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The effects of calcium on stem lesions of silver birch seedlings

By A. Lilja[1], J. Luoranen[2], R. Rikala[2] and R. Heinonen[1]

[1]Finnish Forest Research Institute, Vantaa Research Unit, PO Box 18, FI-01301 Vantaa, Finland. E-mail: arja.lilja@metla.fi; [2]Finnish Forest Research Institute, Suonenjoki Research Unit, Suonenjoki, Finland

Summary

In this study, we tested the hypothesis that decreased liming of growth medium has a role in the increase of stem lesions and top dying caused by *Phytophthora cactorum* in containerized silver birch seedlings (*Betula pendula*) in Finnish forest nurseries. The effect of limestone dose rates on growth and the nutrient status was also monitored. An index based on severity of symptom expression was used to compare the effect of different liming treatments on *P. cactorum* infection. Limestone amended into the sphagnum peat growth medium increased the amount of calcium in the seedling stems. Liming did not significantly decrease the disease severity although index values in most cases decreased with the increased limestone dose rates. In general, the lesions were restricted after out-planting and the mortality of seedlings was low. Only inoculated seedlings on which the lesions had spread around the stem in the nursery died. *Phytophthora cactorum* appears to be a nursery pathogen, as it did not survive under conditions present in the field. Four years after out-planting, the tallest birches were those grown in sphagnum peat amended with the highest limestone dose of 8 kg m^{-3}.

1 Introduction

In 1991, *Phytophthora cactorum* (Lebert et Cohn) Schröter was first isolated from necrotic stem lesions on silver birch (*Betula pendula* Roth) seedlings in Finland (Lilja et al. 1996). Inoculations of birch stems with this Oomycetous Chromista in the Pseudofungi (Baldauf et al. 2000) resulted in necrotic lesions identical to those on birch seedlings observed in nurseries (Lilja et al. 1996; Hantula et al. 2000). Since 1991 stem lesions and top dying have been a severe problem with container-grown silver birch seedlings (Lilja et al. 1997; Juntunen 2000).

The chemical properties of calcium enable it to serve in both structural and messenger roles in plant defence. For example, calcium is required for biosynthesis of cellulose, callose and lignin. Initial active plant defence responses to infections include an influx of Ca^{2+}, efflux of K^{+} and production of hydrogen peroxide (Bach et al. 1993). The stimulation of calcium influx and accumulation of hydrogen peroxide was shown to be dependent on calcium concentration (Bach and Seitz 1997). The importance of calcium for later responses to elicitors produced by pathogens is also evident. It has a role in the induction of salicylic acid, phenylalanine ammonia-lyase and peroxidase (Bach and Seitz 1997; Messner and Schröder 1999). The rapid accumulation of the first defence mechanisms is followed by activation of defence genes and secondary strategies, e.g. formation of flavonoids, phytoalexins, lignin and cell wall-bound phenolics, which would more effectively restrict pests. For example, the phenol content of the bark of apple trees resistant to *P. cactorum* was found to be high compared with less resistant genotypes (Alt and Schmidle 1980).

In the 1960s when peat was popularized as a growth medium for forest tree seedlings, 8 kg of dolomitic limestone m^{-3} of peat was the dose recommended to lower the acidity of

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