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Tree species effects on the balance of carbon and nitrogen in a Swedish boreal forest ecosystem

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Targeted selection of a tree species with a potential for greater C accumulation in the wood but also in the soil is one of the management tools for climate change mitigation. Most of the research has focused on the C sequestration in the aboveground wood biomass. However, far less is known about the influence of Sweden′s two most common tree species, Norway spruce (Picea abies (L.) Karst) and Scots pine (Pinus sylvestris (L.)), and their mixture on the belowground C storage and the C balance of the whole ecosystem. Studies based on forest inventories often report higher wood productivity and soil C storage in spruce forests at a national scale but are unable to discern the tree species effects per se from other confounding factors. We used a well-replicated 60-yr-old common-garden experiment in boreal Sweden to address the effects of Norway spruce and Scots pine stands, as well as their equal mixture on the soil C storage and the major C fluxes in the ecosystem; the soil CO_2 efflux and litterfall inputs. We found a superior growth of Scots pine in the pure stands and in the mixture with almost twice as high standing volume than in the Norway spruce stands. Correspondingly, the total litterfall inputs in the Scots pine and mixed species stands were almost twice the inputs in the Norway spruce stands. Our results suggest that Scots pine was more efficient in allocating C and N to the wood growth than Norway spruce. In contrast, spruce stands retained more N in their larger canopies, both, proportionally and in absolute terms compared to pine stands. Hence, less N returned to the forest floor through litterfall, likely causing stronger N limitation in the spruce stands. This was also reflected in the soil as greater amounts of C and N accumulated in the humus, and in the humus and mineral soil layers combined, in the pine and mixture stands than in the spruce stands. On the other hand, significantly higher soil CO_2 efflux rate in the spruce stands suggests greater allocation of C resources belowground to roots and their ectomycorrhizal fungal associations, likely to increase the acquisition of N. Results from this common-garden experiment show that at this site, equally suitable for Norway spruce and Scots pine, selecting pine or a mixture of pine and spruce increased the C storage in the wood biomass and soil, and reduced the losses of C through soil efflux back to the atmosphere.