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Uptake of urea by “drunken” trees on permafrost

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Boreal forest productivity on permafrost is limited by availability of soil nitrogen (N) in the active layer. Low soil temperature and summer flooding limit microbial N mineralization on shallow permafrost table. Uptake of amino acids by plant root-mycorrhizal association is known to mitigate N limitation in boreal forest soils. However, amino acid hypothesis can not fully explain advantage of black spruce trees in drunken forests due to competition of amino acids between plants, bryophytes, and microbes. Based on the observation of urea accumulation in deeper soil, we test another hypothesis that black spruce trees take up intact urea in deeper soil. Mixture solutions (glutamic acid, urea, ammonium, nitrate), with only one N form labeled by ¹³C and/or ¹⁵N, was injected into the organic/mineral soil layers. We compared two black spruce forest sites with/without shallow permafrost table in northern Canada. We found that black spruce trees take up intact urea as well as amino acids in the shallow permafrost sites. Urea accumulation is explained by low microbial activities to mineralize ¹⁴C-labeled urea. The other plants or bryophyte compete with black spruce for amino acids, but not for urea. Since the other black spruce trees in the deeper soil sites rely on amino acids and inorganic N, urea uptake strategy is specific to black spruce trees on shallow permafrost table. The root expansion on hummocky microrelief provides opportunity for leaning trees to access urea. The uptake of intact urea could be one of strategy of black spruce trees to mitigate N limitation in permafrost-affected hummocky soils.