Foliage diseases – Hardwoods

Pathogenicity of *Marssonina betulae* on *Betula pendula* and *Betula pubescens*

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Abstract – Studies were undertaken to investigate whether *Marssonina betulae* is a causal agent of dieback of young birch in Scotland. *Marssonina betulae* was inoculated onto shoots of *B. pendula* and *B. pubescens* and symptoms monitored over several seasons. On *B. pendula*, but not *B. pubescens*, lesions developed on young shoots which often girdled to cause dieback, and secondary, sunken cankers developed on main stems. These cankers expanded during subsequent seasons, and often coalesced, girdling stems to cause death of some seedlings. A survey of 900 trees at nine planting sites in Scotland found that 50% of *B. pendula* and 17% of *B. pubescens* had *M. betulae* foliar infections, and that 82% of these infected trees also had sunken cankers on shoots and stems. This study has shown that *M. betulae* is an aggressive pathogen on *B. pendula*, causing sunken stem cankers and progressive crown dieback which are symptoms commonly observed on young, planted birch in Scotland.

birch dieback / field surveys / pathogenicity tests

Kivonat – A *Marssonina betulae* patogenitása *Betula pendula* és *Betula pubescens* fajokon. Kutatásaink során azt vizsgáltuk, hogy a *Marssonina betulae* okozza-e a fiatal nyírfák pusztulását Skóciában. *B. pendula* és *B. pubescens* hajtásokat fertőztünk *M. betulae*-val és a tüneteket néhány éven át figyelemmel kísértük. A *B. pendula* fiatal hajtásain nekrózisok fejlődtek, a hajtások befűződtek, elhaltak, a fő szárakon másodlagos, besüppedő nekrózisok keletkeztek. A nekrózisok a következő évek során növekedtek, gyakran összefolytak, a szárat körülölelve a csemeték pusztulását okozták. Kilenc skóciai ültetvényben 900 fa felmérése alapján a *B. pendula* 50%-án és a *B. pubescens* 17%-án találtunk levélfertőzést, a fertőzött fák 82%-án besüppedő nekrózisokat, rákokat is találtunk a hajtásokon és a száron. Eredményeink azt mutatják, hogy a *M. betulae* a *B. pendula* agresszív kórokozója, a száron besüppedő rákokat és fokozódó koronapusztulást okoz, amely tünetek fiatal, ültetett nyírfákon Skóciában gyakoriak.

nyírpusztulás / terepi vizsgálat / patogenitási teszt

1 INTRODUCTION

Birch (*Betula* spp.) is a major component of native woodlands throughout Scotland, and is valued increasingly as a resource for biodiversity, conservation, habitat and landscape purposes (Green 2005). There has also been recent interest in the potential of silver birch (*Betula pendula*) as a timber species in the UK (Malcolm – Worrell 2001). Both silver birch

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and downy birch (*B. pubescens*) are two of the more important broadleaved species in recent native woodland afforestation schemes in Scotland. The area of new native woodland is projected to increase further with continued applications under the Scottish Forestry Grant Scheme. As a result, there are now large numbers of young birch trees on a wide variety of site types across Scotland (Green 2005).

During the last few years there have been reports of widespread die-back of young, planted birch in Scotland, with over 20 native woodland planting schemes reported as affected to date. These planting schemes vary in size from 10 ha to over 450 ha. Affected trees appear to grow well initially, but approximately 5-10 years after planting begin to exhibit shoot die back from the lower crown upwards and from the outer crown inwards (Green 2005). Symptoms include sunken cankers and fissures on stems and branches, and discrete lesions and tip die-back on young shoots. These disease symptoms suggest that attack by fungal pathogens may be an important element in the demise of the trees. However, very little is known about the fungi associated with shoots of birch in the UK, or to what degree pathogenic shoot fungi might be responsible for the observed crown die-back.

A survey of five affected planting schemes was conducted in Scotland in 2002 as the first stage in a research programme to determine the potential roles of fungal pathogens in causing birch dieback (Green 2004). A broad range of fungi were isolated from birch shoots with and without symptoms, and the most frequently isolated fungi were inoculated onto birch seedlings in pathogenicity tests (Green 2004). Subsequent observations of disease over a single growing season indicated a high degree of pathogenicity in *Marssonina betulae* (Green 2004). *Marssonina betulae* is a common foliar pathogen on birch, causing characteristic leaf spots (Bennell and Millar 1984) although this fungus has not been considered previously to be a causal agent of shoot dieback. This paper provides an overview of work already published which confirms the pathogenicity of *M. betulae* on silver birch and its impact on birch at planted sites in Scotland (Green – MacAskill 2007, DeSilva et al. submitted).

2 METHODS

2.1 Inoculation tests

Marssonina betulae was inoculated onto Scottish provenance seedlings of silver birch and downy birch in 2003 and 2004 and symptoms monitored over two to three years. All seedlings were inoculated on the leading shoot, 2-3 cm above the base of the current year's shoot extension. In early June 2003, one-year-old seedlings were inoculated in an experiment designed to test the pathogenicity of *M. betulae* with the following main factors; i) birch species (silver birch or downy birch), ii) inoculum type (conidia or mycelium), iii) wounding or non-wounding of the inoculation site, and iv) age of leading shoot (3, 6 or 9 weeks post-flushing) (Green – MacAskill 2007). In late July 2004, two-year-old seedlings of silver birch were inoculated with conidial suspensions of five isolates of *M. betulae* and in mid-November 2004, two-year old silver birch seedlings were inoculated with mycelial plugs of four isolates of *M. betulae* (Green – MacAskill 2007).

2.2 Field survey

In August and September 2004, 100 birch trees at each of nine WGS plantings in Scotland were surveyed to evaluate the frequency and severity of crown die-back, to record the incidence of *Marssonina betulae* foliar disease and severity of sunken shoot and stem cankers, and to determine whether a relationship exists between incidence of *M. betulae* foliar disease and incidence of sunken cankers on shoots and stems (DeSilva et al. submitted). Eight of the

sites were planted between 1989 and 1995, and one site comprised late-1980's naturally regenerated downy birch of local origin.

3 RESULTS

3.1 Inoculation tests

Inoculation of silver birch seedlings with *M. betulae* resulted in the development of lesions at the inoculation site and secondary, sunken stem cankers, which continued to expand up to two years after initial infection and often girdled, causing extensive shoot die-back and the death of some seedlings (Green – MacAskill 2007). These secondary stem cankers were often centred about the base of a side shoot. Non-wounded shoots inoculated with conidial suspensions caused disease and young shoots inoculated in early June were more susceptible than shoots inoculated in late July which had ceased extension growth. All isolates of *M. betulae* tested caused disease on silver birch (Green – MacAskill 2007). Disease did not develop on downy birch after inoculation.

3.2 Field survey

At six of the nine sites surveyed in 2004 at least half of all birch trees had 40 % or greater crown die-back. In total, 61 % of silver birch (n = 291) and 41 % of downy birch (n = 609) had 40 % or greater crown die-back. Overall, 28 % of the 900 trees surveyed had *M. betulae* foliar disease, with incidences of infection varying quite widely from site to site (DeSilva et al. submitted). *Marssonina betulae* foliar disease occurred more frequently on silver birch (50% affected) than on downy birch (17% affected). The incidence of sunken shoot and stem cankers was also greater on silver birch (63 % affected) than on downy birch (23 % affected). There was a significant interaction ($P < 0.0001$) between the incidence of *M. betulae* foliar disease and incidence of sunken shoot and stem cankers, with 82 % of *M. betulae*-infected trees having these other cankers (DeSilva et al. submitted). There was also a significant relationship between the incidence of *M. betulae* foliar disease and crown dieback ($P < 0.0001$) and the severity of sunken cankers had a significant positive effect ($P < 0.0001$) on the severity of crown dieback (DeSilva et al. submitted).

4 DISCUSSION

This study has demonstrated that *M. betulae* is a more aggressive pathogen on silver birch than previously thought, causing sunken stem cankers and progressive shoot dieback when inoculated onto silver birch seedlings (Green – MacAskill 2007). Primary infections by *Marssonina* spp. tend to occur in spring shortly after the leaves emerge on the host, and are initiated by conidia from acervuli overwintering in lesions on shoots and fallen leaves (Sinclair et al. 1987). This study showed that young shoots of silver birch in early flush were most susceptible to infection by conidia of *M. betulae* with acervuli forming on lesions which developed at the inoculation site. It is not clear how *M. betulae* then spreads to cause secondary stem cankers. Conidia may be washed down the main stem during rainfall and collect at side shoot junctions, forming infection loci at these points. The fungus also causes lesions on young side shoots and may then grow down the side shoot to the main stem, causing cankers at these points (Green – MacAskill, 2007).

Marssonina betulae was also found to be a common pathogen on young birch trees at the nine planted sites surveyed in Scotland, causing foliar disease associated with sunken shoot

and stem cankers which result in crown dieback (DeSilva et al. submitted). This fungus is, therefore, a causal agent of crown dieback and is having a significant impact on the health of birch at these sites. Although *M. betulae* did not cause disease when inoculated onto downy birch seedlings, downy birch trees at field sites in Scotland were found to have the disease. It would appear that silver birch is the more susceptible species, although other factors such as provenance and site conditions may influence this.

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REFERENCES

BENNELL, P. – MILLAR, C. (1984): Fungal pathogens of birch in Britain. Proceedings of the Royal Society of Edinburgh 85 B: 153-167.

DESILVA, H. – GREEN, S. – WOODWARD, S.: Incidence and severity of *Anisogramma virgultorum* and *Marssonina betulae* in birch plantings in Scotland. Plant Pathology (accepted subject to final approval).

GREEN, S. (2004): Fungi associated with shoots of silver birch (*Betula pendula*) in Scotland. Mycological Research 108 (11): 1327-1336.

GREEN, S. (2005): Birch die-back in Scotland. Forestry Commission Information Note 72. Edinburgh, Scotland.

GREEN, S. – MACASKILL, G. (2007): Pathogenicity of *Marssonina betulae* and other fungi on birch. Plant Pathology 56: 242-250.

MALCOLM, D. – WORRELL, R. (2001): Potential for the improvement of silver birch (*Betula pendula* Roth.) in Scotland. Forestry 74: 439-453.

SINCLAIR, W. – LYON, H. – JOHNSON, W. (1987): Diseases of Trees and Shrubs. Ithaca, New York, USA: Cornell University Press.