Perspectives of *sphagnum* farming in the Kolkheti lowland (Georgia): first results

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Summary

The cultivation of *Sphagnum* biomass as an alternative to the extraction of fossil white peat enables the long term supply of raw material for high quality substrates in professional horticulture. The warm temperate and wet climate in the Kolkheti lowland (Georgia) enables *Sphagnum* growth all year. In addition to degraded peatlands *Sphagnum* farming seems even possible on mineral soils that are currently lying fallow or used as low-productive arable land.

Paper reports on first experiments with *Sphagnum* establishment on degraded peatland and mineral soil in the Kolkheti lowland.

Key index words: *Sphagnum* farming, Kolkheti lowland, growing media, renewable resource

Introduction

Sphagnum biomass, cultivated on rewetted degraded bogs ('paludiculture'), could be a promising alternative to white peat for a wide range of horticultural applications (Gaudig 2008). Potential cultivation areas and optimal growth conditions for commercial *Sphagnum* farming are currently being investigated in Germany (Gaudig and Joosten 2007).

Regions with a high natural *Sphagnum* productivity and regeneration ability like the Kolkheti lowland of Western Georgia (Transcaucasia) may provide an excellent habitat for *Sphagnum* farming (Krebs and Gaudig 2005, Haberl *et al.* 2007). The warm temperate and wet climate of Kolkheti – with a mean annual temperature of 14,1°C, a high and evenly distributed annual precipitation of 1500 mm (North) to 2500 mm (South), a high humidity of 80 % (meteorological station Poti) and rare frost events (Joosten *et al.* 2003) – enables year-round peat moss growth.

As a result of peatland improvement and peat excavation since the 1930s (Potskhishvili *et al.* 1997), large parts of the Kolkheti peatlands are degraded. The altered site conditions hamper the natural reestablishment of peat mosses (cf. Money 1995, Price and Whitehead 2001, Kennedy and Price 2005). It is, however, expected that the optimal climatic setting may largely mitigate these conditions and that the sole spreading of *Sphagnum* fragments and straw mulch (Quinty and Rochefort 2003) will suffice to stimulate *Sphagnum* establishment, even without rewetting.

This paper reports on first field experiments to establish *Sphagnum* on degraded peatlands and adjacent fallow and low-productive mineral soils in the Kolkheti lowland.

Materials and Methods

On five sites with different characteristics (Table 1) the vegetation and the upper 5 cm of the surface peat or soil layer were removed to prepare similar starting conditions. On the bare peat or mineral soil, fragments from 10 cm long mosses of pure *Sphagnum papillosum* and *S. palustre* or a mixture of 53% *S. papillosum,* 30% *S. imbricatum* and 17% *S. rubellum* were spread manually in a density of 1 kg fresh biomass per m^2 resulting in a cover of approximately 70%. Three cover treatments with six replicates were tested including mosses 1) without hay, 2) covered with hay, and 3) bedded on and covered with hay (each 150 g/m^2) (cf. Johnson et al. 2000). The less suitable hay was used because straw was not available at the time of installation.

After half a year the cover of living peat mosses, number of living capitula (peat moss heads) and the growth height of living peat mosses were measured at three quadrats (13.5 x 13.5 cm) per treatment (2 x 0.5 m) and tested against various parameters using a three way factorial ANOVA (R Development Core Team 2004).

Results

After half a year most applied moss fragments died but also new plants had established. The number of living capitula and the cover of living mosses of *S. palustre* were significantly higher than from the other species, with a maximum of 1.15 capitula cm^{-2} and 35% cover. The moss height of different species was similar, on average below 0.5 cm with extremes up to 3.1 cm (Figure 1). Straw application did not affect moss height, but hay at the bottom and top of the mosses caused significantly less moss cover and number of capitula. Peat mosses grow significantly better on mineral soil than on degraded peatland.

Discussion

The moss fragments were spread in April, i.e. in the beginning of the driest period of the year. An unusually dry 2007 followed: (precipitation in May 2007: 46 mm compared to an average May: 82 mm, mean from 1961-

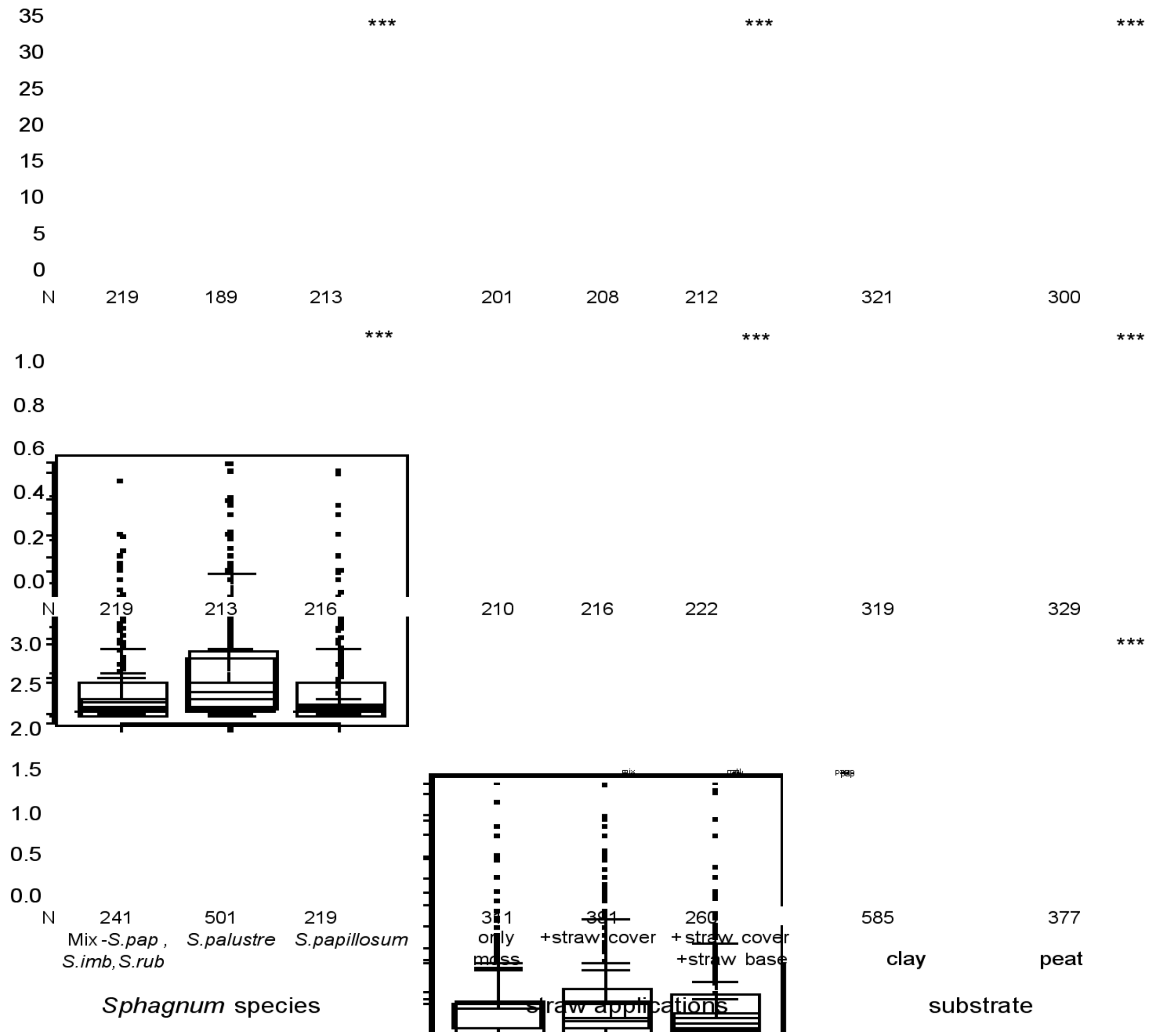

Figure 1. Total cover of living peat mosses (%), number of living capitula (cm^{-2}) and growth height of newly grown peat mosses (cm) of living peat mosses for different Sphagnum species, 'straw' applications and substrates, six months after the spreading of the moss fragments in April 2007. *** level of significance (p < 0,001).

1990, Kaffke unpubl.) and directly after the peat moss application it hardly rained. This probably caused the dying of the peat moss, which cannot control its water loss and is thus dependent on a permanent supply for growth (Tuittila *et al.* 2003), in particular during the initial phase of the peat moss establishment (Kennedy and Price 2005). Due to little precipitation water supply was not sufficient. Furthermore the water levels at all experimental sites were below the hydrological threshold for *Sphagnum* establishment (-24.9±13.3 cm; Price and Whitehead 2001) (Table 1).

The surviving mosses were probably facilitated in their growth by vascular plants – with an average cover of 70% – causing a humid microclimate (cf. Price and Whitehead 2001, Quinty and Rochefort 2003). Differences in species, height and morphology between the vegetation of the peatland sites and that of the mineral sites (Table 1) are probably responsible for differences in moss growth. The slender graminaceous species and *Polygonum spp.* or *Hydrocotyle ramiflora* on mineral soils improve hydro-microclimatic conditions (Rochefort 2000). Additionally the vegetation at the mineral soil starts to grow earlier, so that the peat mosses were more enhanced by the positive microclimate. Because the vascular plants probably 'neutralized' the microclimate effect of hay only small differences in moss growth were found. In addition, the applied straw substitute hay was compact and probably did not create a similar positive microclimate as straw (cf. Rochefort 2000).

S. palustre is the most appropriate of all tested *Sphagnum* species for establishment on degraded peatlands and mineral soils in the Kolkheti lowland. This is probably due to its wide ecological amplitude (Gaudig 2001). It is also the most common species recolonizing degraded and cut-over peatland sites in the Kolkheti lowland spontaneously (own observations). A species mixture does not support the establishment of *S. papillosum*.

Table 1. Characteristics of the experimental sites. pH and EC values of the pore water, (1) N in mg N $100mg_{soil}^{-1}$, (2) P in mg P_2O_5 100 mg_{soil}^{-1}, (3) K in mg K_2O_2 100 mg_{soil}^{-1}, (4) below soil/peat surface ± standard deviation

site		vegetation	substrate	pH	EC [µS]	N(1)	P(2)	K(3)	water level [cm](4)
1	degraded peatland	*Pteridium aquilinum, Rubus* species	peat	4.20	222	2.24	-	-	-45 ±1.1
2			peat/ clay	5.05	43	0.54	1.51	7.27	-73 ±11.6
3		*Polygonum thunbergii, Juncus effusus, Hydrocotyle ramiflora, Paspalum paspaloides, Ambrosia artemisifolia, Bidens frondosa*	peat	5.18	129	0.85	2.35	7.83	-35 ±2.5
4	alluvial soil		clay	5.91	64	0.24	0.62	7.87	-51 ±8.9
5		*Polygonum thunbergii, Bidens frondosa, Juncus effusus, Hydrocotyle ramiflora, Echinogloea grus-galli*	clay	5.91	215	0.91	2.17	14.85	-27 ±3.2

Conclusion/Outlook

Moist conditions during dry periods have to be secured by vascular plant species functioning as companion (nursing) plants, by straw application (but using coarser material than hay), and by rewetting. The growth of peat mosses is expected to be better in wetter periods without extremes. Therefore new experiments with the same treatments were installed in autumn 2007, also to test the effect of the colder winter half year on initial establishment. Peat moss establishment seems to be possible also on mineral soils. This opens new possible areas and enlarges the perspectives of *Sphagnum* farming.

Further research on *Sphagnum* establishment, productivity and regeneration in the Kolkheti lowland in the next two years will enable the identification of suitable *Sphagnum* farming conditions and areas in this region. *Sphagnum* farming around the natural peatlands could work as a buffer, especially for the protected areas, releasing the pressure on the conservation areas by creating economic carriers and a sustainable alternative for income generation in the rural Kolkheti lowland without negatively affecting the unique Kolkheti mires.

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