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Impacts of European spruce bark beetle infestations on Norway spruce BVOC emissions

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Tree killing by spruce bark beetles (*Ips typographus*) is one of the main disturbances to Norway spruce (*Picea abies*) forests in Europe and the risk of outbreaks is amplified by climate change with effects such as increased risk of storm felling, tree drought stress and an additional generation of spruce bark beetles per year[1]. The warm and dry summer of 2018 triggered large outbreaks in Sweden, the increased outbreaks are still ongoing and affected about 8 million m^3 forest in 2020[2]. This is the so far highest record of trees killed by the spruce bark beetle in a single year in Sweden[2]. In 1990-2010, the spruce bark beetle killed on average 150 000 m^3 forest per year in southern Sweden[3]. Bark beetles normally seek and attack Norway spruces with lowered defense, i.e. trees that are wind-felled or experience prolonged drought stress[4]. However, as the number of bark beetle outbreaks increase, the risk of attacks on healthy trees also increase[5]. This causes a higher threat to forest industry, and lowers the possibilities to mitigate climate change in terms of potential decreases in carbon uptake if the forests die[4,5]. Norway spruce trees normally defend themselves by drenching the beetles in resin[6]. The resin in turn contains different biogenic volatile organic compounds (BVOCs), which can vary if the spruce is attacked by bark beetles or not [4,6]. The most abundant group of terpenoids (isoprene, monoterpenes and sesquiterpenes), is most commonly emitted from conifers, such as Norway spruce[7,8]. The aim of this study was to enable a better understanding of the direct defense mechanisms of spruce trees by quantifying BVOC emissions and its composition from individual trees under attack

To analyze the bark beetles' impact on Norway spruce trees a method was developed using tree trunk chambers and adsorbent tubes. This enables direct measurements of the production of BVOCs from individual trees. Three different sites in Sweden, with different environmental conditions were used for the study and samples were collected throughout the growing season of 2019. After sampling, the tubes were analyzed in a lab using automated thermal desorption coupled to a gas chromatograph and a mass spectrometer to identify BVOC species and their quantity.

The preliminary results show a strong increase in BVOC emissions from a healthy tree that became infested during the data collection. The finalized results expect to enable better understanding of how spruce trees are affected by insect stress from bark beetles, and if bark beetle infestation will potentially result in increased carbon emission in the form of BVOCs.

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