SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION

Ready-to-use research results

VELVET GREEN: Potential for *Agrostis canina* on Scandinavian putting greens. Results from test under controlled conditions.

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One of the major concerns regarding use of velvet bentgrass in Scandinavia is whether the current cultivars are sufficiently resistant to frost, ice encasement and winter diseases. We present here the results of the first screening experiments on four velvet cultivars and the creeping bent cultivar Pen A4, testing for winter hardiness under controlled climate laboratory conditions. Tolerance to frost and artificial ice- and snow covers and resistance to snow mould (*Microdochium nivale*) were investigated.

Materials and methods

Four *Agrostis canina* cultivars, Avelon, Greenwich, Villa and Legency, and the creeping bent cultivar (*Agrostris palustris*) Pen A4 were sown (6,7 g/m^2) in USGA growth media with 0,5% w/v organic matter in 7,5x10x10 cm HDPE-pots. The plants were grown in a greenhouse with 16 h days (150 µ mol Einstein/m^2) at 18°C and 8 h night at 12°C for 9 weeks, or for 8 weeks in the greenhouse under these conditions followed by two weeks under hardening conditions (16 h light (250 µ mol Einstein/m^2), at 2°C and 8 h night at 2 °C). The pots were watered regularly and fertilized every 7 days with 25 ml of a solution containing 0,31g/L N, 0,05g/L P, 0,36 g/L K and micronutrients. For the last two fertilizations before the hardening or winter treatments the amount of nitrogen was reduced to 0.20 g/l and the K increased to 1.0 g/L. The grass was cut down to 5 mm three times a week with a hand held electric grass cutter (Gardena). There were three repetitions (i.e., three pots) of each cultivar for each treatment.

To test frost tolerance, the pots were transferred to a controlled climate chamber. The temperature was lowered at a rate of 2°C/h down to -6, -9, -12 or -15°C respectively and maintained at that temperature for 24 h. The temperature was then gradually increased at a rate of 2°C/h to – 2°C, maintained at 2°C for 12 h, and then increased to +2°C. The pots were then transferred back to the greenhouse and grown under the same conditions as previously described. Frost tolerance was measured visually as the % coverage with green leaves after 14 days of regrowth.

To test resistance to *Microdochium nivale* under different simulated winter conditions, unhardened or hardened plants were sprayed with approximately 2 ml per pot of a mycelial suspension of *M. nivale.* The fungus was first grown for 14 days at 9°C, then ground intermittently in a Waring Blender for 5 – 10 min. The concentration of the suspension was adjusted to OD_{430} 0.48, which is roughly equivalent to 10^5 cfu ml^{-1}. The control pots were sprayed with water. The pots were incubated for 6 or 12 weeks in the dark at 0,5- 1,0°C, either uncovered (simulating winter with no snow or ice cover), or enclosed in air-tight vacuum bags to study tolerance to anaerobic conditions (simulating ice cover), or covered with a sheet of wet cotton and wrapped in plastic (simulating snow cover). In all cases, plant responses were evaluated immediately at the end of the simulated winter conditions and again after two weeks of regrowth in the greenhouse.

Results

Tolerance to freezing

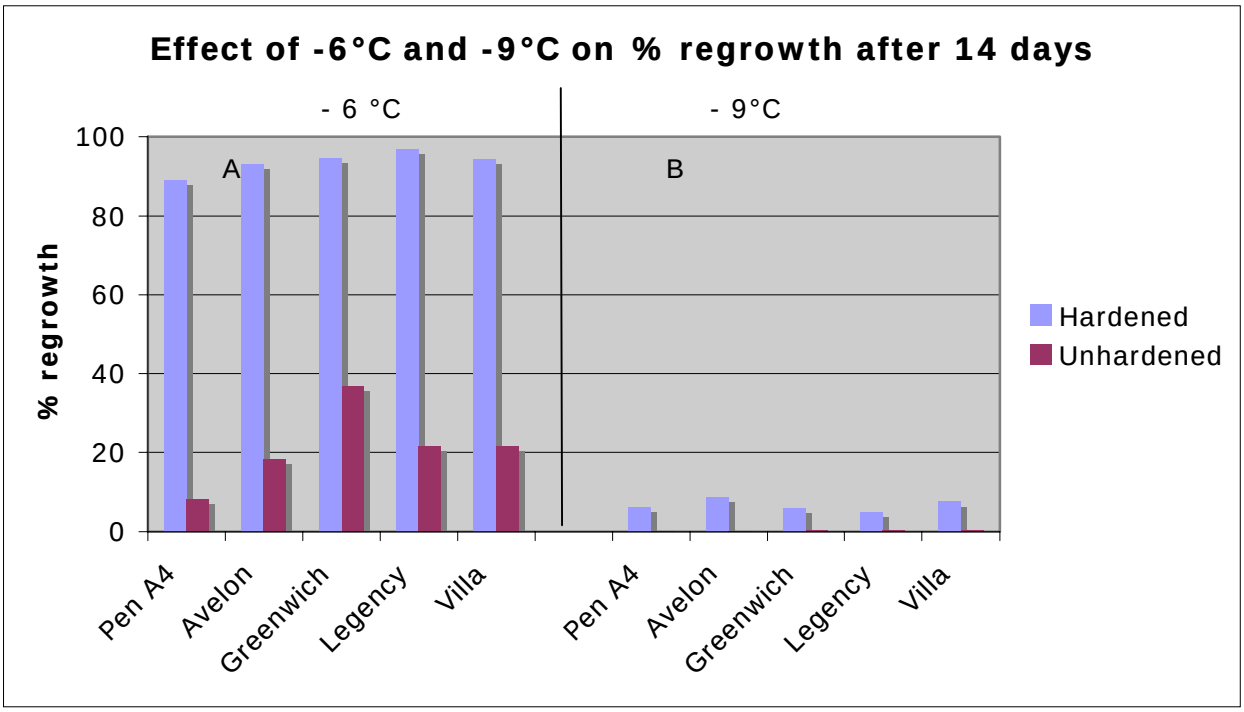


Fig. 1. Regrowth in % of hardened and unhardened plants after freezing to – 6 (A) and– 9 ^{o}C (B).

Figure 1 shows the regrowth measured as the % cover of the soil with green leaves 14 days after the freezing treatment. The hardened plants showed good survival after freezing to - 6°C (89-97% regrowth) but creeping bent Pen A4 survived more poorly than the velvet bents. The unhardened plants had much lower survival (18 – 37%) than the hardened plants. Greenwich had a significantly higher survival than the other cultivars, and Pen A4 had a significantly lower survival than the velvet cultivars. Only 5 – 9% of the hardened plants survived freezing to – 9°C and there were no

significant differences between the cultivars. Only 0.5% of the unhardened plants survived freezing to –9^{o}C.

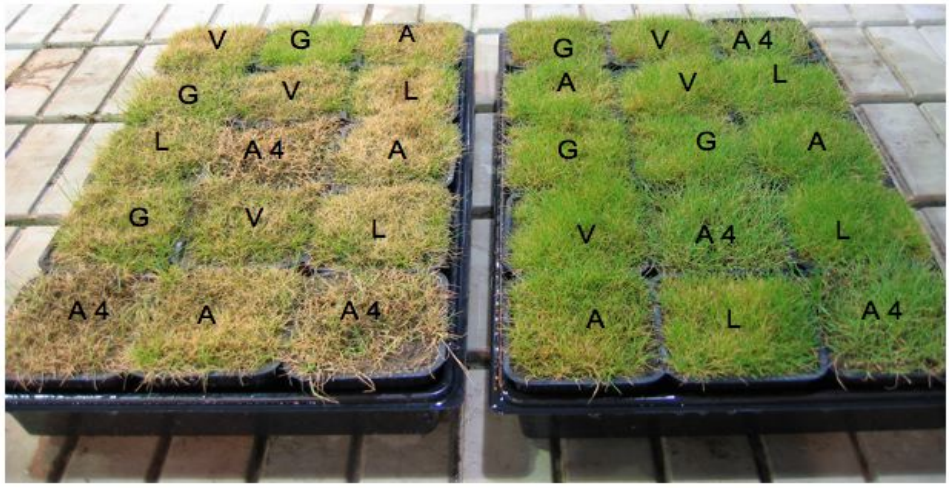


Fig 2. Unhardened (left) and hardened (right) plants frozen to -6°C and regrown for 14 days. A = Avelon V = Villa G = Greenwich L = Legency A 4 = Pen A4

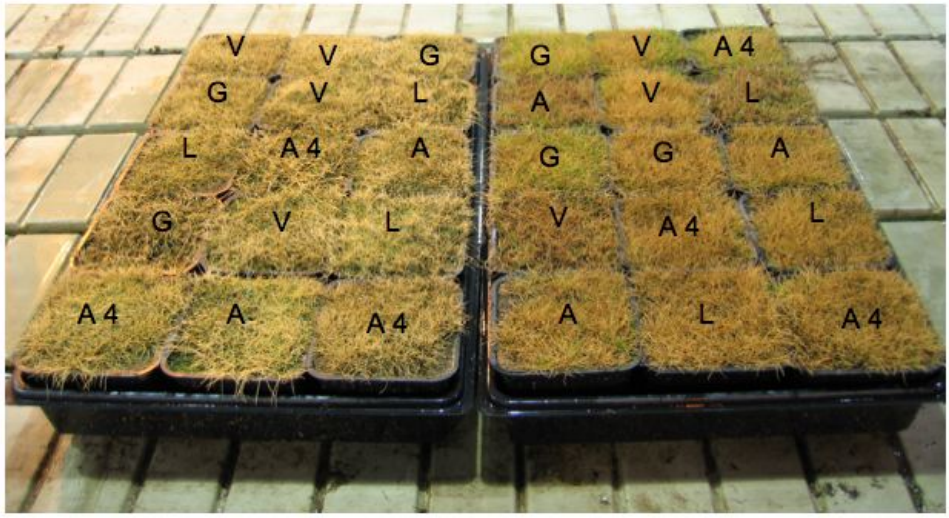
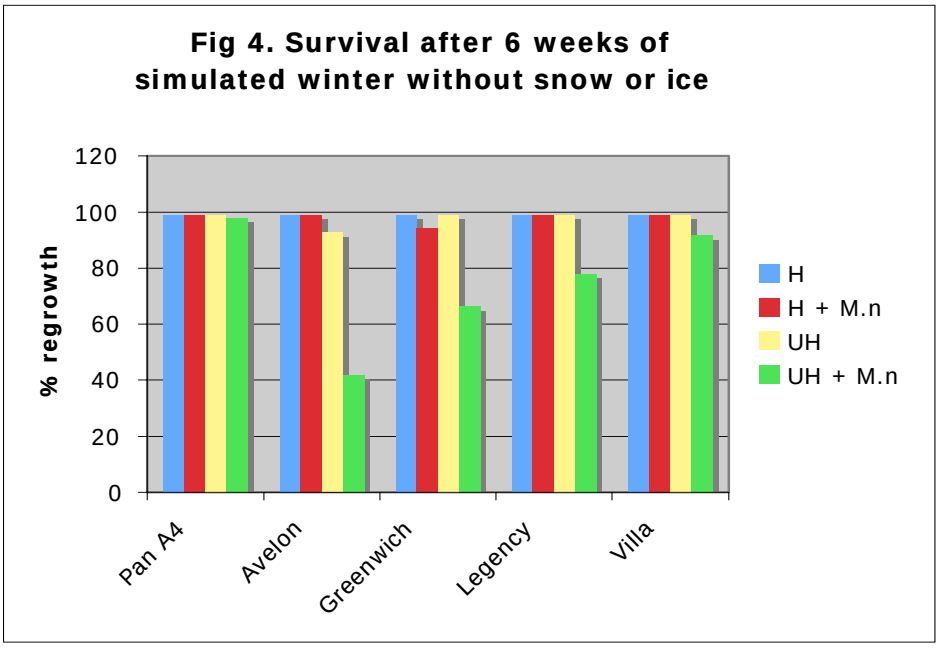


Fig 3. Unhardened (left) and hardened (right) plants frozen to -9°C and regrown for 14 days. A = Avelon V = Villa G = Greenwich L = Legency A 4 = Pen A4

Less than 0.5% of both hardened and unhardened plants survived exposure to – 12 and – 15°C (data not shown).

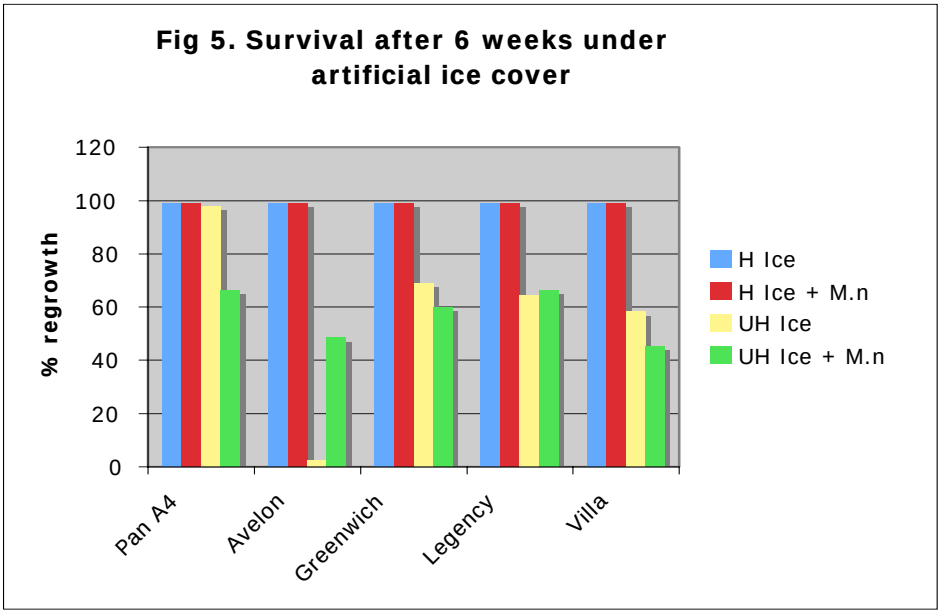
Tolerance to 6 or 12 weeks of winter conditions and infection by *M. nivale*

Nearly 100% of both inoculated and uninoculated hardened, and uninoculated unhardened, grass survived 6 weeks of uncovered winter conditions (Fig 4). Unhardened Avelon was significantly more susceptible to *M. nivale* than the other grasses. Pen A4 was the most resistant to *M. nivale*. (See Fig. 4).

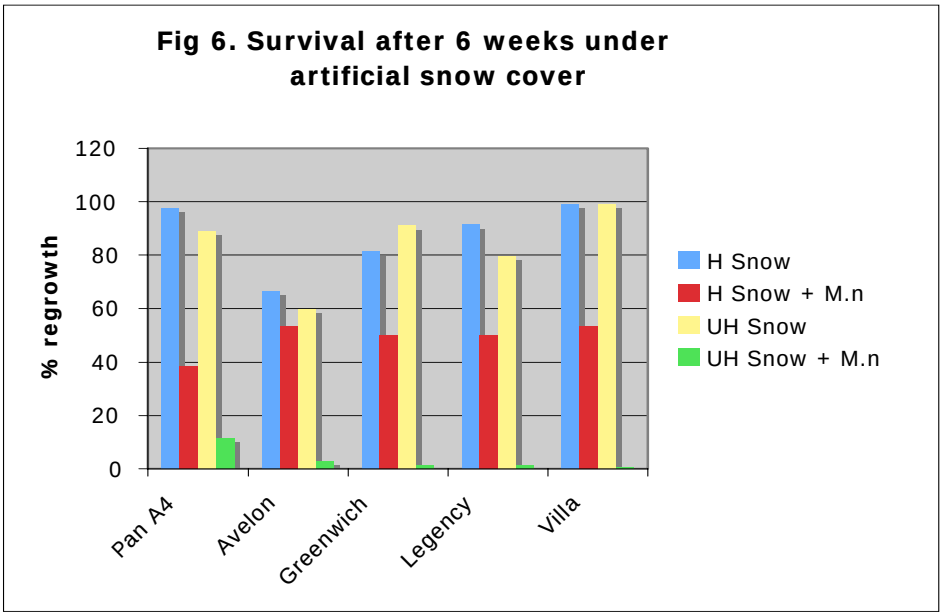


H = hardened. UH = unhardened. M.n. = inoculated with *Microdochium nivale*.

Nearly 100% of the hardened inoculated and uninoculated grass also survived under simulated ice cover (Fig. 5). The unhardened velvet cultivars were more damaged than Pen A4, and Avelon had the lowest survival rate.



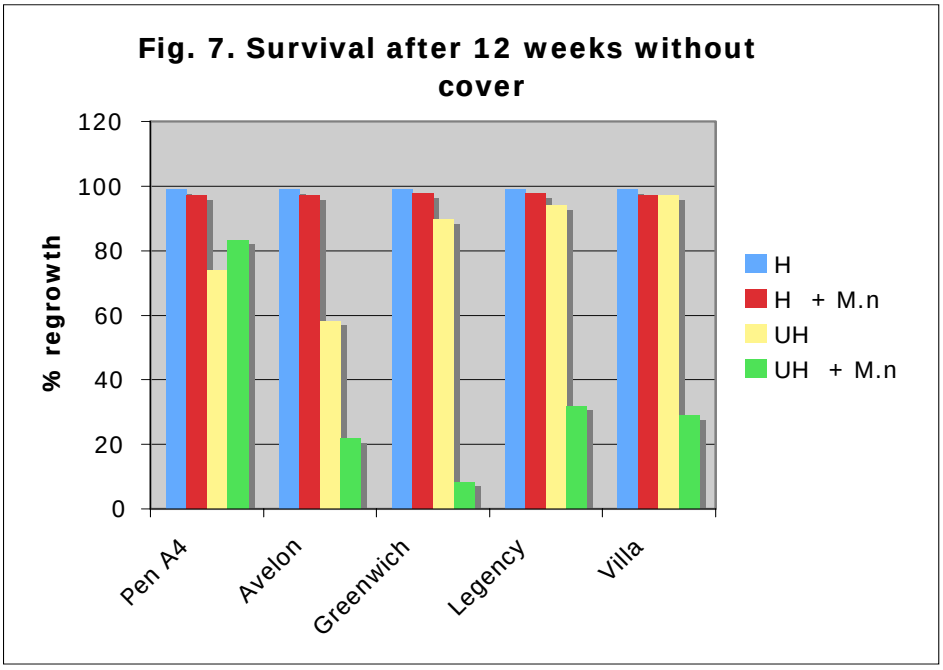
H = hardened. UH = unhardened. M.n. = inoculated with *Microdochium nivale*.



H = hardened. UH = unhardened. M.n. = inoculated with *Microdochium nivale*

There were no significant differences in the regrowth of the hardened plants (inoculated or uninoculated) or the unhardened uninoculated plants after 6 weeks of artificial snow cover (Fig. 6). However, the effect of *M. nivale* was more devastating under artificial snow than under artificial ice. Pen A4 had a survival rate of 12 %, whereas the velvet bents only had a survival rate of 1 - 3%.

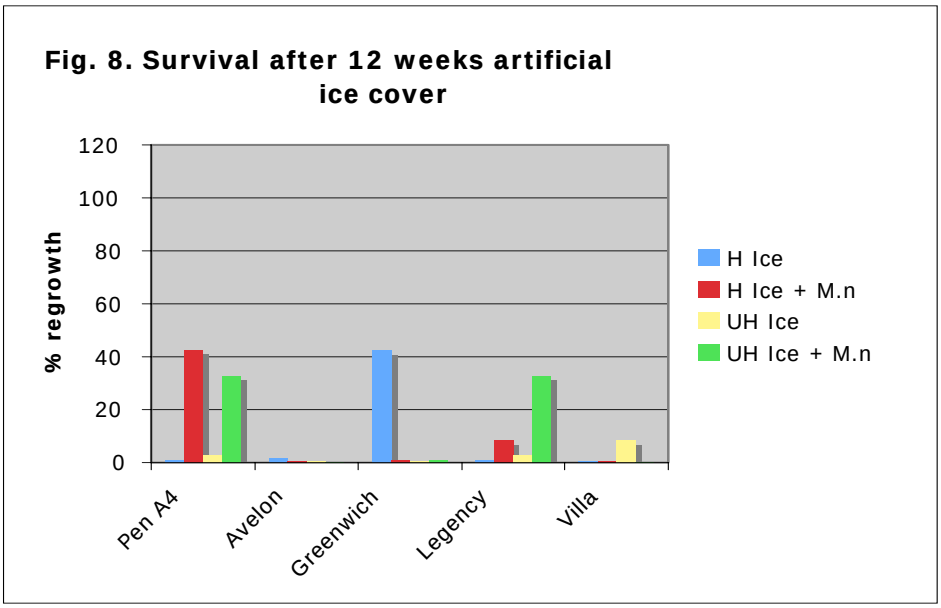
Figure 7 shows the survival of uncovered plants after **12 weeks** of winter conditions and 2 weeks of regrowth. 97-99% of the hardened plants survived, and they were highly tolerant to *M. nivale* under these conditions. Of the unhardened, uninoculated



H = hardened. UH = unhardened. M.n. = inoculated with *Microdochium nivale*

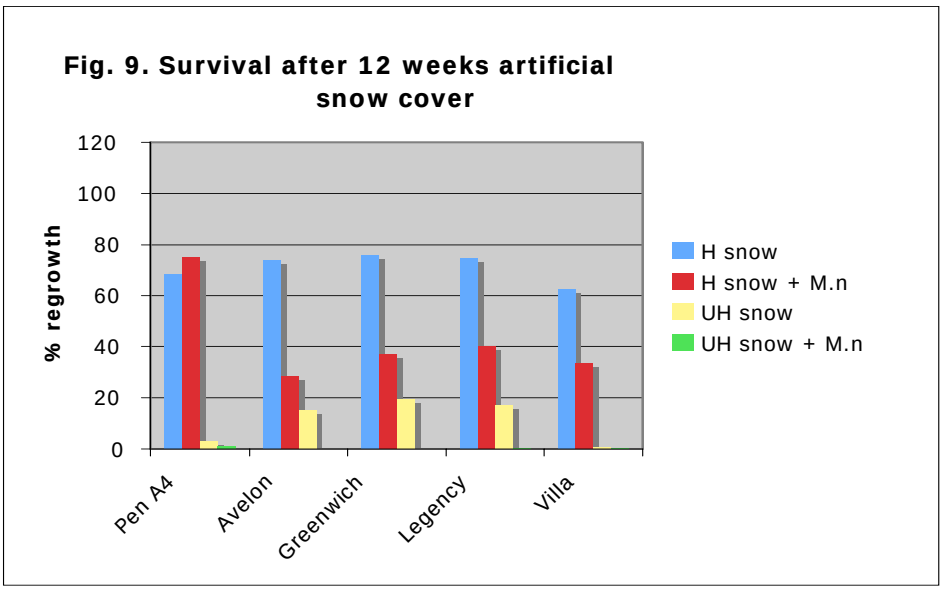
plants, Avelon had the lowest survival rate. Pen A4 was not affected by the *M. nivale* inoculation, whereas the velvet cultivars were susceptible to *M. nivale* under these conditions.

Fig. 8 shows that 12 weeks of simulated ice cover killed nearly all the plants. There was no significant difference between the different treatments.



H = hardened. UH = unhardened. M.n. = inoculated with *Microdochium nivale*

The hardened uninoculated plants had from 63 – 76 % regrowth after **12 weeks** of simulated snow cover (Fig 9). There were no significant differences between the cultivars. Hardened Pen A4 was not affected by the *M. nivale* inoculation, whereas only 50% of the hardened velvet cultivars survived *M. nivale* inoculation. None of the unhardened plants survived both simulated snow cover and *M. nivale* inoculation, whereas between 1 and 19 % of the uninoculated unhardened plants survived simulated snow cover. Avelon, Greenwich and Legency had significant better survival than Pen A4 and Villa.



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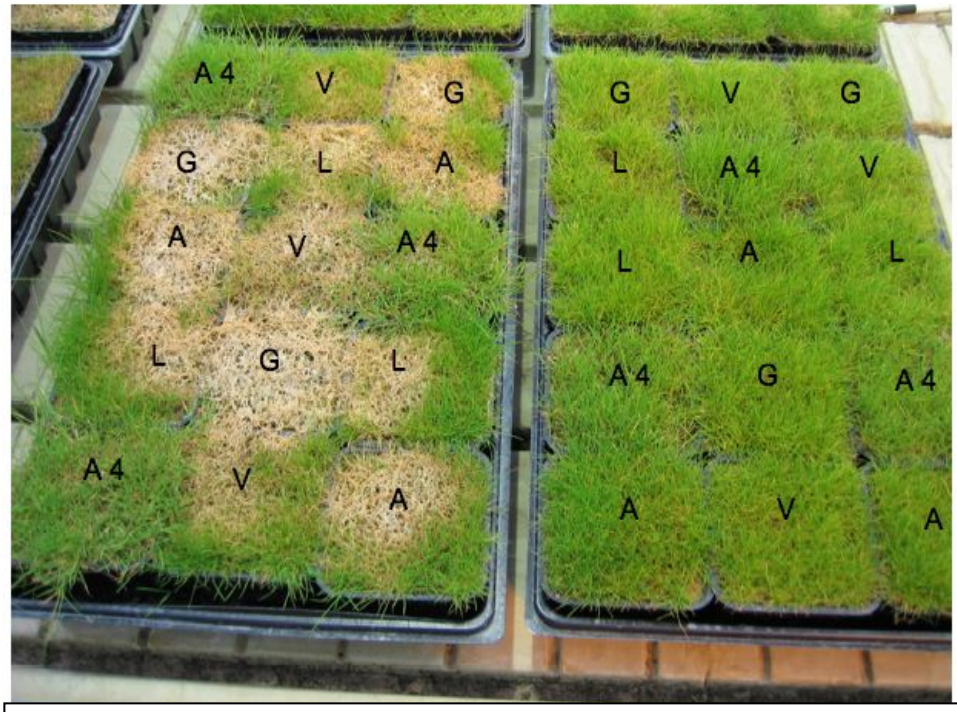

Fig. 10. Attack by *M.nivale* on unhardened (left) and hardened (right) grass after 12 weeks under artificial winter conditions (no cover) and 14 days regrowth in greenhouse. A = Avelon V = Villa G = Greenwich L = Legency A 4 = Pen A4

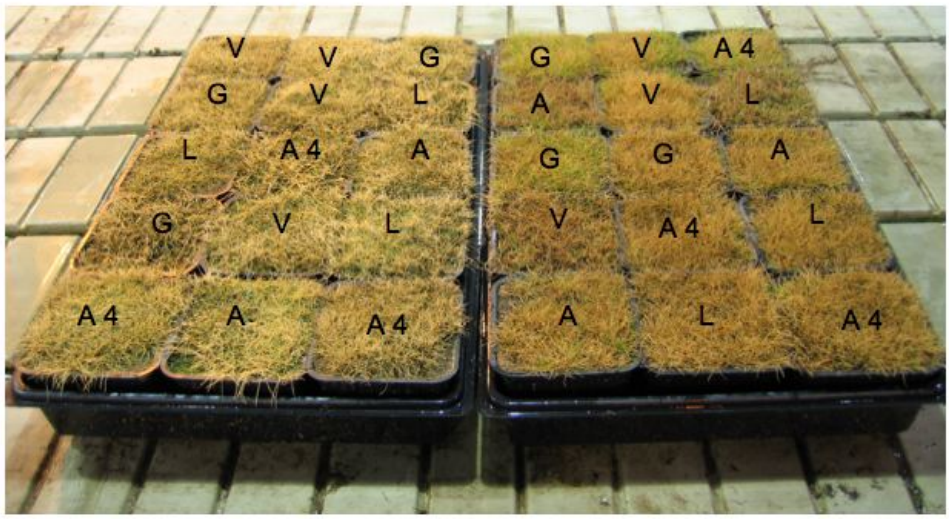

Fig 11. Attack by *M.nivale* on unhardened (left) and hardened (right) grass after 12 weeks under artificial snowcover and 14 days regrowth in greenhouse. A = Avelon V = Villa G = Greenwich L = Legency A 4 = Pen A4

Conclusion

Tolerance to freezing

None of the tested cultivars, whether hardened or not, tolerated freezing to – 9°C or lower. The velvet bents were, after hardening, tolerant to freezing at -6°C, and all the velvet cultivars were more tolerant than the creeping bent Pen A4, with Greenwich as the most tolerant. Unhardened plants were much more susceptible to exposure to – 6°C than the hardened plants. Pen A4 was less tolerant and Greenwich was significantly more tolerant than the other cultivars.

Tolerance to winter conditions and *Microdochium nivale* without ice and snow cover

All the hardened plants tolerated 12 weeks of winter conditions, even if inoculated with *M. nivale*. Unhardened plants were fairly tolerant when not inoculated with *M. nivale*, although Avelon had a lower survival than the other cultivars. Unhardened Pen A4 was not susceptible to *M. nivale* infection under these conditions, whereas the unhardened velvet bents were more susceptible, with no significant difference between the velvet cultivars.

Tolerance to winter conditions and *Microdochium nivale* with artificial ice cover

The hardened plants survived 6 weeks of artificial ice cover, but not 12 weeks. After 6 weeks, unhardened Pen A4 showed significantly higher tolerance to *M. nivale* than the velvet bents, while Avelon was the least tolerant cultivar.

Tolerance to winter conditions and *Microdochium nivale* with artificial snow cover

Artificial snow cover caused more damage than artificial ice cover in these experiments. There was little difference between 6 and 12 weeks´ exposure and there were some contradictory results. There was no significant difference between the grass cultivars, except that hardened Pen A4 had higher tolerance to *M. nivale* than the velvet bents.

Grading of the tested Cultivars

Tolerance to frost: Greenwich > Avelon=Legency= Villa > PenA4

Tolerance to winter conditions without ice and snow cover
Hardened plants, uninoculated or inoculated: No significant differences
Unhardened plants uninoculated: Greenwich = Legency = Villa >Pen A4 > Avelon
Unhardened plants inoculated with *M. nivale*: Pen A4 > Greenwich = Legency = Villa = Avelon

Tolerance to winter conditions with ice or snow cover
Hardened plants, uninoculated or inoculated: No significant differences
Unhardened plants: Greenwich = Legency =Villa = Pen A4 >Avelon
Unhardened plants inoculated with *M. nivale*: No significant differences

Overall ranking of the velvet cultivars: Greenwich > Legency =Villa >Avelon