# Production & Marketing Reports

## Mechanical Container Filling Alters Texture and Water Retention of Peat Growth Media

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***Additional index words.*** nursery management, particle size distribution, physical properties, substrates

***Summary.*** Two commercially produced growth media made of light, low humified sphagnum peat, were used to determine how filling into containers affects the particle size distribution and water retention characteristics of peat. It was shown that the filling procedure used broke up the peat particles, resulting in a significant increase in the proportion of particles <1 mm (g·g$^{-1}$). Due to the increased proportion of fine particles, the water retention of the peat media increased under wet conditions (–0.1 kPa matric potential), while the air-filled porosity decreased to nearly 0. Also, at matric potentials lower than –0.1 kPa, the reduction in air-filled porosity may restrict aeration and availability of oxygen to roots, thus reducing growth of plants.

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*In addition to the referees selected by the editor, the manuscript was commented on by H. Smolander and R. Rikala. The language of the manuscript was revised by J. von Weissenberg.*

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Texture and structure are important physical properties of a growth medium. These properties, together with external conditions, affect water retention and air diffusion in the growth medium (Currie, 1984; Hillel, 1971). Therefore, the availability of water and oxygen to the roots of containerized plants grown in nurseries greatly depends on the physical properties of the growth media and on the factors that affect these properties (Heiskanen, 1993a). Peat growth media consist almost totally of organic material and therefore possess a specific texture and structure, which differ from those of mineral soils. In addition, the mechanical stability and resiliency of organic material in containers may differ from that of mineral soil (Landis et al., 1990). With changes in external physical conditions and handling, the physical properties of peat may therefore alter differently and more markedly than those of mineral soil. However, for production of containerized plants, there is little information concerning how container filling and other precultivation practices in nurseries affect the properties of peat (Heiskanen, 1993a, 1993b; Landis et al., 1990; Puustjärvi, 1982b).

The aim of this study was to determine how filling low-humified peat growth medium into containers affects the particle size distribution and water retention characteristics of the peat.

### Materials and methods

The growth media studied were commercial coarse- (ST-400 M6) and medium- (ST-400 PP6) grade peat (Kekkila Corp., Finland). The grades were specified by the producer to comply with the Nordic standards for grades of peat growth media (Puustjärvi, 1982a). These peat media were light, low-humified (H1-3, von Post scale) sphagnum peat and are commonly used in Finnish tree nurseries.

Two random samples of ≈3 dm$^3$ from three randomly chosen delivery bales of both peat media were collected into plastic bags in Spring 1993. The ranges of the water content and the dry bulk density of both peat media in bales were 55% to 80 % (g·g$^{-1}$ of dry mass, ≈35% to 45 % of fresh mass) and 0.072–0.081 g·cm$^{-3}$, respectively (Heiskanen, 1993b). After sample collection, the rest of the peat media from the bales was placed in the feeding screw of a filling machine (FL2 / 1988, Lannen Corp., Finland), which loosened and filled the peat media into plastic containers with an average volume of 360 cm$^3$ (Plantek 25, Lannen Corp., Finland). The filled container trays were then placed outdoors, covered with plastic, and stored in a pile for ≈4 weeks (during April in central Finland). Then, before sowing and cultivation began, for each bale from which peat had been filled into the containers, peat samples were taken from two container trays (one sample from five containers per tray). Therefore, a total of 24 samples were collected and analyzed.

The particle size distribution of the samples was determined by dry sieving air dry peat through standard sieves (hole size 20, 10, 5, 1, and 0.06 mm) for 2 min using a mechanical sieving machine (Retsch Corp., Germany) (Heiskanen, 1993b; Wilson, 1983). The water retention characteristics of the peat media samples were measured using a pressure-plate apparatus (Soil Moisture Equipment Corp.) and procedures described in detail elsewhere (Heiskanen, 1993b). Volumetric water retention (percentage) at each matric potential used (0, –0.1, –1500 kPa) was determined in relation to the saturated peat volume (approximate container volume) as $\theta = \{[(M - Ms) / Dw] / (Ms / Db)\} \times 100$, , where $\theta$ = water content, M = total mass of the sample, Ms = dry mass of the sample, Dw = density of water, and Db = bulk density of the sample (e.g., Hillel, 1971). To compare the differences between group means, one-way analysis of variance and Tukey's test were applied.

### Results and discussion

The filling procedure used significantly reduced the particle size of the peat media (Fig. 1). The propor-

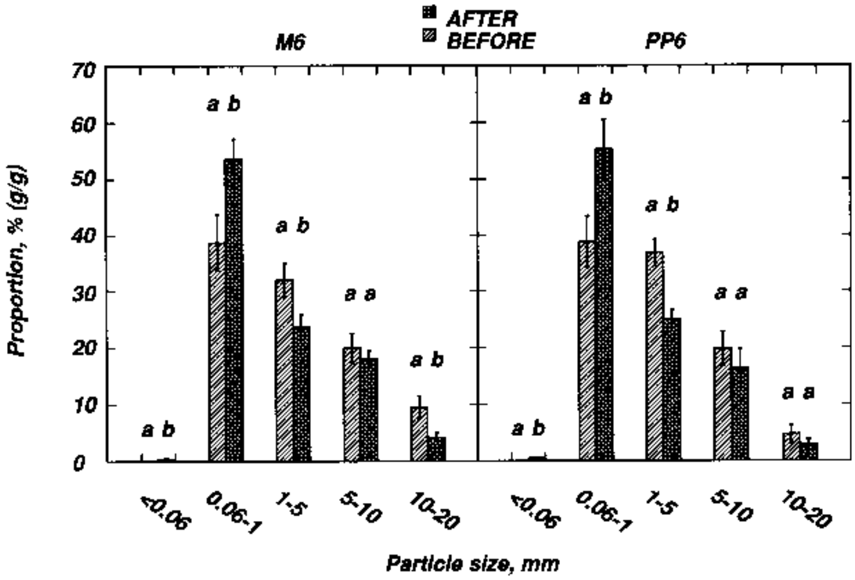


Fig. 1. *Mean particle size distribution for coarse- (M6) and medium-grade (PP6) peat growth media before and after container filling (n = 6 within group). Vertical lines indicate standard deviation. Different letters indicate a significant difference before and after container filling within each particle size (*P *≤ 0.05, Tukey Studentized range test).*

tion of particles <1 mm increased, and that of particles 1 to 5 mm decreased markedly. The amount of 10- to 20-mm particles also clearly decreased in the M6 peat. Although the proportions of 1- to 5- and 10- to 20-mm particles differed significantly between the two peat media before the filling procedure, according to Nordic standards they both were still of medium grade (Puustjärvi, 1982a). After container filling, none of the size fractions measured differed between the two peat media, and, according to Nordic standards, both peat media were of fine grade. Therefore, feeding the peat media into the filling machine and the filling procedure made the size of peat particles smaller. In addition, it seems that the initially coarse particles had become relatively smaller than the initially fine particles. Container-filling procedures have also previously been suggested to deaggregate and break up particles of peat (Heiskanen, 1993b). Similarly, other mechanical treatments, such as sieving and mixing, have also been shown to reduce the size of peat particles (Landis et al., 1990; Puustjärvi, 1982b). It is possible that the altered peat texture and structure found here were also affected by changes in weather and night frosts (temperature, moisture) during storage.

Some variation in filling volume (320–370 $cm^3$), density (fresh bulk density 0.13-0.21 $g{\cdot}cm^{-3}$) and the proportion of particles of peat media mainly <1 mm was detected between the filled containers. Thus, the filling procedure had also graded and distributed the peat media differently into various trays and into individual containers. In addition, it is probable that any initial variation in moisture and particle size distribution between and within peat bales also contributed to these variations in the filled containers.

The water content of the peat media varied somewhat between and within the different delivery bales (55% to 80 %, $g{\cdot}g^{-1}$ of dry peat mass). However, because the mean dry bulk density of both peat media was about the same before and after the containers were filled (0.078 $g{\cdot}cm^{-3}$), the total porosity of the peat media (matric potential symbol ≈0) was, on average, unaltered after container filling (Fig. 2). On the other hand, at –0.1 kPa matric potential, the water retention of both peat media studied increased significantly (≈6% to 8% units) due to the filling procedure, which decreased air-filled porosity to nearly 0. The finer particle size of the peat media had thus increased the water retention. In addition, at –0.1 kPa matric potential, slight variation in the water retention was observed between the peat media in various trays (93% to 97 %, $cm^3{\cdot}cm^{-3}$). During cultivation of containerized plants, the matric potential of the growth medium occurs frequently between –1 and –5 kPa. If water retention within this matric potential range is also increased so that the air-filled porosity is decreased excessively (below 40%), the growth of plants is at risk of being reduced due to the decreased availability of oxygen to the roots (Heiskanen, 1993a, 1993b; Puustjärvi, 1977). Therefore, under these conditions of low aeration, the risk for root suffocation and root dieback may also increase (Beyer-Ericson et al., 1991; Lilja et al., 1992). At the wilting point (–1500 kPa), water retention was not found to

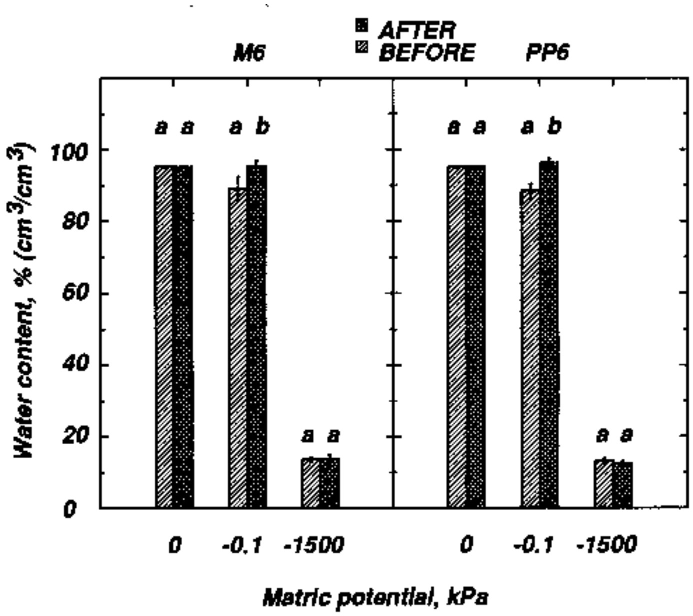


Fig. 2. *Mean water retention at different matric potentials for coarse- (M6) and medium-grade (PP6) peat growth media before and after container filling (n = 6 within group). Matric potential 0 refers to total porosity. Vertical lines indicate standard deviation. Different letters indicate a significant difference before and after container filling within each matric potential (*P *≤ 0.05, Tukey Studentized range test).*

be changed due to the container filling, which indicates that the very finest structure of the peat media was unaltered.

## Conclusions

It was shown that filling peat medium into containers reduces the proportion of coarse particles (>1 mm) and, correspondingly, increases the proportion of fine particles (<1 mm). This also increases water retention under wet conditions, which may further decrease air-filled porosity so that air diffusion and hence oxygen availability to roots decrease. In nursery management, to preserve the initial favorable structure of light, low-humified peat, container-filling procedures and other mechanical precultivation practices for peat should be as infrequent and gentle as possible.

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# Potential Utilization of Yardwaste Compost in Virginia: A Survey of Nursery Operators

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***Additional index words.*** municipal landfills, nursery composting

***Summary.*** **Registered nursery operators on Virginia were surveyed to determine the potential utilization of yardwaste compost (YWC) from a proposed statewide yardwaste composting system. Respondents reported using 94,000 yd$^3$ of potting medium, 36,000 yd$^3$ of peat in containers, and 9000 yd$^3$ of peat for field soil amendment, and retailing 144,000 yd$^3$ of organic materials per year. Many of the respondents indicated that YWC could be used as a substitute for peat or other organic materials in potting mixes (56%), field-grown nursery crops (54%), and lawn establishment (21%), and more than 30% were interested in selling retail. Nursery operators (30%) expressed interest in contracting with municipalities to do the composting and using or marketing it directly.**

Recycling goals have been set by the U.S. Environmental Protection Agency, and several states have mandated recycling goals that are more rigorous than federal guidelines. In Virginia, landfills were required to reduce the volume of intake 15% by 1993, and 25% by 1995 (Simpson and May, 1990).

A study to determine the feasibility of implementing a yardwaste composting program in Virginia was conducted by Virginia Cooperative Extension (VCE) for the Virginia Dept. of Waste Management (Virginia General Assembly, 1989). A segment of the study focused on the nursery industry and its potential role in producing and using YWC.

Yardwaste, consisting of three types of material—leaves, grass clippings, and brush and prunings—is estimated to comprise an average of 15% to 20% of the municipal solid waste, or 1 million tons, in Virginia (Simpson and May, 1990). Elimination of this material from landfills would allow Virginia to meet a large portion of its 1995 recycling goals. Of the three types of yardwaste, leaves are believed to be the most suitable for municipal composting. Grass clippings are best left on the lawn after mowing or used in backyard composting to avoid the cost of municipal collection and handling. Woody wastes, such as shrub and tree prunings, often are shredded in the collection process and are suitable as mulch.

The tipping fee, or cost assessed by the landfill to receive refuse, varies widely. In Virginia in 1989, this cost was as high as $150 per ton, with a state average of just under $20 per ton (Simpson and May, 1990). In 1993, fees had risen on average to $28 per ton (personal communication, Dept. of Environmental Quality, Richmond, Va.). Fees are projected to rise dramatically in the next few years as landfill space becomes scarcer. Production costs for a ton of finished YWC range from $12 to $20 per ton, and can be recovered by a tipping fee paid to the composting facility. For each ton of incoming yardwaste, ≈1 yd$^3$ of finished compost is generated. A cubic yard of finished compost will have a final weight of ≈0.5 ton (Richard and Ferenz, 1988). Compost typically is sold for $10 to $20 per yd$^3$, depending on quality. As production costs are covered by the tipping fee, the marketing income would be profit.

YWC is a dark, crumbly material with many physical and chemical properties similar to peatmoss that make it suitable for use by the nursery industry as a soil amendment for beds and field-

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