Title
Effects of silicon on growth of silver birch (Betula pendula)

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Introduction

Silicon (Si) is known to have beneficial effects on the growth and stress tolerance of many plant species (Epstein 1999). However, Si uptake varies very much between plant species, and it is not well known how widely spread the beneficial effects are. In particular, peat soils are likely to have very low Si levels. Consequently low Si may be an issue in the boreal region, where these soils are common. We studied the effects of Si on a deciduous forest tree, silver birch (*Betula pendula*). Additionally, we tested whether an insect herbivore, autumn moth (*Epirrita autumnata*) prefers leaves from plants without Si.

Materials and methods

One-year-old birch seedlings in peat plugs were defrosted and planted in larger pots in unfertilized, unlimed peat. After two weeks, the treatments started. The plants were fed with a complete nutrient solution (N concentration 7 mM) with or without Si for 7 weeks. Si was applied as Na_2SiO_3. The Si concentration was 0.65 mM, and the control solution had the same Na concentration as NaCl. pH was adjusted to 4.5.

A cafeteria test was done with excised leaves at the end of the growth experiment. One young fully expanded leaf from each treatment was enclosed in a large Petri dish with a single *Epirrita autumnata* larva. There were 90 leaf pairs. Leaf area at the beginning and end was taken as a measure of feeding of the larva. As the leaves dried during the experiment, a regression was computed between the original and final areas using those leaves that remained intact. A single regression was used for the correction for drying, but the regressions were also calculated for both treatments separately and tested for difference (general linear model with treatment as explanatory factor).

Height of the new stem and stem diameter at the base were measured after planting, at the beginning of the treatment, mid treatment period, and end. Plant parts were dried and weighed after final harvest. Aboveground parts were harvested and divided into old and new leaves and stems (including branches). New plant parts had grown during the treatment period and old ones prior to that. The two treatments were compared with a t-test.

Results

No Si effect on herbivory was observed, either in terms of number of intact leaves or leaf area consumed. However, the leaves with no Si dried significantly faster after excision (P=0.007).

The mean heights and diameters were very similar in the two treatments at each date. There was a slight positive effect of Si on leaf growth (new leaf dry weight 19.0g and 17.9g in the +Si and –Si plants, P=0.030), but the total aboveground dry weight (51.7g and 49.7g) was not significantly different between the treatments.

Discussion

There was a 6% increase in leaf growth in silver birch seedlings provided with Si in the peat growing medium. This suggests that Si has a role in this species, and further studies into both growth and stress tolerance are warranted. The result on leaf drying may indicate that water relations in particular are affected by Si availability, as has been found earlier in pine (Emadian

and Newton 1989).

The results did not lend support to hypotheses of increased tolerance to herbivory in Si-fed plants. However, *Epirrita autumnata* larvae are sensitive to drying of their food; they do not drink, and the food is their only source of water. Hence the difference in the drying of the leaves due to the treatment may have affected the larvae more than Si directly in this case. Furthermore, insect and mammal herbivores vary in their reactions to plant defences.

Silver birch is usually grown in a pure peat medium in forest tree nurseries, and afterwards planted in field sites where temporary dry periods are likely soon after planting. One possible application therefore is to add Si in the fertilisers in nurseries.

References

Emadian SF, Newton RJ. 1989 Growth enhancement of Loblolly pine (*Pinus taeda* L.) seedlings by silicon. J Plant Physiol 134: 98-103.

Epstein E. 1999. Silicon. Annu Rev Plant Physiol Plant Mol Biol 50:641-664.