptable quality (Florida Fancy Grade). Cultural practices are described in Boudreau et al. (2001) and Caron et al. (2005).

Economic and Statistical Analysis

Profits were calculated over six years by the difference between total revenues and total expenses estimated (installation and production) to bring plants to 92% of marketability. Expenses and revenues were based on 2001 market costs in Florida, USA. Production expenses included containers, fertilizer, soil mix, water and labor costs. Statistical analyses of data were performed using SAS (SAS Institute). Additional economical and statistical data analysis details can be found in Boudreau et al. (2001).

RESULTS AND DISCUSSION

Substrate Physical Properties

Initial physical properties of the media are presented in Table 1. Changing peat type did not significantly change these properties. Adding more *Sphagnum* peat to the medium increased the proportion of fine particles, decreasing air-filled porosity and improving capillary rise properties. Nevertheless, easily available water, saturated hydraulic conductivity and gas diffusivity did not differ significantly.

Production Period and Water-Use

Plant growth was improved by changing from sedge to *Sphagnum* peat, with greater gains incurred by increasing the proportion of *Sphagnum* peat from 30 to 60%. Under overhead irrigation, increasing the quantity of *Sphagnum* peat to 60% reduced production periods by 11 weeks for *Viburnum* and 6.5 weeks for *Ligustrum* compared to sedge peat (Fig. 1). As a result of this accelerated growth, the amount of irrigation water was reduced by 15 and 22% for *Viburnum* and *Ligustrum*, respectively (Fig. 2).

Use of the capillary mat resulted in notable water savings compared to the overhead irrigation. By using 60% *Sphagnum* peat instead of sedge peat on the capillary mat, the production period was shortened by 3.5 weeks for *Viburnum* and 4 weeks for *Ligustrum*, reducing irrigation requirements. Based on these results, the best water saving strategy tested was the capillary mat combined with the substrate containing 60% *Sphagnum* peat.

Crop Performance

For *Viburnum* growth measurements, interactions of the irrigation system with the substrate were significant (Figs. 3 to 5). Plant growth was enhanced with 60% *Sphagnum* peat compared to sedge peat under overhead irrigation. With the capillary mat, the tallest and largest plants were obtained with 30% *Sphagnum* peat.

Economic Analysis

Sphagnum peat is more expensive than sedge peat or some local sources of bark. However, the economic analysis indicated that the investments required were compensated by a shorter production period, resulting in reduced water consumption and saved labour. After 6 years, profits generated were higher using *Sphagnum* peat (Fig. 6). For *Viburnum*, the most profitable system was the Aquamat with the 60% *Sphagnum* peat substrate.

CONCLUSIONS

Using *Sphagnum* peat instead of sedge peat is a profitable water saving solution. Added at proportion higher than commonly made in the nursery industry, *Sphagnum* peat improves aeration and water transfer in the substrate, increasing crop performance. Changing the mix composition is an easy way to save water in nursery production. Investments required initially for this increased proportion are largely compensated by the savings resulting from the shorter production periods. Combined with a capillary mat system, incorporating *Sphagnum* peat in the substrate resulted in substantial water savings and considerable increases in profits.

ACKNOWLEDGEMENTS

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Tables

Table 1. Initial physical properties of substrates.

Substrate	Mean weight diameter (mm)	Air-filled porosity (m^3 m^{-3})	Easily available water (m^3 m^{-3})	Saturated hydraulic conductivity (cm s^{-1})	α_1 (cm^{-1})	ψ_b (cm)	Gas relative diffusivity
Se30	4.27 [ab]	0.47 [a]	0.20 [a]	0.49 [a]	1.27	-3.32	0.010 [a]
Sp30	5.13 [a]	0.52 [a]	0.25 [a]	0.21 [a]	1.27	-3.32	0.022 [a]
Sp60	2.93 [b]	0.30 [b]	0.28 [a]	0.16 [a]	0.96	-5.08	0.013 [a]
LSD	1.88	0.08	0.16	0.79	-	-	0.035

Source: Caron et al. (2005). α_1 and Ψ_b: Unsaturated conductivity curve characteristic parameters. Means with the same letter are not significantly different (protected LSD, p=0.05).

Figures

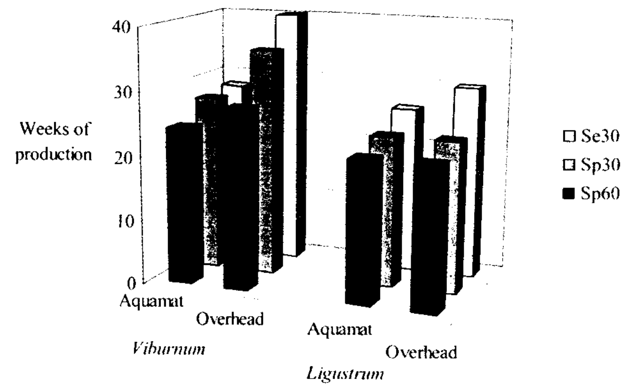

Fig. 1. Weeks of production required to obtain 92% marketable *Viburnum* or *Ligustrum* plants.

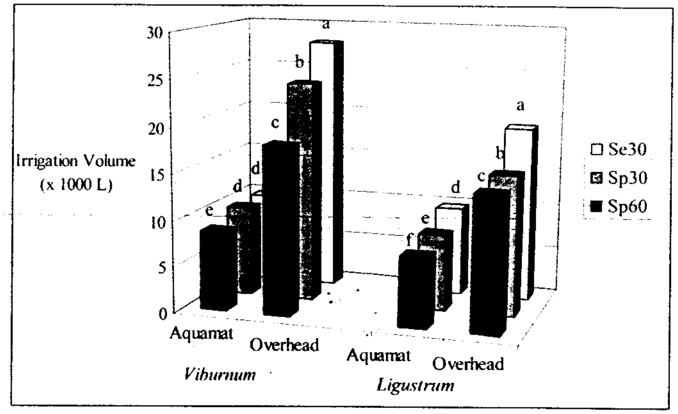

Fig. 2. Irrigation volume applied to obtain 92% marketable *Viburnum* or *Ligustrum* plants. For each plant, columns with the same letter are not significantly different (protected LSD, p=0.05).

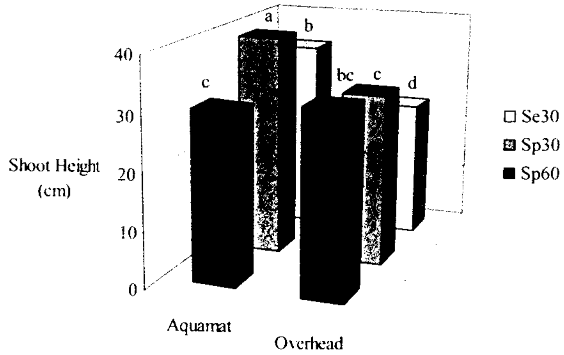

Fig. 3. Mean shoot height of *Viburnum* when a minimum of 92% of the measured plant obtained marketable size. Columns with the same letter are not significantly different (protected LSD, P=0.05).

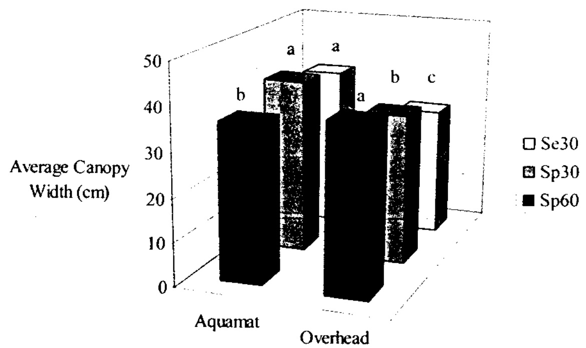

Fig. 4. Mean shoot average width of *Viburnum* when a minimum of 92% of the measured plant obtained marketable size. Columns with the same letter are not significantly different protected LSD, p=0.05).

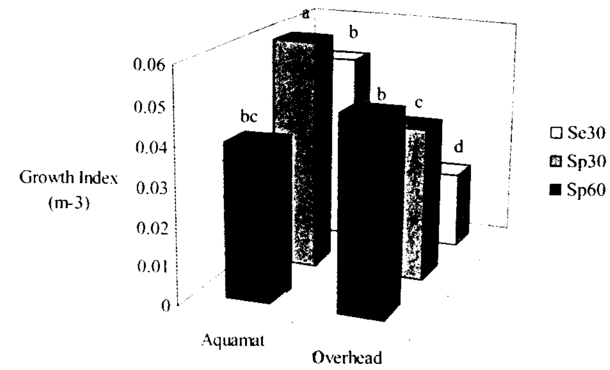

Fig. 5. Mean growth index of *Viburnum* when a minimum of 92% of the measured plant obtained marketable size. Columns with the same letter are not significantly different (protected LSD, p=0.05).

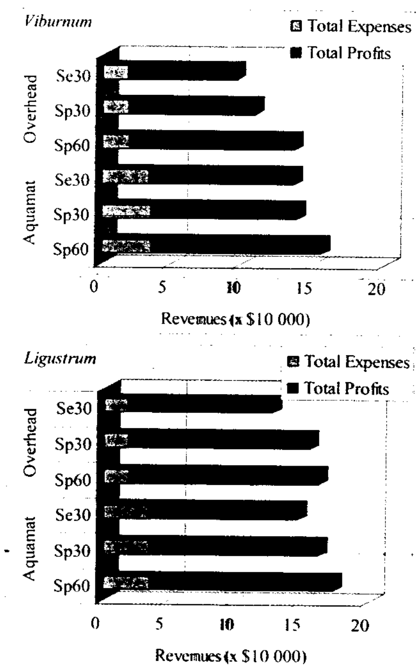

Fig. 6. Total revenues for 0.1 ha *Viburnum* or *Ligustrum* production after 6 years.

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