

Forest tree seedlings may suffer from predicted future winters

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Future climate scenarios predict increased precipitation and air temperatures, particularly at high latitudes, and especially so during winter, spring and autumn. However, soil temperatures are more difficult to predict, since they depend strongly on the insulating snow cover. Warm periods during winter can lead to thaw-freeze cycles and flooding, which again can result in the formation of ice layers, affecting soil properties, soil gas concentrations and the survival of tree seedlings. We conducted two laboratory experiments of 20 weeks duration each, simulating winter, spring and early summer, and imposed Scots pine (*Pinus sylvestris* L.) or downy birch (*Betula pubescens* Ehrh.) seedlings to four different winter scenarios: (1) ambient snow cover, (2) compressed snow and ice encasement, (3) frozen flood and (4) no snow. We estimated the stress that the seedlings experienced by means of gas exchange, chlorophyll fluorescence and determining above- and belowground biomass and carbohydrate contents, as well as measuring soil oxygen and carbon dioxide concentrations. The seedlings in the snow and compressed snow treatments survived until the end of the experiments, although only those covered with an ambient snow cover showed normal height growth and typical carbohydrate contents. The seedlings in the other treatments showed symptoms of dieback already during early spring and had almost completely died at the end of the experiment. Our results suggest the crucial significance of the protective snow cover, and that a missing soil cover or soil hypoxia and anoxia during winter can be lethal for seedlings, and that respiratory losses and winter desiccation of aboveground organs can further lead to the death of tree seedlings.