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The susceptibility of *Betula pendula* and *B. pubescens* saplings to stem spot disease on different soils

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TIIVISTELMÄ: RAUDUS- JA HIESKOIVUN TAIMIEN ALTTIUS VERSOLAIKKUTAUDILLE ERILAISILLA KASVUALUSTOILLA

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The susceptibility of *Betula pendula* and *B. pubescens* saplings to stem spot disease caused by *Godronia multispora* and *Fusarium avenaceum* was studied. *B. pendula* proved to be more susceptible than *B. pubescens* on all studied soils, especially on peat. *G. multispora* was more pathogenic than *F. avenaceum*. Inoculations with *G. multispora* in the spring and summer induced smaller cankers than in the autumn.

Tutkimuksessa selvitettiin raudus- ja hieskoivun taimien altistumista *Godronia multispora*- ja *Fusarium avenaceum*-sienten aiheuttamalle versolaikkutaudille erilaisilla kasvualustoilla. Rauduskoivu osoittautui alttiimmaksi kuin hieskoivu kaikilla käytetyillä alustoilla. Turvealustalla rauduskoivu oli erityisen altis versolaikkutaudille. *G. multispora* osoittautui patogeenisemmaksi kuin *F. avenaceum* kummallekin koivulajille kaikilla käytetyillä kasvualustoilla. Keväällä ja kesällä *G. multispora*-sienellä inokuloinnit aiheuttivat pienemmät korot kuin syksyllä. Inokulointiajankohta ei vaikuttanut *F. avenaceum*-sienen muodostamien korojen kokoon.

Key words: Fungi, *Godronia multispora*, *Fusarium avenaceum*
ODC 172.8 *Godronia multispora* + 172.8 *Fusarium avenaceum* + 443.2 + 176.1 *Betula*
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1. Introduction

Stem spot disease has become a serious problem in *Betula pendula* Roth saplings in nurseries and on peatland cultivations (Kurkela 1973, Lehtiniemi and Sarasto 1973, Juutinen et al. 1976, Petäistö 1983) (figure 1). Kurkela showed that *B. pendula* saplings were more susceptible to this disease than *B. pubescens* Ehrh. The cause of the disease is usually *Godronia multispora* J. W. Groves, but other pathogenic fungi have also been isolated from

the spots, for example *Fusarium avenaceum* (Corda ex Fr.) Sacc. (Juutinen et al. 1976, Petäistö 1983).

The soil is an important factor with regard to the frequency of the disease. It is possible that the nutritional status of peat does not meet the requirements of *B. pendula* (Kurkela 1974). The disease can also be found on mineral soils, but not to a significant extent.

The aim of this study was to establish how different soils affect the occurence of stem spot disease on *B. pendula* and *B. pubescens* saplings, and to compare the pathogenicity of *G. multispora* and *F. avenaceum* in both birch species. In addition, the effect of inoculation date on the growth of the fungi in bark was studied.

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Figure 1. Stem spot disease.
Kuva 1. Versolaikkutauti.

2. Material and methods

In the spring of 1982, one year old *B. pendula* and *B. pubescens* potted seedlings were planted in Röykkä (60°29′N, 24°39′E), which is the central nursery of The Foundation for Forest Tree Breeding. *B. pendula* was provenance Loppi (60°43′N, 24°28′E) × Vihti (60°25′N, 24°20E). The provenance of *B. pubescens* was Kangasala (60°28′N, 24°5′E). The *B. pendula* seedlings were planted in plots of 40, and *B. pubescens* in plots of 30 seedlings. There were three replicates, therefore together, 480 *B. pendula* and 360 *B. pubescens* seedlings were planted. The plant distances were 0,5 × 1,0 m, and they were planted on four different soils which were:

Soil 1 = gravel and garden peat, ratio 1:1
" 2 = mineral soil (fine sandy till)
" 3 = drained peatland
" 4 = gravel and garden peat, ratio 1:1, as a planting bed

Each soil received the same fertilizer: 250 kg/ha chlorate free NPK. In the spring, summer and autumn of 1983, two seedlings in each plot were inoculated with *G. multispora* (2 isolates : Röykkä and Virolahti), and another two with *F. avenaceum* (2 isolates : Patama 108L and 106L). Each seedling received one inoculation. Mycelium from the edge of fungal culture, which was grown on malt agar for 3–4 weeks, was transferred into a hole made in the bark of the seedling, and this was then covered with parafilm for 1–2 months. The size of the hole was 12,6 mm^2. Inoculations took place on 19.5., 5.7., 6.9, and 30.9. Altogether 384 seedlings were inoculated with fungi. One seedling per plot was inoculated with sterile agar on 12. 4. 1984 in the same way.

The number and the size of the cankers caused by natural infections were also studied and the fungi were isolated.

3. Results

31. Height growth of the saplings

During the two years of the experiment, *B. pendula* saplings grew on average 129 cm (st.dev. 43, 4 cm), and *B. pubescens* on average 117 cm (st.dev. 35,3 cm). The soil proved to affect growth significantly (F = 135,19; d.f. = 3, 819; p<0,001) (figure 2). Both birch species grew best on soil Nr. 4, which was a planting bed with garden peat and gravel ratio 1:1. The worst results were on drained peatland (Nr. 3), on which, however, *B. pubescens* grew better than *B. pendula*.

32. Inoculated seedlings

G. multispora caused the largest cankers in both species, but it was significantly more pathogenic to *B. pendula* than to *B. pucescens* (table 1). Cankers caused by *F. avenaceum* or sterile agar were approximately the same size on both birch species. The comparison between the inoculation with strile agar and fungi is difficult, because they were made at different times.

Secondly, the inoculation date affected the canker size most. The largest cankers were formed with inoculations at the end of September using *G. multispora* (figure 3). Cankers formed from inoculations in May and July were not much larger than those formed from inoculations with sterile agar. The inoculation date did not affect the size of cankers caused by *F. avenaceum*.

B. pendula saplings proved more susceptible to inoculations in September than in May and July. The difference was statisticaly significant with *G. multispora* inoculations (figure 3). There were no differences in susceptibility between spring and summer inoculations.

The effect of soil on the size of the cankers was not statisticaly significant (F = 1,28; d.f. = 3,384; p>0,05). Inoculations at the end of September showed that *G. multispora* grew best in birch on peat. *F. avenaceum* grew the same on all soil types (figure 3).

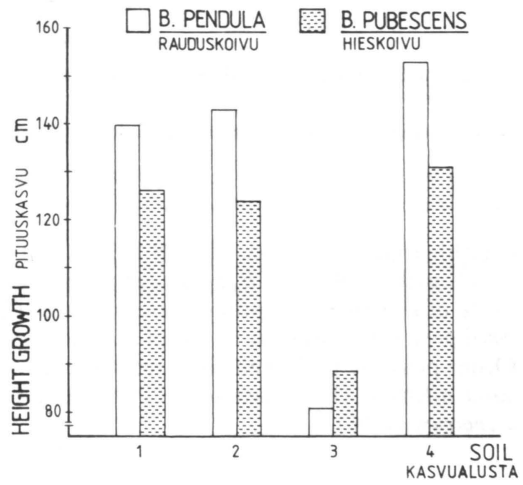

Figure 2. The average height growth of *Betula pendula* and *B. pubescens* on different soils.
Kuva 2. Raudus- ja hieskoivun taimien keskimääräinen pituuskasvu kasvualustoilla.

Table 1. The size of cankers caused by *Godronia multispora* and *Fusarium avenaceum* on *Betula pendula* and *B. pubescens*.
Taulukko 1. Godronia multispora- ja Fusarium avenaceum-sienten aiheuttaman koron suuruus raudus- ja hieskoivuissa.

The fungal species and isolate / *Sienilaji*	The size of canker, mm^2 / *Koron koko, mm^2* *B. pendula*	*B. pubescens*
G. multispora		
Röykkä	73,7	41,4
Virolahti	80.8	46,2
F. avenaceum		
Patama 108L	28,0	27,8
Patama 160L	30,9	34,5
Control / *vertailu*		
Sterile agar / *Steriili agar*	*18,2*	*14,9*

Analysis of variance (logarithm conversion)
Varianssianalyysi (logaritmimuunnos)

The effect of fungal species/isolates Sienilajin/isolaatin vaikutus	F = 25,58*** (d.f. = 4,407)
The effect of birch species *Koivulajin vaikutus*	F = 6,92*** (d.f. = 1,407)

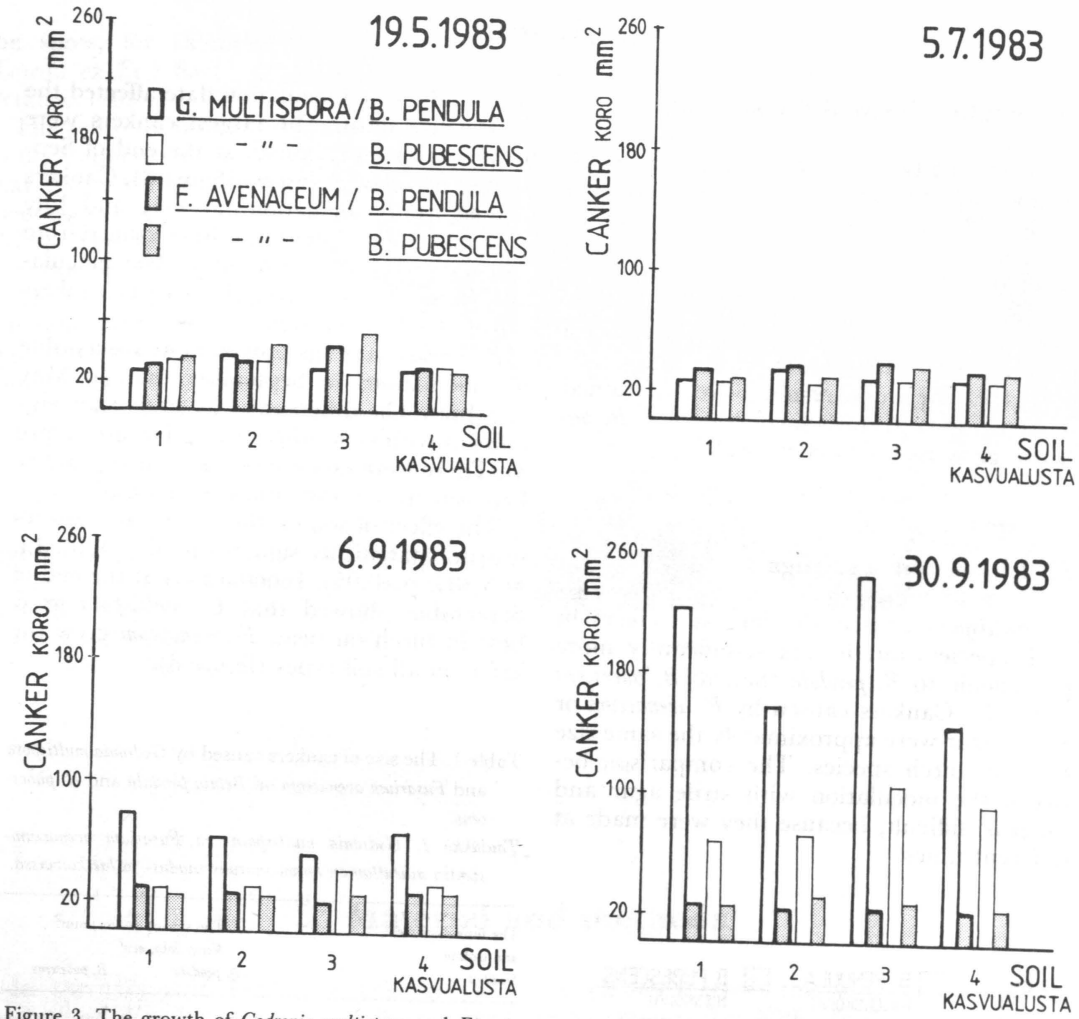

Figure 3. The growth of *Godronia multispora* and *Fusarium avenaceum* in *Betula pendula* and *B. pubescens* after different inoculation times.

Kuva 3. Godronia multispora- ja Fusarium avenaceum -sienten kasvu raudus- ja hieskoivun taimissa eri inokulointiajankohtien jälkeen.

33. Natural infections

The largest number of cankers were found on birch growing on peat. The difference was statisticaly significant compared to other soils ($F = 3{,}60$; d.f. = 3, 241; $0{,}01<p<0{,}05$) (figure 4). There were no statistical differences between other soils. *B. pendula* was more susceptible than *B. pubescens* ($F = 8.27$; $p<0{,}01$).

Altogether, 36 % of *B. pendula* saplings and 21 % of *B. pubescens* saplings were infected. *G. multispora* was found in 38 % of the isolates. Other possible pathogens isolated were *Alternaria alternata* (Fr.) Keissler (17 %) and *F. avenaceum* (7 %).

4. Discussion

In this experiment the soil proved to be an important factor in birch cultivation. *B. pendula* usually grows on mineral soils, whereas *B. pubescens* in also common on peat. The reason why *B. pendula* seedlings cannot be grown on peat is unknown. *B. pendula* seedlings grown on mineral soil were healthier (c.f. Kujala 1946, 1964, Sarvas 1949). The best height growth results, which were achieved on a gravel and garden peat planting bed, were probably due to favourable temperature conditions in the soil (c.f. Lähde 1978).

On the studied soil types, *G. multispora* clearly caused more stem spot disease than *F. avenaceum*. This has been established with birch grown on peat soils and those grown on garden peat in nurseries (Lehtiniemi and Sarasto 1973, Kurkela 1974, Petäistö 1983). On the other hand, *F. avenaceum* and *A. alternata* have been known to cause stem spot disease on *B. pendula* saplings planted on fields overgrown with grass. The infection takes place through wounds in the bark caused by the cicada for oviposition (Juutinen et al. 1976). On peat soils, the infection is most probably brought about by mechanical injury due to ice and snow (Lehtiniemi and Sarasto 1973). According to Kurkela (1974), infection may also take place through leaf scars. In this study, many natural infections seemed to have started at the branch base, which excess snow had evidently cut.

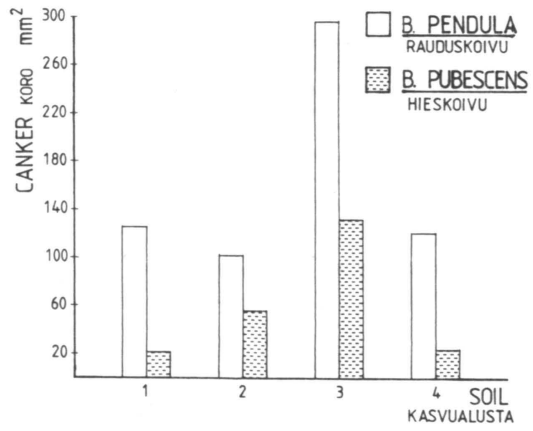

Figure 4. The total area of cankers caused by natural infection on *Betula pendula* and *B. pubescens* on different soils.

Kuva 4. Luonnoninfektioiden aiheuttamien korojen yhteenlaskettu pinta-ala eri kasvualustoilla raudus- ja hieskoivuissa.

In this study as in previous ones, *B. pubescens* proved more resistent than *B. pendula* (c.f. Kurkela 1974). The reason for this is unknown. Preliminary studies showed, however, that with stressed *B. pendula* saplings phellogen restoration under the damaged area is delayed. *B. pubescens* saplings are capable of restoring the phellogen in a shorter time compared to stressed *B. pendula* saplings (Romakkaniemi, unpublished result). It has been found that phellogen restoration is also delayed with stressed conifers (Puritch and Mullick 1975). It is possible that *B. pendula* suffers from water and nutrient stress on peat soils and from nutrient stress on garden peat.

In this experiment and in studies by Kurkela (1974), wounds healed when inoculations took place in the summer. In the autumn and early spring, the defense mechanism slows down and most probably this allows the growth of fungi in the birch bark. However, at least *G. multispora* can also grow during the growing season in the bark if birch trees are weakned enough (Romakkaniemi, unpublished result).

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