Report of Short Term Scientific Mission (STSM)

"Growth of fast-growing coppice species in two environmental conditions at juvenile age"

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Introduction

Successful establishment of both traditional and short rotation coppice is crucial for profitable outcome. Coppice establishment requires more intense management than traditional forestry – soil preparation should be done properly, as well as weeding should be carried out more often, several times per year during the first years after establishment. Also fencing adds additional expenses. Establishment costs might be reduced if proper stocking type is used. High survival prevents need for complementary planting, and promotes higher yield from the first rotation, as well as in the following rotations. There are not only price differences between stock types but also different starting conditions. Longer cuttings could form shoots higher, thus they could exceed height of ground vegetation faster, and in turn lower costs of weeding. Also rooted stock type could have advantage in comparison to cuttings due to faster root development, and that could be important if following weeks after planting has low precipitation.

Differences during the establishment could lead to differences in height growth. It could be expected that trees emerging from longer cuttings are higher due to higher start of the leading shoot. However it should be tested if such differences occur and if they are remaining during the following seasons. For instance, if the growth rate of trees that have emerged from 20 and 40 cm long cuttings is similar, the absolute difference of 20 cm after three growing seasons is negligible. Thus, costs of planting material could be reduced by half if shorter cuttings are used. However, other aspects, such as survival and times of required weeding should be taken into consideration.

Under different environmental conditions and prices of applied management measures, stock types might show different results. Therefore, to increase knowledge of performance of different stocking types, survival and height growth of five stocking types of several clones was compared in three sites in Denmark and one site in Latvia,

Purpose

The main aim of this mission was to increase the knowledge of establishment and growth of the fast-growing coppice species under temperate and hemi-boreal conditions at juvenile age.

1. Poplar clone and stock type trials

Data collection was done in three sites in Denmark – Års, Stoholm and Bregentved (Fig. 1), and in one site in Latvia, near Skrīveri (56°39′ N, 25°7′ E).

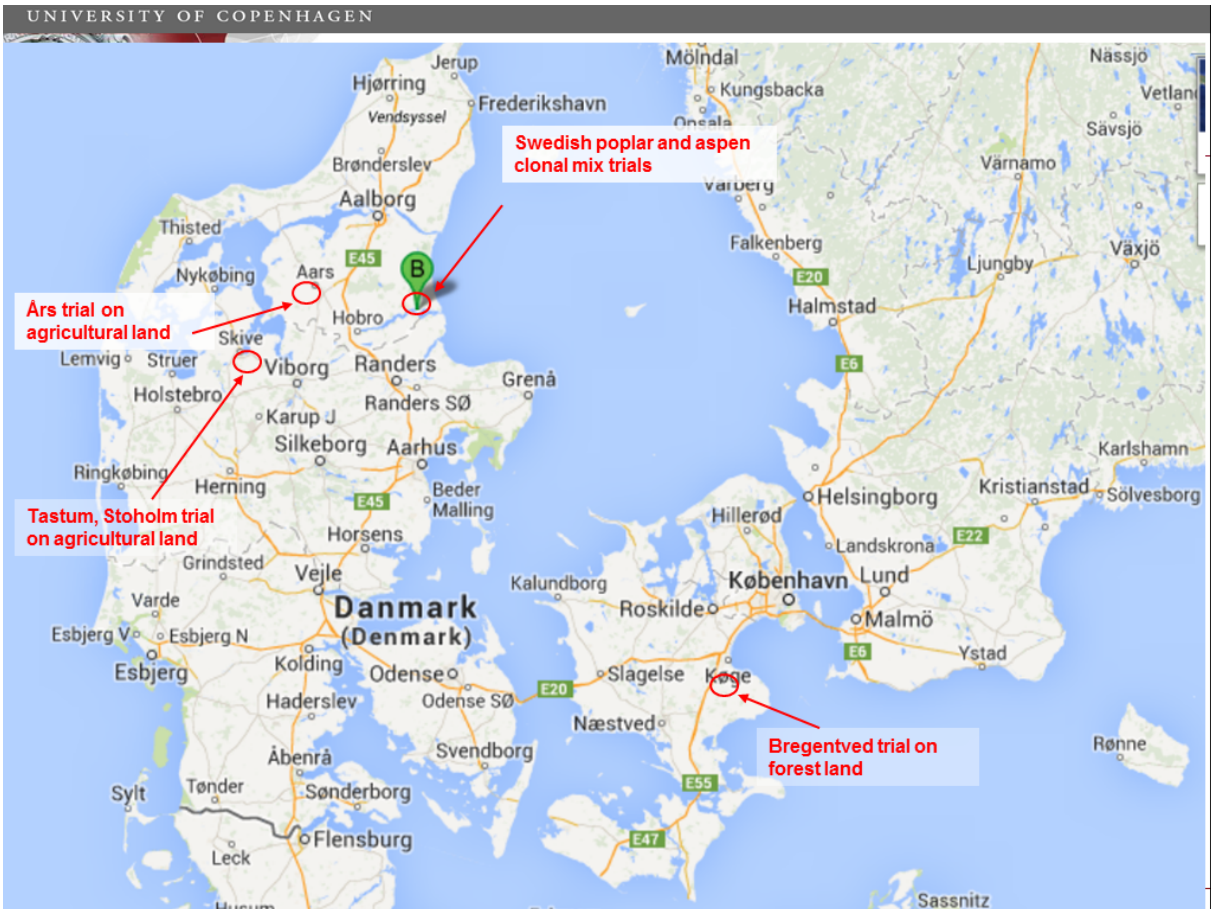


Figure 1. Screen-shot of location of studied sites, map provided by host Palle Madsen.

During STSM we also visited clonal trial of Swedish hybrid aspen and poplar clone mix (Lounkær Forest District; Fig. 1). In total, clonal trial contains 30 clones of hybrid aspen and 15 poplar clones from Sweden. The trial was established in 2012, planting density 3 × 3 m. The stocking type for hybrid aspen was herbaceous root sprout cuttings, and containerised cuttings for poplars. In Denmark, three such trials have been established: two on forest land

and one on agricultural land. The hybrid aspen show higher height growth on the forest sites but poplars – on agricultural land.

The same poplar clone mix is used to establish experimental trials in 2010 in Sweden (several sites) and in 2011 in Latvia, near Skrīveri (the same site where measurements of AF2, AF6, AF7 and AF8 clones were done). Although no measurements were done in visited site during the STSM, it could be of interest to compare growth of this clone mix in all three countries – Sweden, Denmark and Latvia, thus representing three environmental conditions – boreal, temperate and hemiboreal, respectively. Such collaboration between these countries would provide knowledge about differences between clones not only regarding growth, but also resistance to environment, i.e. frost and drought.

1.1. Overview of collected data

1) Års, Denmark

The trial was established in June 2014 on agricultural land to compare different stock type of poplar clones AF2, AF6, AF7, AF8, AF13, AF34 and OP42. Five stock types were used: 22 cm, 40 cm and 175 cm cuttings (the latter was used only for clone AF2), barerooted and containerised cuttings. In each plot, 60 trees were planted in density 1.33 × 3 m. Height of the highest living bud was measured for each tree, and survival was assessed after the second growing season.

2) Stoholm, Denmark

The trial was established in spring 2013 on agricultural land (fertilized before the trial was established, i.e. while used for agricultural crop production). Only clones OP42 and AF8 were measured. Used stock types were 22 cm (only for clone AF8), 40 cm cuttings, and barerooted cuttings. In each plot 100 trees were planted in density 2 × 2 m. Tree height was measured for 12 trees per plot, and survival was assessed after the third growing season.

3) Bregentved, Denmark

The trial was established in spring 2013 on forest land. Used clones: OP42 and AF2. Five stock types were planted: 22 cm, 40 cm and 175 cm cuttings (the latter only for clone AF2), barerooted and containerised cuttings. In each plot 30 trees were planted in density 1.5 × 3 m. Tree height was measured for 12 trees per plot, and survival was assessed after the third growing season.

4) Skrīveri, Latvia

The trial was established in spring 2011 on agricultural land. The clones planted in mono-clonal row-plots on flat area with similar growing conditions. The distance between the rows 2.2 m, between the trees within the row 0.7 m. Height of clones AF2, AF6, AF7 and AF8 was measured after the second and third growing season. Survival was assessed after the first growing season.

2. Results based on collected data

2.1. Survival

Survival of trees was determined in each plot, but due to low number of plots within each group, only ranges of survival (Tab. 1) and mean values (Tab. 2) are given.

Table 1. Range of survival (%) of plots according to trial, clone and stock type.

Trial	*Clone*	*Stock type*					
		20 cm	*22 cm*	*40 cm*	*barerooted*	*containerized*	*175 cm*
Års (DK)	AF13		2–47	7–52			
	AF2		0–10	18–47	12–37		3–53
	AF34		0–37	0–23			
	AF6		0–17	2–63			
	AF7		0–27	3–70			
	AF8		0–58	13–65			
	OP42		5–82	47–90	68–88	53–90	
Bregentved (DK)	AF2		53–97	10–87	87–97		77–100
	OP42		7–10	27–100	33–80	20–50	
Stoholm (DK)	AF8		68–83	80–100	100–100		
	OP42			85–99	100–100		
Skrīveri (LV)	AF2	56–79					
	AF6	89–90					
	AF7	65–85					
	AF8	56–92					

Table 2. Mean survival (%) of plots according to trial, clone and stock type.

Trial	*Clone*	*Stock type*					
		20 cm	*22 cm*	*40 cm*	*barerooted*	*containerized*	*175 cm*
Års (DK)	AF13		19	24			
	AF2		4	28	20		28
	AF34		12	10			
	AF6		10	27			
	AF7		9	30			
	AF8		34	36			
	OP42		42	63	76	72	
Bregentved (DK)	AF2		76	56	92		91
	OP42		8	79	53	41	
Stoholm (DK)	AF8		76	90	100		
	OP42			90	100		
Skrīveri (LV)	AF2	70					
	AF6	89					
	AF7	78					
	AF8	72					

High variance of survival was found within same stock type and clone (Tab. 1). For instance, survival of 22 cm cuttings of clone OP42 between plots varied from 5 to 82% in the same trial. Also differences between trials could be noticed. Overall, survival of all stock types in Års was lower than in the other trials (Tab. 2). In this trial clone OP42 of all stock types had generally higher survival than the other clones. Regardless of the poor survival of 22 cm cuttings in Års, clones AF2 (Bregentved) and AF8 (Stoholm) had similar survival to 20 cm cuttings of AF clones in Skrīveri.

2.2. Height

Tree height showed significant differences (Analysis of variance ($\alpha = 0.05$); all calculations done in R 3.0.2.) both between different stock types and clones. Due to differences of growing conditions and applied treatments, all trials were analysed separately.

Bregentved

Significant differences were found between stock types of both clones. The best height growth of clone OP42 was observed for 40 cm cuttings, which significantly (all $P < 0.01$) exceeded trees of the other stock types (Fig. 2, Tab. 3). Growth of the other stock types was mutually similar ($P > 0.05$), with the exception of containerised cuttings which were significantly ($P = 0.01$) lower than barerooted cuttings. High poles (175 cm cuttings) of clone AF2 significantly (all $P < 0.001$) exceeded trees which emerged from the other stock types. Also barerooted cuttings exceeded 22 cm ($P = 0.03$) and 40 cm ($P < 0.01$) cuttings, although differences of mean height were not large.

Differences between clones were analysed for stock types, which were common for both clones, i.e. 22 cm, 40 cm and barerooted cuttings. Within all stock types clone OP42 was significantly higher ($p=0.003$, $p<0.001$ and $p=0.005$, respectively) than clone AF2.

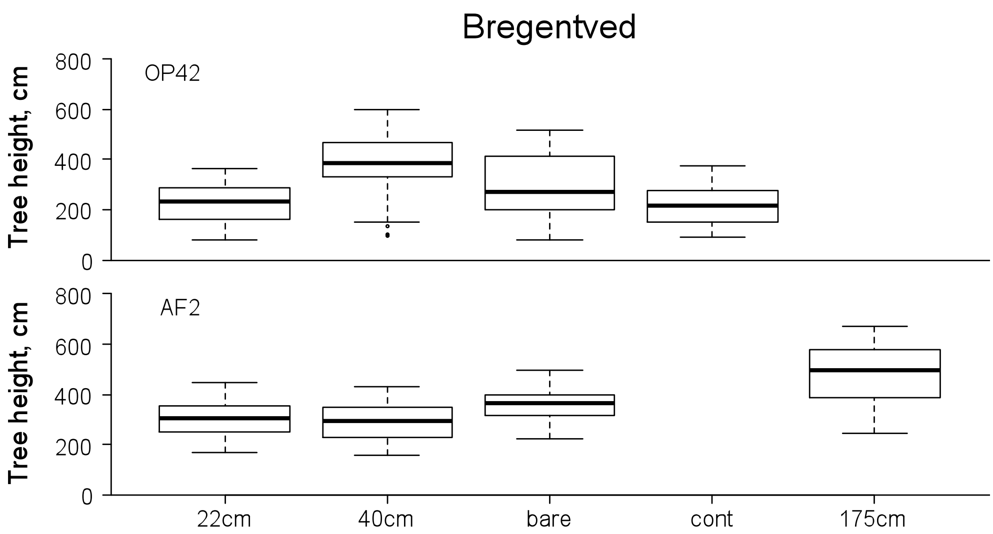


Figure 2. Tree height according to clone and stock type in Bregentved.

Table 3. Mean height (cm ±CI) of plots according to trial, clone, stock type and age.

2-year-old

Trial	*Clone*	*Stock type*					
		20 cm	*22 cm*	*40 cm*	*barerooted*	*containerized*	*175 cm*
Års (DK)	AF13		50.6±5.24	68±4.83			
	AF2		54.4±21.34	67.1±6.84	104.6±16.96		190.9 ±14.63
	AF34		45.6±6.64	51.6±7.00			
	AF6		50.6±6.37	52±4.33			
	AF7		52.1±9.85	64.9±4.22			
	AF8		55.8±5.07	52.5±4.33			
	OP42		63.4±4.86	73.2±3.8	102.2±6.54	65.2±5.18	
Skrīveri (LV)	AF2	103.6±7.45					
	AF6	159.5±10.54					
	AF7	118.6±3.93					
	AF8	110.1±2.94					

3-year-old

Trial	*Clone*	*Stock type*					
		20 cm	*22 cm*	*40 cm*	*barerooted*	*containerized*	*175 cm*
Bregentved (DK)	AF2		302.5±22.24	287.3±23.93	359.1±22.46		478.1 ±33.71
	OP42		223.5±65.14	372.9±37.19	291.7±37.18	218.6±22.10	
Stoholm (DK)	AF8		306.3±27.39	300.3±28.46	332.3±16.97		
	OP42			487.5±39.33	528.5±24.15		
Skrīveri (LV)	AF2	205.4±4.41					
	AF6	266.9±15.49					
	AF7	195.5±4.93					
	AF8	193.1±4.30					

Stoholm

Within both clones (OP42 and AF8), height of all stock types was similar ($P > 0.05$). Clone OP42 significantly (both $P < 0.001$) exceeded clone AF8 for 40 cm and barerooted cuttings (Fig. 3, Tab. 3).

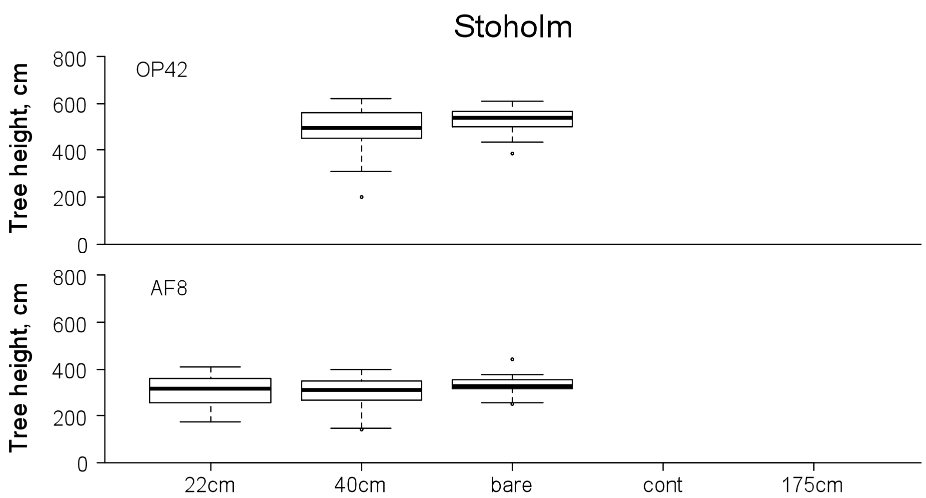


Figure 3. Tree height according to clone and stock type in Stoholm.

Års

High poles of clone AF2 were significantly (all $P < 0.001$) higher than all other stock types (Fig. 4, Tab. 3). Also barerooted cuttings were significantly higher ($P = 0.001$) than 40 cm cuttings, but 22 cm and 40 cm cuttings had similar ($P > 0.05$) height. Similarly, barerooted cuttings showed the best growth also for clone OP42 and it significantly (all $P < 0.001$) exceeded other stock types. Relatively small but significant ($P = 0.01$ and $P < 0.001$, respectively) differences were found between 22 cm and 40 cm cuttings of clones AF7 and AF13; but clones AF8, AF6 and AF34 had similar (all $P > 0.05$) height of these stock types.

Some differences were found also between clones. Short cuttings (22 cm) of clone OP42 was significantly higher than of clones AF13 and AF34 ($P = 0.02$ and $P = 0.002$, respectively). Clones AF34, AF6 and AF8 had significantly (all $P < 0.05$) lower height of 40 cm cuttings than all other clones. Height of barerooted cuttings of clones AF2 and OP42 was similar ($P > 0.05$).

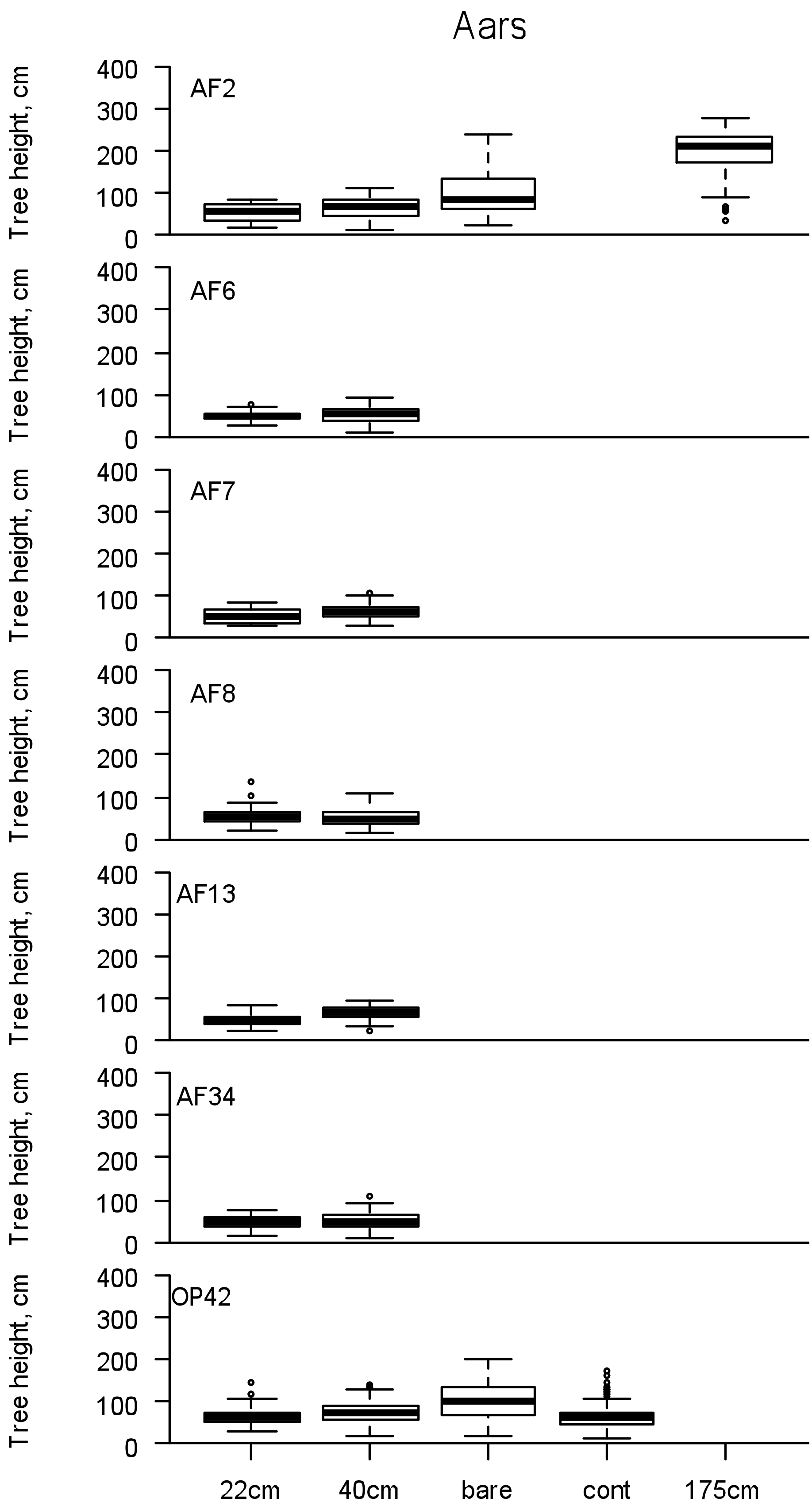


Figure 4 Tree height according to clone and stock type in Års.

Skrīveri

At age of 2 years, height of all clones differed significantly (all $P < 0.001$), except between clones AF2 and AF8 ($P > 0.05$). Similarly, at age of 3 years, height of all clones differed significantly (all $P < 0.05$), except between clones AF7 and AF8 ($P > 0.05$).

Although not measured during the visit, it would be interesting to study the height at which the leading shoot emerges. My field observations are that in the open field (agricultural land, Års) most part of the cutting that was left above ground was dried out, and shoots emerge from the middle of cutting or close to ground (Fig. 5). This was more often seen for 40 and 175 cm cuttings. In contrast, in forest land (Bregentved) near to old forest, shoots were also emerged from the top part of the cutting. These differences could be caused by microclimate, particularly – wind, which could dry out tops of the cuttings.

Figure 5. Shoots emerging from the 40 cm cuttings on the agricultural land.

During the last 10 years several poplar trials have been established in Latvia using 20 cm cuttings, leaving only 2–3 buds above ground. Majority of these sites have shown high (Tab. 2) survival rates. In contrast, 22 cm cutting survival and growth show relatively poor results in studied sited in Denmark. One of the possible reasons for these differences could be weed control during the first vegetation season. In experimental sites in Latvia, it was possible to ensure manual spot weeding, making 15–20 cm diameter wide zone with no herbaceous plants around each cutting. In studied sites in Denmark, weed control was done by machinery (soil scarification between rows, mowing) that might not be enough for small size cuttings. However, it should be stressed that manual weeding is not a feasible option for a practise and large scale plantations. Moreover, longer cuttings (40 and 175 cm) has height advantage during the first growing season, therefore may not require that intensive weed control if compared with 22 cm cuttings.

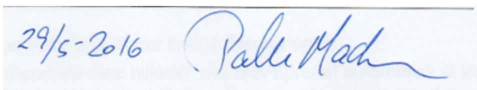
High poles (175 cm cuttings) are not used in Latvia, therefore it was novel experience to see how they develop. At juvenile age, cuttings may form more than one strong shoots, which might cause stem defects (Fig. 12) and also might provide path for infections. However, stem quality is important only if first rotation if grown for solid wood production, not for biomass. Moreover, for fast growing species such defects overgrow within few years.

a b c d

Figure 12. Stem defects at the top of the 175 cm cuttings.

3. Conclusions

Survival and height growth of studied clones does not give unambiguous results. Significant differences of performance of same clone and stock type between trials denote effect of microclimate and applied management. Yet, observation within same site suggests that stock type can have significant effect on both survival and height growth of poplar clones during the first years after coppice establishment. More studies should be done to detect factors affecting performance of same planting material under different conditions.

Signed for acceptance 

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