

**CHARACTERISTICS OF NUTRITIONAL STATUS OF SCOTS
PINE TREE-STANDS IN THE BAIKAL NATURAL TERRITORY**

© T. A. Mikhailova,¹ O. V. Shergina, O. V. Kalugina

Siberian Institute of Plant Physiology and Biochemistry of Siberian Branch
of the Russian Academy of Sciences, Irkutsk

¹E-mail: mikh@sifibr.irk.ru

REFERENCES

1. Bazilevich N. I., Titlyanova A. A. 2008. Bioticheskiy krugovorot na pyati kontinentakh: azot i zolnye elementy v prirodnykh nazemnykh ekosistemakh [Biotic rotation on five continents: nitrogen and ash elements in natural terrestrial ecosystems]. Novosibirsk. 381 p. (In Russian)
2. Bergh J., Nilsson U., Grip H., Hedwall P.-O., Lundmark T. 2008. Effects of frequency of fertilization on production, foliar chemistry and nutrient leaching in young Norway spruce stands in Sweden. — *Silva Fenn.* 42(5): 721–733.
3. Prietzel J., Kölling C. 1998. Trajectory analysis of long-term changes in the nutritional status of a Scots pine stand. — *Forstwiss. centralbl. vereinigt mit tharandter forstliches Jahrbuch.* 117(1–6): 137–155.
4. Cape J. N., Freer-Smith P. H., Paterson I. S., Parkinson J. A., Wolfenden J. 1990. The nutritional status of *Picea abies* (L.) Karst. across Europe, and implications for «forest decline». — *Trees.* 4(4): 211–224.
5. Hytönen J., Wall A. 2006. Foliar colour as indicator of nutrient status of Scots pine (*Pinus sylvestris* L.) on peatlands. — *Forest Ecol. Manag.* 237(1–3): 156–163.
6. Garg V. K., Khanduja S. D. 1976. Nutritional status of some fruit trees grown on normal and alkali soils. — *Sci. Hortic. (Amst.).* 5(3): 243–247.
7. Erel R., Yermiyahu U., Van Opstal J., Ben-Gal A., Schwartz A., Dag A. 2013. The importance of olive (*Olea europaea* L.) tree nutritional status on its productivity. — *Sci. Hortic. (Amst.).* 159: 8–18.
8. Saarsalmi A., Tamminen P., Kukkola M., Levula T. 2011. Effects of liming on chemical properties of soil, needle nutrients and growth of Scots pine transplants. — *Forest Ecol. Manag.* 262: 278–285.
9. Moilanen M., Saarsalmi A., Kukkola M., Issakainen J. 2013. Effects of stabilized wood ash on nutrient status and growth of Scots pine — comparison between uplands and peatlands. — *Forest Ecol. Manag.* 295: 136–144.
10. Johnson D. W., Lindberg S. E., Miegroet H. V., Lovett G. M., Cole D. W., Mitchell M. J., Binkleyan D. 1993. Atmospheric deposition, forest nutrient status, and forest decline: implications of the integrated forest study. In: *Forest Decline in the Atlantic and Pacific Region.* P. 66–81.
11. Kopinga J., Burg J. 1995. Using soil and foliar analysis to diagnose the nutritional status of urban trees. — *J. Arboric.* 21(1): 17–24.
12. Ewald J. 2005. Ecological background of crown condition, growth and nutritional status of *Picea abies* (L.) Karst. in the Bavarian Alps. — *Eur. J. Forest Res.* 124(1): 9–18.
13. Dominguez M. T., Maracyn T., Murillo J. M., Schulin R., Robinson B. H. 2010. Nutritional status of mediterranean trees growing in a contaminated and remediated area. *Water Air Soil Poll.* 205(1): 305–321.
14. Dmuchowski W., Brogowski Z., Baczewska A. H. 2011. Evaluation of vigor and health of street trees using foliar ionic status. — *Pol. J. Environ. Stud.* 20(2): 489–496.

15. Kolomytsa V. A. Results of researches of soil nutrient regime of in the corn cultivation combined method of irrigation. In: Melioratsiya i vodnoe khozyaystvo. 2005. Vol. 4: 73—75. (In Russian)
16. Vasilev M. V. 2011. Pitatelnyy rezhim dernovo-podzolistykh pakhotnykh i zalyezhykh suglinistykh pochv Severo-Zapada RF: Avtoref. dis. ... kand. s.-khoz. nauk [Nourishing mode of sod-podzolic and arable zalezh governmental loamy soils of the North-West of Russia: Author. Dis. ... Cand. (Agriculture) Sci.]. SPb.; Pushkin. 18 p. (In Russian)
17. Fiziologiya sosny obyknovnoy [Physiology of *Pinus sylvestris*]. 1990. Novosibirsk. 248 p. (In Russian)
18. Sazonova T. A., Bolondinskiy B. K., Pridacha V. B. 2011. Ekologo-fiziologicheskaya kharakteristika sosny obyknovnoy [Eco-physiological characteristics of *Pinus sylvestris*]. Petrozavodsk. 207 p. (In Russian)
19. Lukina N. V., Nikonov V. V. 1998. Pitatelnyy rezhim lesov severnoy taygi: prirodnye i tekhnogennye aspekty [Nutritional rezhim of the forests of north taiga: natural and technogenic aspects]. Apatity. 316 p. (In Russian)
20. Yaroshenko A. Yu., Potapov P. V., Tyrybanova S. A. Malonarushennyye lesnye territorii evropeyskogo severa Rossii [Intact Forest Landscapes of European North of Russia]. Moscow. 2001. 75 p. (In Russian)
21. Bobkova K. S., Robakidze E. A., Galenko E. P. 2010. Vital state of stands and subheight indigenous spruce forests of the foothills of the Urals basin upper Pechora. — Sibirskiy ekologicheskiy zhurnal. 17(2): 271—280. (In Russian)
22. Atlas. Irkutskaya oblast (ecologicheskie usloviya razvitiya) [Atlas. Irkutsk region. Ecological conditions of development]. 2004. Moscow; Irkutsk. 90 p. (In Russian)
23. Gosudarstvennyy doklad «O sostoyanii i ob okhrane okruzhayushchey sredy Irkutskoy oblasti za 2012 god» [State report «On the state and environmental protection of the Irkutsk region for 2012»]. 2013. Irkutsk. 337 p. (In Russian)
24. Metodicheskie rekomendatsii po provedeniyu polevykh i laboratornykh issledovaniy pochv i rasteniy pri kontrole zagryazneniya okruzhayushchey sredy metallami [Methodical recommendations on realization of the field and laboratory researches of soils and plants in the control of environmental pollution metals]. 1981. Moscow. 108 p. (In Russian)
25. Probbnyye ploshchadi lesoustroitelnye: metody zakladki. OST 56-69—83. [Trial forest management area]. 1983. Moscow. 11 p. (In Russian)
26. Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests / UNECE, ICP Forests Programme Coordinating Centre. Hamburg, 2010; <http://www.icp-forests.org/Manual.htm>
27. Klassifikatsiya i diagnostika pochv Rossii [Classification and diagnostics of soil of Russia]. 2004. Smolensk. 342 p. (In Russian)
28. Vorobeva G. A. 1999. Klassifikatsiya i sistemetika pochv yuzhnoy (osvoennoy) chasti Irkutskoy oblasti. In: Metodicheskie ukazaniya [Classification and systematization of soils of south (development) part of the Irkutsk region. Methodical instructions]. Irkutsk. Part 1. 47 p. (In Russian)
29. Agrokhimicheskie metody issledovaniya pochv [Agrochemical methods of soils research]. 1975. Moscow. 656 p. (In Russian)
30. Praktikum po agrokhimii [Workshop on agrochemistry]. 1989. Moscow. 304 p. (In Russian)
31. Pleshkov B. P. 1976. Praktikum po biokhimii rasteniy [Workshop on biochemistry of plants]. Moscow. 256 p. (In Russian)
32. Vadyunina A. F., Korchagina Z. A. 1986. Metody issledovaniya fizicheskikh svoystv pochv [Methods of research of physical properties of soils]. Moscow. 416 p. (In Russian)
33. Kabata-Pendias A., Pendias Kh. 1989. Mikroelementy v pochvakh i rasteniyakh [Microelements in soils and plants]. Moscow. 439 p. (In Russian)

34. Rozhkov A. S., Mikhailova T. A. 1989. Deystvie ftorsoderzhashchikh emissiy na khvoynye derevyia [The Effects of Fluorine-Containing Emissions on Conifers]. Novosibirsk. 159 p. (In Russian)
35. Iljin V. B., Syso A. I. 2001. Mikroelementy i tyazhyelye metally v pochvakh i rasteniyakh Novosibirskoy oblasti [Microelements and heavy metals in soils and plants of the Novosibirsk region]. Novosibirsk. 229 p. (In Russian)
36. Vakhmistrov D. B., Vikyams M. V., Sharma G., Yagodin B. A. 1986. The ratio of N : P : K and selective ability of plants (theoretical analysis). — Fiziologiya i biokhimiya kulturnykh rasteniy. 18(4): 326—333. (In Russian)
37. Pridacha V. B., Sazonova T. A. 2004. Age-related changes in the content and the ratio of nitrogen, phosphorus and potassium in the organs of *Pinus silvestris* and *Picea abies* (Pinaceae). — Botanicheskiy zhurnal. 89(9): 1486—1496. (In Russian)
38. Wehrmann J. M. 1963. Möglichkeiten und Grenzen der Blattanalyse in der Forstwirtschaft. — Landwirtsch. Forsch. 16(2): 130—145.
39. Spravochnik poprimeneniyu udobreniy v lesnom khozyaystve [Reference book on application of fertilizers in forestry]. 1977. Moscow. 312 p. (In Russian)
40. Kuzmin V. A. 2002. Pochvy tsentralnoy zony Baykalskoy prirodnoy territorii (ecologogeokhimicheskiy podkhod). Irkutsk. 166 p. (In Russian)
41. Kovalskiy V. V. 1974. Geokhimicheskaya ekologiya [Geochemical ecology]. Moscow. 282 p. (In Russian)
42. Ponomareva V. V., Plotnikova T. A. 1980. Gumus i pochvoobrazovanie (metody i rezyltaty izycheniya [Humus and soil formation (methods and results of the study)]. Leningrad. 222 p. (In Russian)
43. Motuzova G. V. 2013. Soedineniya mikroelementov v pochvakh: Sistemnaya organizatsiya, ekologicheskoe znachenie, monitoring [Compounds of microelements in soils: System organization, ecological value, monitoring]. Moscow. 168 p. (In Russian)
44. Aleksandrova L. N. 1980. Organicheskoe veshchestvo pochvy i protsessy ego transformatsii [Organic substance of soil and processes of his transformation]. Leningrad. 288 p. (In Russian)
45. Sokolova T. A., Tolpeshta I. I., Trofimov S. Ya. 2007. Pochvennaya kislotnost. Kislotno-osnovnaya bufernost pochv. Soedineniya alyuminiya v tverdoy faze pochvy i v pochvennom rastvore [Soil acidity. Acid-base buffering capacity of soils. Aluminium compounds in the solid phase in the soil and the soil solution]. Tula. 96 p. (In Russian)
46. Raznoobrazie pochv i bioraznoobrazie v lesnykh ekosistemakh sredney taygi [Variety of soils and biodiversity in forest ecosystems of the middle taiga]. 2006. Moscow. 287 p. (In Russian)
47. Regulyatornaya rol pochv v funktsionirovanii tayezhnykh ekosistem [A regulator role of soil in the functioning of taiga ecosystems]. 2002. Moscow. 364 p. (In Russian)