Extended abstract No. 137

HARVESTING OF *SPHAGNUM* BIOMASS AND ITS USE AS A GROWING MEDIUM CONSTITUENT

Olli Reinikainen[1], Juha Korpi[1], Risto Tahvonen[2], Juha Näkkilä[2], Niko Silvan[3], Kaisa Silvan[3]

1) VAPO Oy, Business Development, P.O. Box 22, FI-40101 Jyväskylä, Finland, +358 400 280263, olli.reinikainen@vapo.fi
2) MTT Agrifood Research Finland, Plant Production Research, Horticulture, Toivonlinnantie 518, FI-21500 Piikkiö
3) Finnish Forest Research Institute, Kaironiementie 15,FI-39700 Parkano

SUMMARY

The lack of efficient harvesting technology has restricted the use of *Sphagnum* biomass as a growing medium constituent. Our intention was to develop a mechanical harvesting method for naturally grown *Sphagnum* and ensuring its renewability. Secondly, we wanted to study the efficiency of *Sphagnum* moss as a growing media constituent. We succeeded to mechanically harvest 25 cm thick layers of *Sphagnum* vegetation on the surface of a natural peat bog in winter conditions. This material was dried in a nearby load-bearing area in spring conditions. The follow-up of the regeneration of *Sphagnum* vegetation showed a development of new *Sphagnum* fragments even after the first summer. Environmental impacts are minimal in harvesting. Studies on the growing media use of *Sphagnum* moss qualities showed excellent results with cucumber, tomato and lettuce seedlings compared to white peat and mineral wool.

KEYWORDS: *Sphagnum*, harvesting technology, renewability, growing medium

INTRODUCTION

Mires and peatlands cover one third, i.e. 9,3 million hectares, of Finland’s surface area (Marttila 2011). This gives a huge potential for versatile utilization of peat and peatlands. One of the most widely known uses of peat is its use as a horticultural growing medium constituent. Growing media play a key role in determining the quantity and quality of a crop in greenhouse production. Peat has been a predominant constituent of growing media in professional horticulture for decades. *Sphagnum* peat fulfils best the essential physical, chemical and biological characteristics set for growing media constituents (Schmilewski 2008). High total porosity, divided appropriately between air and water volume, good structure stability and good wettability are the most desirable physical characteristics. Balanced chemical properties play a major role in plant nutrition and the safe biological quality benefits the health development of the crop. The search to find substitutes to peat for various reasons has been active for more than twenty years in universities, institutes and companies. Regardless of this the share of peat as a growing media constituent used in professional horticulture accounts currently for 85 % (Altmann 2008). However, also the peat industry needs to improve the sustainability of its functions. Based on previous experiences with peat moss biomass as a growing medium constituent, we decided to start up a project to develop harvesting technology for renewable *Sphagnum* biomass and to refine it for growing purposes.

Over decades *Sphagnum* farming has been introduced as a promising alternative to produce a useful growing media constituent for horticulture (Gaudig and Joosten 2002; Krebs and Gaudig 2005; Gaudig et al 2008). Especially in Germany and Canada developments in this area of research have been ongoing. It is a good alternative for the restoration of abandoned peat production areas (Quinty and Rochefort 2003; Silvan 2010). A drawback is the long time span from the establishment of a *Sphagnum* plantation to harvesting of biomass. No industrial scale harvesting technology is available, either. Operating effectively with machines on the wet, embedding mire surface is almost impossible. So far, very small volumes of *Sphagnum* biomass have been available as growing media constituents in horticulture. Our intention was to develop harvesting technology for naturally existing *Sphagnum* biomass on suitable mire areas and to ensure vital regrowth of a *Sphagnum* carpet on the same site. Drained peatlands which are not presently suitable for forestry purposes account for almost one million hectares in Finland. This area serves as a large resource for harvesting renewable *Sphagnum* biomass. The suitability of *Sphagnum* moss for growing purposes has been studied for decades. However, practical applications have been merely in orchids growing. Some of the results from growth trials with different horticultural crops have been published e.g. by Jobin et al (2005), Emmel (2008) and Oberpaur et al (2010). According to them, promising results have been obtained with *Sphagnum* moss as such or mixed with peat in horticultural crop production. Besides harvesting technology, the focus of our interest was on the performance of Finnish *Sphagnum* mosses as growing media constituents in professional horticulture.

MATERIALS AND METHODS

Our harvesting development is based on operations in Finnish winter conditions. The steps in harvesting are: selection of a suitable area, preparatory work, actual excavating of lumps of *Sphagnum* vegetation and their transfer to a drying area in winter, drying stage and delivery to further refining in a growing media plant. The harvesting area was a slightly drained peat bog of 5 hectares in western Central Finland. We used an ordinary excavator and tractors with trailer for handling and pallets and cages as drying base. The drying and monitoring of the moisture content took place during spring and early summer. For *Sphagnum* capitula monitoring, systematic monitoring plots of 0.07 m^2 were laid down on the *Sphagnum* harvesting site. *Sphagnum* capitula regeneration follow-up was carried out in August 2011.

Sphagnum biomass was tested in the seedling production of greenhouse cucumber (*Cucumis sativus* L. ´Annica´), tomato (*Lycopersicon esculentum* Miller ´Encore´) and leaf lettuce (*Lactuca sativa* var. *crispa* ´Grand Rapids Ritsa´). Seven growing media were used in the experiment: white peat (Kekkilä White), mineral wool, three *Sphagnum* species separately (*S. fuscum*, *S. magellanicum* and *S. riparium*) and two mixtures of *Sphagnum* species, (natural mixture of *S*. species and manual mixture of *S. fuscum* 33,3 % (v/v), *S. magellanicum* 33,3 % (v/v) and *S. riparium* 33,3 % (v/v). *Sphagnum* biomass was selected from slightly drained, nutrient poor mires.

Sufficiently dry *Sphagnum* lumps were crushed with a chaff-cutter. Crushed *Sphagnum* material was screened with a 20 mm sieve. The physical and chemical properties of white peat and *Sphagnum* materials were determined. Properties monitored were pH, electrical conductivity (EC), particle size distribution and water retention. The pH and nutrient level of *S.*-based substrates were adjusted with fine-grained lime (Nordkalk Oy) and a compound fertilizer (NPK 14-4-20, Kekkilä Oy).

Cucumber, tomato and lettuce seeds were sown on 23.6.2011, 11.7.2011 and 22.7.201. The trial lasted 19, 36 or 18 days, respectively. The plants were cultivated in a greenhouse on an ebb and flow growing table. Cucumber and tomato were sown one seed per 12 cm pot (Combipot 12 BT) or in a mineral wool propagation block (10 x 10 x 7 cm, Grodan Delta). The germination temperature was 24 °C; later on the propagation temperature was 21 °C. The plants were fertilized with a commercial liquid fertilizer, NPK 10-5-31 + trace elements (Superex, Kekkilä), EC 2.5-3.5 dS m^{-1}. For the first two weeks after sowing, the cucumber and tomato plants were watered with a hose. Later the plants were watered daily with a hose or on an ebb and flow table. Four lettuce seeds were sown in a plastic pot (Vefi PR 306), but three seedlings were allowed to grow in a pot. The mineral wool used with lettuce was a cube (36 x 36 x 40 mm, Grodan AO). After seeding, the pots were kept in refrigerated (18 C°) storage for one day. After germination, the heating temperature was 16 °C. The plants were fertilized with a commercial liquid fertilizer (Superex, Kekkilä) using an EC value of 1,9 dS m^{-1}. Lettuce plants were watered with a hose only. The nutrient level and pH of the fertigation solution were similar in all substrates and crops.

The germination of the seeds was monitored. In the end, the fresh and dry weights of the plants were determined. There were seven or eight blocks in a completely randomized block design and each block comprised three plants in each treatment. The dataset was analyzed by using the analysis of variance and estimate statement in the SAS Mixed procedure (Package 9.2, SAS Institute, Cary, NC, USA). White peat was used for comparison.

RESULTS

The mechanical harvesting of *Sphagnum* biomass succeeded well in winter conditions when the ground was frozen. By adjusting the harvesting time so that the frozen layer of mire was 20-25 cm, we could easily loosen and excavate the desired thickness of *Sphagnum* carpet. The excavated lumps were transferred to a carrying ground for drying. The drying took place on pallets or in cages and the moisture content of the lumps was 70-75 % by weight until the end of June in unprotected, natural conditions. Development of new *Sphagnum* capitula was evident during the first summer.

After adding of lime and fertilizer to *Sphagnum*-based media the pH (7.3-7.8) was higher than in white peat (7.0), but the EC was similar as in white peat (2.0 dSm^{-1}). White peat and *Sphagnum*-based media had nearly the same particle size distribution (data not shown). White peat contained more water than *S*.-based substrates (Figure 1) and there was more easily available water in peat than in *Sphagnum* moss media. On the other hand, *S*.-based substrates contained more air than white peat if plants were watered frequently.

In the growth trials, small tomato and lettuce seeds did not germinate in *S. riparium growing media* as fast as in other media (data not shown) .Wet, fine *S. riparium* particles aggregated, which allowed small seeds to sink too deep into the material, hindering germination Cucumber and tomato plants grew in white peat as well as in mineral wool (Table 1), but slower in *Sphagnum riparium* than in white peat. Cucumber and tomato grew faster in *S.*

fuscum, *S. magellanicum* and both mixtures of *S.* species than in white peat. Lettuce grew slower in mineral wool than in white peat and faster in all *Sphagnum*-based media than in white peat.

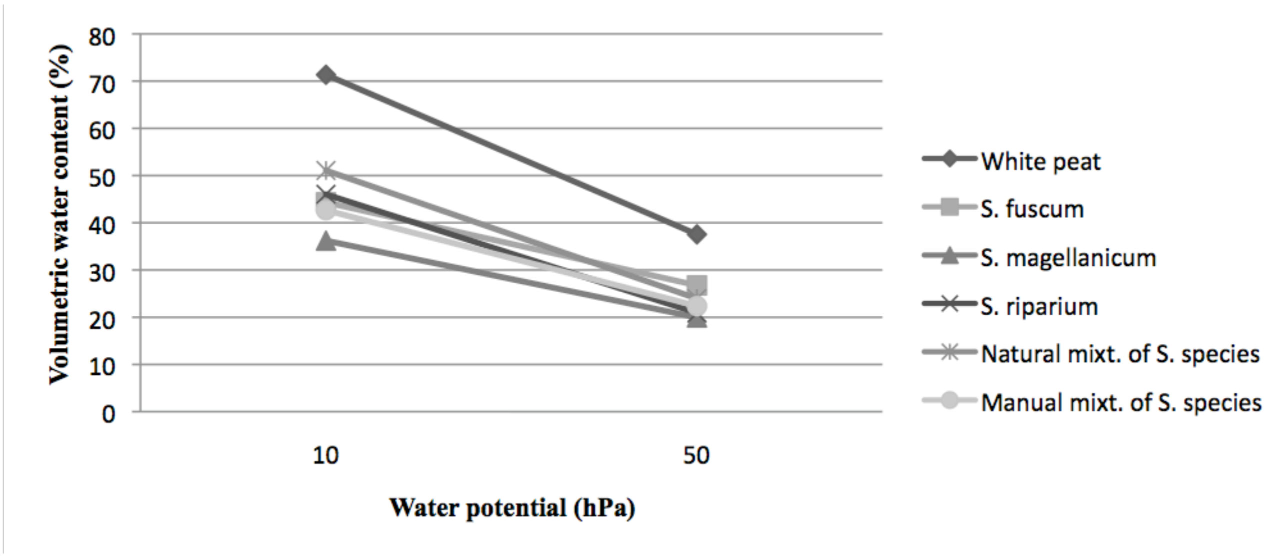

Figure 1. Water retention curves of white peat and *Sphagnum*-based constituents

Table 1. Fresh weights of cucumber, tomato and lettuce seedlings by different growing media. In each column, the values followed by the same letter do not differ significantly, P=0.05.

Substrate	Cucumber	Tomato	Lettuce
	Fresh weight g plant^{-1} or g seedling^{-1}		
White peat	79b	125b	5.8b
Mineral wool	80b	136b	3.9a
Sphagnum fuscum	100c	184c	8.1c
S. magellanicum	99c	170c	7.8c
S. riparium	71a	69a	7.3c
Natural mixt. of *Sphagnum* spp.	98c	182c	7.8c
Manual mixt. of *Sphagnum* spp.	100c	183c	8.3c

DISCUSSION AND CONCLUSIONS

Operations with machines succeeded well on mire surface in winter if the right preparatory work had been done. The drying of the *Sphagnum* lumps took place fairly slow under natural weather conditions in 2011. This part of the production chain must be developed further. According to earlier results, light *Sphagnum* biomass harvesting extended down to a depth of about 25 cm will cause only very short-term effects (under 5 years) on *Sphagnum* carpet coverage and carbon sequestration. Additionally, *Sphagnum* biomass harvesting has not been observed to cause detrimental effects on watercourses (Silvan, 2008). We could record development of new *Sphagnum* fragments even during the first summer after excavation. This is a clear indication that the re-establishment of a new *Sphagnum* carpet starts shortly after harvesting. This is in line with earlier studies carried out in Finland (Silvan 2010). Minor environmental impacts of this harvesting method and utilization of renewable growing media constituents are big advantages. The target of harvesting 500, 000 m^3 of *Sphagnum* biomass annually only requires 300 hectares. The total need for production area annually for this amount by renewable means during 30 years rotation time is only 9000 hectares. This is a very insignificant area compared to the unsuitable forestry peatland area in Finland, about one million hectares.

The physical and chemical characteristics of *Sphagnum* biomass maintain favourable conditions for root activity and plant growth. Additionally, the structure stability of *Sphagnum* mosses allows us to expect very good growth performance also in long term cultivation. There are however differences between different *Sphagnum* species. *Sphagnum fuscum*, *S. magellanicum* and mixtures of *S.* species are promising constituents in transplant production. *S. riparium* is not a suitable material as such in transplant production, but it can be used in mixtures. The availability of this practical harvesting technology allows large-scale utilization of renewable *Sphagnum* biomass from the extensive Finnish mire resources.

REFERENCES

Altmann, M. (2008). Socio-economic impact of the peat and growing media industry on horticulture in the EU. *Study commissioned by EPAGMA*

Emmel, M. (2008). Growing ornamental plants in *Sphagnum* biomass. *Acta Horticulturae 779, ISHS Symposium on growing media, September 4.-10.2005,* Angers, France.

Gaudig, G. & H. Joosten. (2002). Peat moss (*Sphagnum*) as a renewable resource – an alternative to *Sphagnum* peat in horticulture? *Pp. 117-125 in G. Schmilewski and L. Rochefort, eds. Peat in horticulture – quality and environmental challenges. Proceeding of the 2002 International Peat Society Symposium, Pärnu, Estonia.* International Peat Society, Jyväskylä, Finland.

Gaudig, G., Joosten, H. and Kamermann, D.(2008). Growing Growing Media: Promises of *Sphagnum* Biomass. *Acta Horticulturae 779, ISHS Symposium on Growing Media, 4-10 September, 2005,* Angers, France.

Jobin, P., Caron.J., L. Rochefort & B. Dansereau.(2008). Developing new substrates with *Sphagnum* fibres. Acta Horticulturae 779, *ISHS Symposium on Growing Media, 4-10 September, 2005,* Angers, France.

Krebs, M. and Gaudig, G. (2005). Torfmoos (*Sphagnum)* als nachwachsender Rohstoff - Untersuchungen zur Maximierung der Produktivität von *Sphagnum* papillosum im Regendurchströmungsmoor Ispani 2 (Georgien). *Telma **35**, 171-189.*

Marttila, V. (2011). A Proposal for a National Strategy for sustainable and responsible use and protection of mires and peatlands. Unofficial translation of the Finnish summary of the Strategy. *Peatlands International 1/2011: 12-15.*

Oberpaur, C., Puebla, V., Vaccarezza, F., and Arévalo, M.,E. (2010). Preliminary substrate mixtures including peat moss (*Sphagnum magellanicum*) for vegetable crop nurseries. *Ciencia e Investigació Agraria*

Quinty, F. and Rochefort, L. (2003). Peatland Restoration Guide, second edition. *Canadian Sphagnum Peat Moss Association and New Brunswick Department of Natural Resources and Energy, Québec.*

Schmilewski, G. (2008). The role of peat in assuring the quality of growing media. *Mires and Peat*, Volume 3 (2008).

Silvan, N. (2008). *Sphagnum* biomass production in cut-away peatlands as an after-use alternative. In: Riitta Korhonen, Leila Korpela and Sakari Sarkkola (eds.). *Finland-Fenland.* pp. 230-233.

Silvan, N. (2010). Sphagnum farming – a quick restoration for cut-away peatlands. *Peatlands International* 1/2010: 24-25.