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SPHAGNUM PROPAGULES FROM SPORES: FIRST EXPERIENCES

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SUMMARY

In order to test the possibility of large scale generative *Sphagnum* propagation, growth from spores of the species *Sphagnum fimbriatum, S. palustre* and *S. papillosum* was tested. Trials included a range of different substrates and two nutrient levels where moss development was monitored for ten weeks under controlled conditions. Of the two nutrient regimes tested the equivalent to 20-fold concentrated rain water yielded significantly higher percentage cover of all three *Sphagnum* species. Substrate tests resulted in adequate *Sphagnum* growth on sterilised peat, sterilised and ground sterilised *Sphagnum* biomass as well as nutrient agar. A trial to disperse *Sphagnum* spores directly onto field experimental sites was unsuccessful.

KEYWORDS: *Sphagnum* farming, propagules, spores, generative propagation

INTRODUCTION

Sphagnum farming is explored as a possibility to mass-produce *Sphagnum* biomass as a substrate for the horticultural industry. A challenge is to obtain sufficient propagules for initial large scale *Sphagnum* establishment. In Germany, natural *Sphagnum* vegetation is legally protected and hence gathering of mosses for the purpose of obtaining material for commercial proliferation not an option. This study investigates the potential of *Sphagnum* spores as a basis for large scale commercial *Sphagnum* establishment. The advantage of using *Sphagnum* spores instead of moss fragments collected outdoors is that the seeding material is clean of any contamination by other plant or animal species, thus free from alien species and meets the requirements of the horticultural industry of a uniform substrate.

MATERIALS AND METHODS

The species in the trials included *Sphagnum fimbriatum, S. palustre* and *S. papillosum*, which were tested involving initially two nutrient levels (R1= equivalent to rainwater, R20 = equivalent to 20-fold concentrated rainwater) following Rudolph *et al.* (1988). The range of substrates in the experiments include sterilised peat, dried (80°C, 24h) and grounded *Sphagnum* biomass, dried (80°C, 24h), grounded and sterilised (1 h in pressure cooker) *Sphagnum* biomass, polypropylene fleece, filtering paper, straw mat, STOCKOSORB® gel and nutrient agar. All trials on different substrates were accompanied by control samples on sterilised peat. Spore capsules were gathered from *Sphagnum* vegetation from earlier field experimental trials in Lower Saxony (Gaudig *et al*., this volume). *S. fimbriatum* was tested on

all substrates; the other two species only on selected substrates because of limited spore material availability. 3000 spores per cm² were dispersed onto the different substrates in petri dishes with three replications per variant. Spore numbers were estimated by measuring the size of spore capsules and 20 spores from each capsule (Sundberg and Rydin, 1998). The petri dishes were covered with lids but not closed airtight (Sundberg and Rydin, 2002). The samples were fertilised weekly with nutrient solutions R1 and R20. The trial was commenced under controlled conditions at 20°C with fourteen hours of daily lighting and ten hours of darkness. After ten weeks the petri dishes were placed in a greenhouse and covered with larger lids to allow further growth in height. The plantlets were gradually transplanted into seed trays, covered with lids and cultivated for 4 months in the greenhouse (April-August 2011). In August 2011 the young mosses were transplanted directly onto peat and onto floating mats in the field site, where their further outdoor development was monitored. Additional field experiments were conducted outdoors to test whether it is possible to accelerate *Sphagnum* establishment and to minimize working costs, by directly dispersing spores onto field experimental sites. The substrates were floating mats, peat and polypropylene fleece under protective shading.

Statistical analysis and figures were made with the software R (R Development Core Team 2009). Differences between sites were analysed with the non parametric Kruskal Wallis test and a multiple comparison test after Siegel & Castellan (1988, R package pgirmess, Giraudoux, 2010).

RESULTS

After spore germination and formation of protonemata, plantlets of all three species developed after six weeks on sterilised peat, nutrient agar and sterilised *Sphagnum* biomass. On these substrates small, dense growing mosses developed within 10 weeks with highest covers at sterilised *Sphagnum* biomass (Fig. 1A). The cultivation on unsterilised *Sphagnum* biomass failed as it showed a strong overgrowth with algae and mould leading to the delayed formation of only few protonemata and plantlets. On polypropylene fleece, filtering paper or STOCKOSORB® hardly any protonemata developed and no plantlets at all grew within the investigation period.

S. fimbriatum shows at the nutrient level R1 highest cover of plantlets after 10 weeks, but still less than all *Sphagnum* species at the nutrient level R20 (Fig. 1B).
In contrast, under nutrient regime R1 the number of plantlets was significantly higher than under R20 (Fig. 2). *S. fimbriatum* developed more plantlets than the other two species (Fig. 2).

Into the field transplanted *Sphagnum* plantlets show successful establishment on peat by the development of numerous new capitula after three months.
The trials to grow *Sphagnum* from spores directly on field experimental sites did not result in viable growth of protonemata and plantlets.

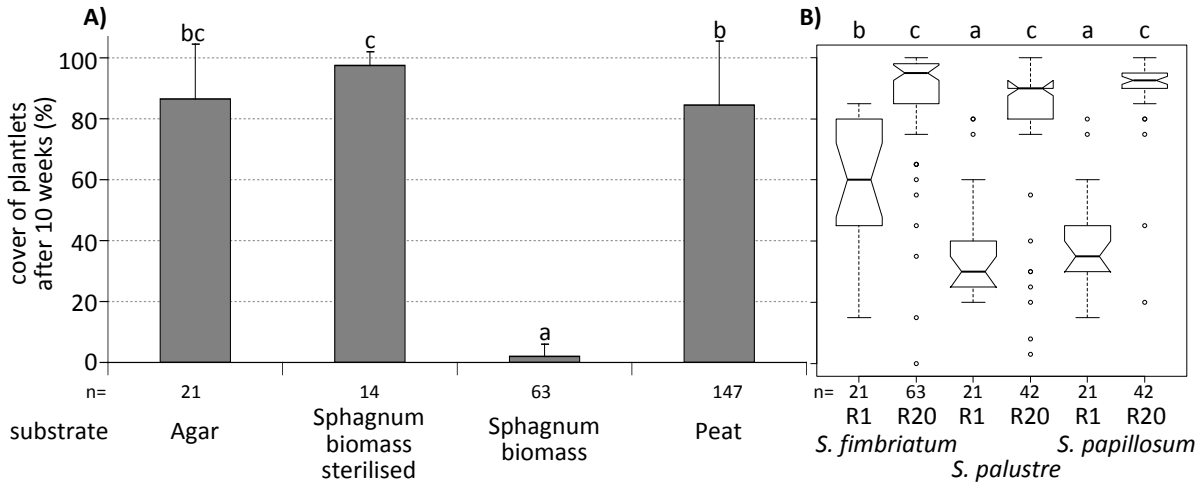

Fig. 1. Percentage cover of *Sphagnum* plantlets with regard to A) different tested substrates (nutrient level R20); represented by the mean (grey bars) and its standard deviation and B) of the different peat moss species and nutrient levels (R1= equivalent to rainwater, R20 = equivalent to 20fold concentrated rainwater) on sterilised peat in Petri dishes 10 weeks after spore spreading, n indicates the number of measurements. Differences were tested within each box separately (Kruskal Wallis and multiple comparison test). Values with different letters differ significantly ($P \leq 0.05$).

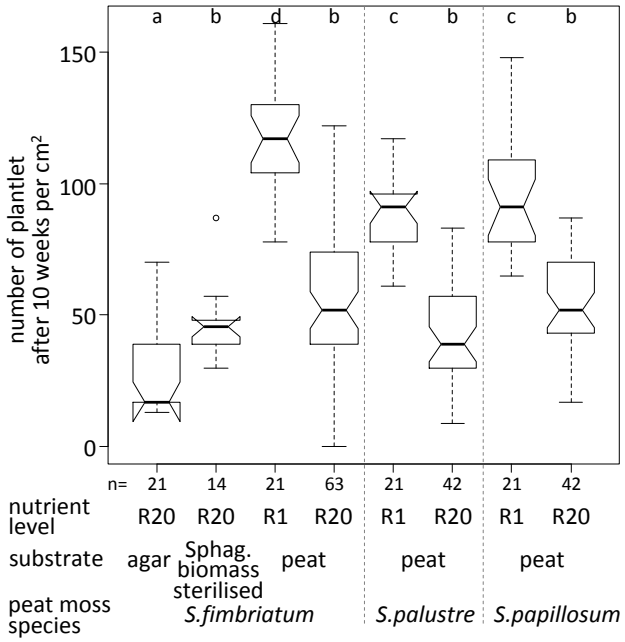

Fig. 2. Number of *Sphagnum* plantlets of the different peat moss species at the different substrates and nutrient levels in petri dishes 10 weeks after spore spreading. Differences were tested within each box separately (Kruskal Wallis and multiple comparison test). Values with different letters differ significantly ($P \leq 0.05$).

DISCUSSION

Sphagnum plantlets were successfully cultivated from spores within the 10 weeks study period under controlled conditions in the greenhouse (Fig. 1 and 2). The trials demonstrated that nutrient regime 20-fold equivalent of rain water (R 20) promotes *Sphagnum* growth better than nutrient regime of rain water (R1) (Fig. 1B). This is confirmed by other studies

indicating an absent spore germination by P-deficiency (Boatman and Lark, 1971; Rydin, 1986).
The nutrient level affects the robustness of the plantlets. While their coverage is high at R20, their number is significantly lower compared to R1, especially at nutrient agar. This indicates that R1 plantlets are smaller and more fragile, less suitable for the installation of a *Sphagnum* cultivation field.
Sterilisation of *Sphagnum* biomass as substrate seems essential as excessive growth of algae and fungi inhibits the growth of *Sphagnum*
The unsuccessful trials to grow *Sphagnum* from spores directly in the field might be ascribed to unfavourable weather conditions during the summer of 2011 which was extremely wet and the spores could have been washed away by the high water level. Other reasons could be the shorter time span of the trial (3 months in comparison to the 4.5 months conducted by Sundberg and Rydin, 2002).

CONCLUSIONS

The fast and high rate to germinate *Sphagnum* plantlets from spores under controlled conditions in the greenhouse is very effective and seems to produce faster more robust plantlets than by vegetative propagation, at least at a high nutrient level (R20).

It was proven that *Sphagnum* plantlets grown from spores are suitable as propagules for Sphagnum farming (the mosses grew well on the field experimental sites)

The efficiency of the production of *Sphagnum* plantlets needs still to be improved; testing of further *Sphagnum* species with reduced density on further substrates.

As the initial trial to disperse spores directly onto field experimental sites, further trials are required in order to minimise steps in the production chain and to incease cost effectiveness.

The production of seeding material via generative propagation is very promising and has the advantage that storage is easier.

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REFERENCES

Boatman, D.J. and Lark, P.M. (1971). Inorganic nutrition of the protonemata of *Sphagnum papillosum* Lindb., *S. magellanicum* Brid. and *S. cuspidatum* Erh. *New Phytologist*, 70, 1053 – 1059.

Gaudig, G., Gahlert, F., Krebs, M., Prager, A., Schulz, J., Wichmann, S. and Joosten, H. (2012). *Sphagnum* farming in Germany – 10 years on the road to sustainable growing media. *This volume*.

Giraudoux, P. (2010). pgirmess: Data analysis in ecology. R package version 1.4.9. http://CRAN.R-project.org/package=pgirmess

Popov, S.Y. (2000). After fire successions of peat mosses in Central Russia. *Botanicheskii Zhurnal*, 85, 89-96.

R Development Core Team (2009). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org.

Rudolph, H., Kirchhoff, M. and Gliesmann, S. (1988). *Sphagnum* culture techniques. *Proc. Bryol. Meth. Worksphop, Mainz*. 29-34.

Rydin, H. (1986). Competition and niche separation in *Sphagnum*. *Canadian Journal of Botany*, 64, 1817 – 1824.

Siegel, S. and Castellan, N. J. Jr. (1988). *Nonparametric Statistics for the Behavioral Sciences.* McGrawHill, New York.

Sundberg S and Rydin H (1998). Spore number in *Sphagnum* and its dependence on spore and capsule size. *J. of Bryology* 20(1):1-16.

Sundberg S and Rydin H (2002). Habitat requirements for establishment of *Sphagnum* from spores. *J. of Ecology* 90: 268-278.