

Seasonal dynamics of nitrogen and source of nitrogen for larch in the taiga forest in north-eastern Siberia

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Nitrogen (N) is known to be one of the major limiting factors for plant growth in the northern hemisphere. CO₂ assimilation is directly related to N contents in the plant leaf as it is the major component of photosynthetic system.

We conducted the study on N dynamics at Spasskaya Pad Experimental forest station located near Yakutsk city, Russia in 2009-2011 years. Amount of N input with atmospheric deposition occurred to be very low (about 48 mgN m⁻² year⁻¹). It was found that in the beginning of the growing season the content of inorganic N in the soil pool was very few (about 1 to 2 gN m⁻² was observed at depth 0 to 50 cm mineral layer of soil). From the mid-July (when soil temperatures at 20 cm depth reached about 300 degree days) intensive mineralization of N started. The largest content of inorganic N was observed in the end of August (about 14 gN m⁻² at the same soil depth). And then, in the beginning of the next growing season, soil inorganic N pool was small again, which indicated large amount of microbial immobilization. Ammonium dominated soil inorganic N pool. Amount of water extractable N in the soil was much lower than KCl extractable, because ammonium was bound to clay particles in the soil.

Results of tracer ¹³C¹⁵N-amino acid, ¹⁵N-ammonium and ¹⁵N-nitrate experiments showed that larch did not uptake organic N and inorganic N was the source of N for larch. Also in the beginning of growing season amino acid was not mineralized to inorganic N within two days but rather stayed in the soil or was immobilized by microbes.

Allocation of N uptaken from soil by larch varied during growing season. N that was uptaken in the beginning of growing season (June) was used for the growth of new organs: new shoots and needles; however, N that was uptaken in the middle of growing season (from the mid-July) was stored in the tree perennial parts (branches, trunk and short branches carrying buds) to be used in the beginning of the next growing season. Also, retranslocation of N prior to needle senescence was very high (60 to 70% of needle N content).

Needle N content was affected by environmental conditions (soil water and temperature) in the previous growing season. This can be explained by observed discrepancy between timing of N mineralization by soil microorganisms (in the late summer) and plant N demand (in the beginning of summer during larch needle and new shoot formation). Needle N content affected amount of litterfall also with one year delay. Therefore, there was a positive relationship between N availability and amount of CO₂ assimilated by larch trees in the area of study.

Keywords: boreal forest, taiga, nitrogen cycle, organic nitrogen uptake, soil nitrogen pool, nitrogen allocation