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Influence of woody vegetation on physico-chemical properties of sod-podzolic soils at Lesnaya Opytnaya Dacha of RSAU-MTAA named after K.A. Timiryazev

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Abstract. A research of the dependence of Lesnaya Opytnaya Dacha (LOD) soil properties on the varieties of the woody vegetation grown on these soils has been conducted. Measurements of the humus content, hydrolytic soil acidity, saline soil acidity and the sum of exchange base cations were used as main soil properties. Different types of vegetation were studied, including pure deciduous and pure coniferous stands and their mixtures in different proportions. Some controversial data was acquired, according to which, it appears that deciduous stands and coniferous stands do not have a statistically significant impact on the studied soil properties.

1 Introduction

V. Dokuchaev, the founder of genetic soil science, pointed out the dependence of soil properties on the type of forest vegetation [1, 2]. In his works, he noted that in the same climatic conditions, different soils are formed under different tree species and supported this hypothesis with numerous examples. He pointed out the importance of studying the influence of individual tree species on the soil [3].

G. Morozov [4] noted that forestry is interested in the subject of plantings influence on soils. A forestry specialist has always known how to use the synergy between the forest canopy and the generated litter in its favor to preserve the forests' fertility and to facilitate the emergence of the undergrowth.

A significant number of works on the importance of the influence of individual tree species on soil properties have been published (M. Tkachenko, 1939 [5]; N. Remezov, 1953 [6]; S. Sonn, 1954 [7]; B. Zaitsev, 1964 [8]; G. Demin, 1997 [9]; L. Karpachevsky, 1997 [10]; K. Gavrilov, 2000 [11], etc.).

Currently, the forest vegetation influence on the soil is assessed in many different ways. L. Karpachevsky and M. Stroganova [12] raise the question of what is primary: changes in soil due to the influence of vegetation, or differentiation of vegetation due to the soil properties. At the same time, L. Karpachevsky [13] identifies two aspects of studying the influence of tree species on soil formation: 1) the influence of plants in pure plantings; 2) the total effect in mixed plantings.

In their works, K. Gavrilov [11] and G. Demin [9] have confirmed that there would be significant differences in soil chemistry and morphology under different types of forestry vegetation, all other factors being equal (e.g.: climate, landform, soil genesis, soil texture, etc.). It is known that each tree species has its own requirements for soil conditions and, above all, there is the moisture-to-air ratio in the soil and the amount of available nutrients.

2 Materials and methods

A. Pozdnyakov et al. [14] have noted that the soil is an inhomogeneous natural formation, characterized by both temporal and spatial variabilities. Anisotropy is common at all levels of soil organization, yet it still has to be studied further.

Through their works, N. Lukina et al. [15] indicate that trees should be regarded as ecosystem engineers, since they form the horizontal mosaic structure of forests.

According to A. Gennadiev et al. [16], M. Gerasimova and L. Isachenkov [17], certain soils correspond to each stage of the succession of woody vegetation, which differ primarily in the upper horizons.

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V. Karminov [18] notes that despite soil characteristics being rather consistent in the short run, age-related changes in forestry vegetation noticeably change properties of the upper horizons of soils.

M. Gerasimova et al. [17], L.O. Karpachevsky [10], Yu. Demakov et al. [19], V.D. Naumov et al. [20] note that the current soil formation processes are affected by the woody vegetation. The dynamic soil properties are as follows: pH, cation exchange capacity, biogenic accumulation of ash constituents, etc. Alongside with these changes, heights of genetic horizons change too.

A review of available literature shows that a number of opinions regarding the effects of vegetation on soils exist. It is still debatable whether woody plants change soil properties or vice versa – soil properties determine the composition of woody vegetation. Despite a lot of conducted research, the relationship between forest vegetation and soils is still evaluated insufficiently. The obtained data is ambiguous and controversial, which has served as the reason for conducting this research.

The goal of this research is to study the influence of woody plants of various compositions on the physico-chemical properties of the upper horizons of sod-podzolic soils at the Lesnaya Opytnaya Dacha (LOD) station of the Russian State Agricultural Academy named after K.A. Timiryazev.

The study was conducted at the Lesnaya Opytnaya Dacha (Experimental Forest) station at the RSAU-MTAA n. a. K. A. Timiryazev. LOD was founded in 1862 and is used to this day as a native scientific laboratory, being the oldest of its kind in Europe. During its existence, LOD was subjected to continuous monitoring and extensive research. The forest in the area is presented by both native and artificially planted parts, where some trees are over 300 years old. Considering the age, LOD has an immense scientific and industrial significance, as it provides an opportunity to conduct long-term research and data aggregation that excludes errors of short-term research.

LOD is situated at the north-west part of Moscow, being the southmost part of RSAU university. Its shape resembles a rectangle, being approximately 1.6km wide and 2.8km long. According to soil-geographic zoning, LOD is placed at the European-North-Siberian taiga-forest continental area, in a southern-taiga sod-podzolic zone.

From the geological perspective, LOD finds itself in a Central-Moscow structural-geomorphological block, which is a gently sloping dome-like elevated area. It is worth noting that LOD has none of the upper Pleistocene cover loam, which is very commonly present through the city of Moscow [20].

The relief of the LOD territory is moraine-plain. Soil-forming rocks are represented by moraine deposits of various sizes.

3 Results and discussion

The LOD is located on a flat watershed moraine hill with a very gentle slope to the southwest (on average, 0.01 m falls per 1 linear meter) and with a steeper slope to the northeast. The highest part of this hill is 175 m above sea level and is located in the middle between the VII and XI quarters (Fig. 1). The lowest part is 160 m above sea level and is located in the northern part of the LOD on the territory of the I and III quarters. The relief is represented by a combination of Middle Pleistocene, Late Middle Pleistocene and Late Pleistocene-Holocene genetic types of surfaces that were formed as a result of the processes of accumulation of glacier deposits and flows of thawed glacial waters.

During LOD organization in 1892 by Vargas de Bardemar, a famous forester, it was split in 14 quarters, represented by roman numbers in fig. 1.

The soil cover of the LOD is represented by sod-podzolic soils, differing in the manifestation of sod, podzolic and gley processes. The taxation-forestry and soil survey of the quarters [20] showed that all the quarters have a different composition of stands.

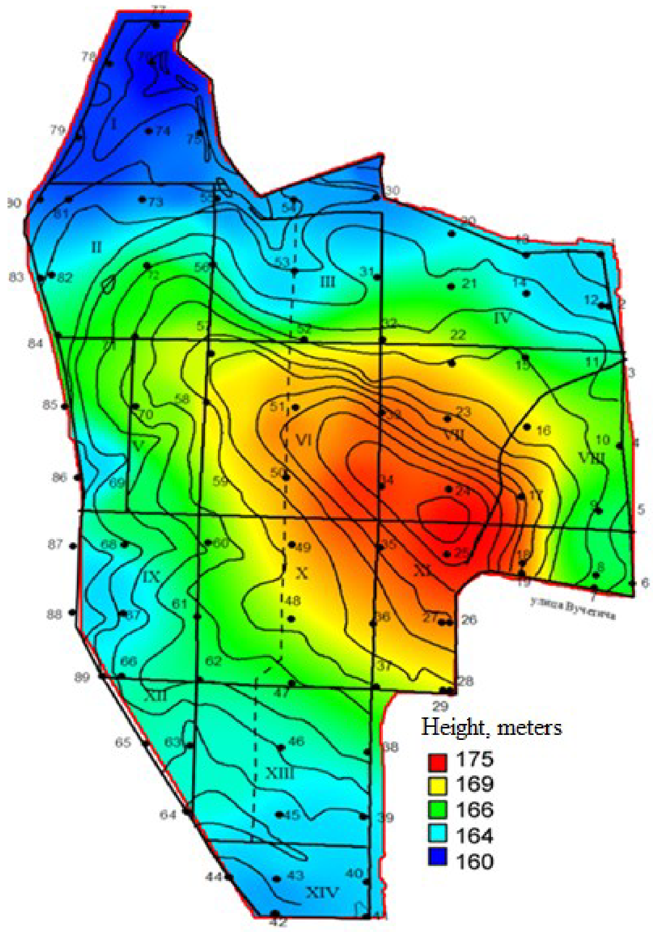

Fig. 1. LOD elevation map.

The relief of the III quarter is represented in the north and east of the site by the subhorizontal surface of the water-glacial plain, the central part is occupied by inclined surfaces of valley-like depressions, in the northwest there is a cirque–shaped depression, in the west - the slope of a moraine hill. The soil-forming rock is represented by moraine deposits of various textures (mainly medium loamy).

The soils are sod-podzolic, medium-fine, shallow, low-power in terms of the thickness of the humus horizon; in terms of the intensity of the manifestation of the podzolic process – strongly and medium-podzolic; in terms of the depth of the podzolization – deep and ultra-deep podzolic. The texture is light and medium loamy. Signs of gley-building were detected on 4 test areas: E, 6, 1, and 2. According to the depth of gleying, profile-gleyed soils are marked under mixed plantings with a predominance of conifers located on the inclined surfaces of the circus depression, superficially–gleyed soils are confined to the area of the valley-like depression.

Vegetation is mainly represented by mixed stands. For sample areas 6 and 1, vegetation is mixed with a predominance of coniferous species mixed vegetation with a predominance of deciduous species for areas 5 and 2; for area E – pure coniferous stands and area 4 – pure deciduous stands.

The relief of the IV quarter is represented by the Middle Pleistocene surfaces, mainly the subhorizontal surfaces of the water-glacial plain. Accumulative-erosive inclined surfaces of valley-like depressions are present in the southwest and northwest. The soil-forming rock is represented by moraine deposits of various texture (mainly light loamy).

The soils are sod-podzolic, medium-fine, shallow and extremely shallow in terms of the thickness of the humus horizon; in terms of the intensity of the podzolic process – strongly podzolic; in terms of the depth of podzolization – deep and ultra-deep podzolic. According to the texture, they are light and medium loamy. Signs of gley forming were revealed on 4 test areas: 2*, Ш, E and B. According to the depth of gley forming, the soils are mainly profiled, deeply gleyed and confined to the area of valley-like depression.

Vegetation is mainly represented by mixed stands with a predominance of coniferous species on test areas 2* and Ъ. Test areas E and B are represented by pure coniferous stands.

The relief of the V quarter is represented by the subhorizontal top of a moraine hill in the northeast of the site, turning into a northwestern slope, to the south, accumulative-erosive inclined surfaces of the valley-like depressions stretch from west to east. The soil-forming rock is represented by moraine deposits of various textures (mainly light loamy).

The soils are sod-podzolic, medium–fine and shallow in terms of the thickness of the humus horizon; strongly and medium-podzolic in terms of the intensity of the manifestation of the podzolic process; deep and ultra–deep podzolic in terms of the depth of podzolization. Texture wise, they are light loamy. Signs of gleybuilding were detected on all test areas. According to the depth of the gleying, the soils are profile gleyed.

Vegetation is mainly represented by mixed stands with a predominance of coniferous species on trial areas M4 and У. For the trial area Ж and section 85, pure coniferous stands of origin artificial were present.

The main territory of the VI quarter is situated on a subhorizontal peak and the slopes of a moraine hill. The soil-forming rock is represented by moraine deposits of various texture (mainly medium loamy).

The soils are sod-podzolic, mainly medium–shallow and partially shallow according to the thickness of the humus horizon; strongly and medium-podzolic according to the intensity of the manifestation of the podzolic process; deep and ultra–deep podzolic according to the depth of the podzolization. Texture wise soils are light loamy. Signs of gleying were detected on all test areas, except 13. According to the depth of gleying, the soils are mainly profiled.

Vegetation is mainly represented by mixed stands with a predominance of coniferous species on test areas П, B, 15. Pure deciduous stands are represented on areas Ъ and 13. Single pure coniferous stands and mixed stands, with a predominance of deciduous, are on areas E and C, respectively. Everything is of artificial origin.

The territory of the VII quarter is represented by subhorizontal peaks and a moraine hill slope. A suffusion depression is located in the central part of the site. A narrow sloping surface of a valley-like depression stretches from the north-eastern corner. The soil-forming rock is represented by moraine deposits of various textures (predominantly light loamy).

The soils are sod-podzolic, mainly medium–shallow in terms of the thickness of the humus horizon, mainly medium-podzolic in terms of the intensity of the manifestation of the podzolic process, deep- and ultra-deep podzolic in terms of the depth of the podzolization. According to the texture, light loamy soils predominate. Signs of gley building were revealed in the trial areas E and K. According to the depth of gleying, the soils are deeply and profile gleyed.

Vegetation is mainly represented by mixed plantings with a predominance of conifers on test areas E, C, K. Pure coniferous stands dominate on the areas П and P. All stands of artificial origin.

The territory of the VIII quarter consists of subhorizontal surfaces turning into the slopes of a moraine hill, with inclined and horizontal surfaces of valley-like depression stretching from the north-eastern part of the quarter. The soil-forming rock is represented by moraine deposits of various textures (mainly light loamy).

The soils are sod-podzolic, medium–fine and shallow in terms of the thickness of the humus horizon; mainly medium-podzolic in terms of the intensity of the podzolic process; deep- and ultra-deep podzolic in terms of the depth of podzolization. Soil texture is light loamy. Signs of gley building were revealed on the test areas T1, П and O. According to the depth of the soil gleying, soils on test areas T1 and П are deeply gleyed and profile gleyed on the test area O.

Vegetation is mainly represented by mixed stands with a predominance of deciduous on test areas T1 and H. Pure deciduous stands are found on areas 3e, 3 and O. The test area П is characterized by mixed stands with predominance of conifers. Stands on areas 3, O and H are of natural origin, whereas П is artificial.

The relief of the X quarter is represented by the horizontal surface of the stone terraces bordered from the northeast by the slope of the moraine hill. From west to east, the inclined and horizontal surfaces of valley-like depressions extend, in the south there is a suffusion depression. The soil-forming rock is represented by moraine deposits of various textures (mainly heavy loamy).

The soils are sod-podzolic, medium–shallow in terms of the thickness of the humus horizon; medium–podzolic in terms of the intensity of the podzolic process; deep- and ultra-deep-podzolic in terms of the depth of the podzolization. The texture is light loamy and sandy loam. The signs of gleying are found in the test area T soil profiles – deeply gleyed soils.

Vegetation is represented by mixed stands with a predominance of coniferous species on test areas 3 and 1. Single pure coniferous stands are represented on the test area T, mixed with deciduous on test area 4. Through the quarter, except for the test area T, stands have artificial origin.

The territory of the XI quarter is confined to a subhorizontal top of the moraine hill, passing into the slopes to the west, in the westernmost part of the site there is a subhorizontal surface of the water-glacial plain. In the southern part of the quarter, there is a suffusion depression and a horizontal surface of the stone terraces. The soil-forming rock is represented by moraine deposits of various textures (mainly light loamy).

The soils are sod-podzolic, medium-small and low-power in terms of the thickness of the humus horizon, occasionally extremely small; mainly medium-podzolic, partially - strongly podzolic and shallow-podzolic in depth in terms of intensity of the manifestation of the podzolic process. Texture wise soils are light loamy and sandy loam. Signs of gleying were noted in all test areas, except for K. According to the depth of gleying, the soils on the test areas E and M are deeply gleyed, the areas 3 and Г* are superficially gleyed, the areas B2 and G are profile gleyed.

Vegetation is mainly represented by pure coniferous stands (trial areas K, Г and Г*), mixed with deciduous on test areas 3 and M. Single pure deciduous stands are represented on the test area E, mixed with coniferous species on the test area B2. The origin of stands in most cases is artificial (B2, K, Г*, Г); stands on areas E and M are of natural origin.

The territory of the XII quarter is a subhorizontal surface of the water-glacial plain in the west, passing into the north-western slope of the moraine hill. In the north-eastern part of the site, a part of a horizontal surface of the stone terraces is marked. In the east there is a suffusion depression. The southernmost edge of the quarter is represented by an inclined surface of a valley-like depression. The soil-forming rock is represented by heavy loamy moraine deposits.

The soils are sod-podzolic, medium-shallow and low-power in terms of the thickness of the humus horizon; strongly podzolic in terms of the intensity of the manifestation of the podzolic process; deep podzolic in terms of the depth of the podzolization. The texture of soils is light and medium loamy. Signs of gleying were detected on test area 11. According to the depth of the gleying, the soils are deeply gleyed.

Vegetation is represented by mixed stands with a predominance of deciduous plants. The origin of the stands is not specified.

The main area of the XIII quarter is occupied by the subhorizontal surface of the glacial plain, located in the central part of the site. In the south-western part, the presence of inclined and horizontal surfaces of valley-like depression was noted. The north-eastern part is distinguished by the slope of the moraine hill passing into the horizontal surface of the kama terraces. The soil-forming rock is represented by moraine deposits of various textures (mainly medium loamy).

The soils are sod-podzolic, medium–small in terms of the thickness of the humus horizon; strongly podzolic in terms of the intensity of the manifestation of the podzolic process; mainly ultra-deep podzolic in terms of the depth of the podzolization. The texture of the soil is light loamy. Signs of gley building were noted in all soils on the test areas. According to the depth of the gleying, the soils are deeply gleyed.

Vegetation is mainly represented by mixed stands with predominance of coniferous species (test areas 9, 7, 6). Single pure deciduous stands are represented on the test area 8, mixed with deciduous woods on the test area 5. The origin of the stands is not specified.

The territory of the XIV quarter is a subhorizontal surface of the water-glacial plain in the west. An inclined surface of a valley-like depression stretches from the south-east to the north. Moraine deposits of various granulometric compositions represent the soil-forming rock.

The soils are sod-podzolic, shallow in terms of the thickness of the humus horizon; strongly podzolic in terms of the intensity of the podzolic process; deep and ultra–deep podzolic in terms of podzolization. Soil texture is light and medium loamy. Signs of gleying were revealed on test areas 1 and 3. According to the depth of gleying, the soils are deeply glued.

Vegetation is represented by mixed stands with a predominance of deciduous woods. The origin of the stands is not specified.

To establish links between the physico-chemical properties of the upper horizons of sod-podzolic soils and stands of various species composition, plants were grouped. The composition of stands was chosen as a feature. 4 groups of stands were identified (pure coniferous, pure deciduous, mixed stands with a predominance of coniferous and mixed stands with a predominance of deciduous) (Tables 1 and 2).

Table 1. Test areas of pure stands grouped by wood composition.

Coniferous			Deciduous		
Quarter	Test area	Stands composition	Quarter	Test area	Stands composition
III	E	I-10C ed.B, Lp II-7D3Kl ed.Lp,B	III	4	9D1Lp
IV	E	9C1Lp,Kl ed.B,D,B	VI	Ъ	9B1Lp,D
IV	B	I-9C1Lp ed. Kl II-6Kl2Lp2D	VI	13	9B1Kl
V	85	10L+Lp	VIII	3	10Lp
V	Ж	10L ed.D	VIII	O	I-10D ed.Lp II-10Lp ed.Kl
VI	E	9C1Kl ed.Lp	XI	E	9D1Lp ed.C,B
VII	П	I-10L+B ed.B II-6B3Kl1Lp+B	XIII	8	10IVD
VII	P	10L+Lp	XIII	3e	I-9Lp1D ed.C II-6Lp3B1Kl
X	T	10L ed.D,B	XIV	1	9Iv1D ed. B,B,Kl,O
XI	Г*	10L+Lp ed.D			
XI	K	10L+Lp			
XI	Г	10L+Lp ed.D			

Pure coniferous stands are confined to the territory of the III quarter (E), IV quarter (E, B) V quarter (85, Ж), VI quarter (E), VII quarter (П, P), X quarter (T) and XI quarter (Г*, K, Г). The III, IV and VI quarters are characterized by the predominance of pine in stands with single inclusions of linden, maple and birch. The stands of other sites are dominated by larch, linden, oak with birch being singly marked. For test areas E of the III quarter, B of the IV quarter, П of the VII quarter, a distinctive feature is the presence of 2 tiers of mixed stands with a predominance of deciduous woods.

Pure deciduous stands are represented in the III quarter (4), VI quarter (Ъ, 13), VIII quarter (3, O), XII quarter (E), XIII quarter (8, 3e) and XIV quarter (1). In the VI quarter, the predominance of birch is in the composition of plantings with 10% admixture of linden, maple and oak. Oak is predominant on the III, VIII (O) and XI quarters. The VIII (3) and XIII (3e) quarters are distinguished by the predominance of linden in the composition of stands. Willow prevails in the stands of the XIII (8) and XIV quarters with an admixture of elm and oak. The second tier of stands, represented by mixed deciduous plantings, was identified in the VIII and XIII quarters.

Table 2. Test areas of mixed stands grouped by wood composition.

Mixed with coniferous predominance			Mixed with deciduous predominance		
Quarter	Test area	Stands composition	Quarter	Test area	Stands composition
			II	1	8B2Ded.Lp
			II	2	6B3D1Lp ed.OC
III	6	5C4B1B ed. Lp,K, O	II	3	5Lp4C1B ed.OC
III	1	6C4D ed.Lp, Kl, O	II	4	8D2C ed.Lp
IV	2*	5C3D2L+B,Lp, ed. E	III	5	7D3C ed. Lp,Kl,O
IV	Ъ	8C1Lp1D ed.B,Kl			
V	M4	5C5B ed.D,Lp	III	2	6D3Lp1C ed.Kl,O
V	У	6L3B1Kl ed.C,D			
VI	П	5C2B1Lp1B1D,Kl,E	IV	Ш	4C6B ed.B,Kl,D
VI	B	8C1Lp1D,Kl ed. B	V	B	4C6Lp
VI	15	5C5Lp ed.D,B	VI	C	5B3C1B1D ed.Kl
VII	E	I- 6L2Kl1C1Lp ed.B II- 8Kl1Lp1B	VIII	T1	4Kl2L2B2D
			VIII	H	8D2Lp ed.C
VII	C	ed.B 8L2Lp	X	4	5B2Kl2B1D ed.C
VII	K	I- 8C2Kl ed.B II- 10Kl ed. B,D	XI	B2	4C6Lp ed.B
VIII	П	5L5Bed.D,Kl,B,C,Lp	XI	3	5Kl4D1P
X	3	I- 7L3C ed.Lp,E,B II- 10Kl ed.Lp,B	XI	M	4D5Lp1B ed.B,Kl
X	1	I- 8C1B1Lp ed.E,D II- 8Kl2Lp +B	XII	10	7D3Lp ed. Kl,O
			XII	11	5B3D1Lp1Kl ed. O
XIII	9	5L4B1Lp ed. Kl, O			
XIII	7	6C3B1Kl,O	XIII	5	8B1Lp1KlO
XII	6	6L2C1Lp1Kl,O	XIV	3	8D2B ed. Kl,OB
			XIV	4	8D1C1Iv ed.DB

Mixed stands with a predominance of coniferous species are widespread throughout the territory of the LOD in VI, VII and XIII quarters. The predominant species is pine, less often larch. The admixture of deciduous plants is mainly represented by birch, oak and maple.

Mixed stands with a predominance of deciduous woods are also evenly distributed throughout the LOD. A greater number of such stands were noted on the II and XI quarters. The predominant species are oak and birch with linden and maple being less common.

For each group of stands, statistical processing of data from analyses of the upper horizons of sod-podzolic soils was performed, representing the following physico-chemical properties: humus content, hydrolytic acidity, sum of exchange bases and exchange acidity.

The humus content in the sod-podzolic soils of LOD ranges from 1.74 to 7.04%. For statistical processing of the obtained results, they were divided into 5 group soils according to the humus content (Fig. 2).

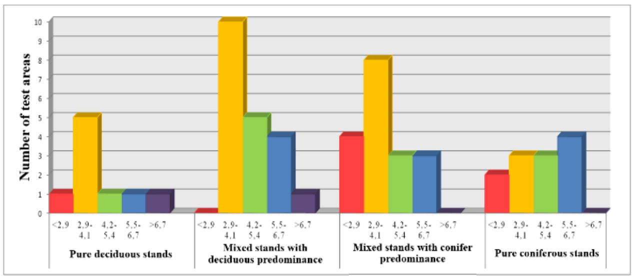

Fig. 2. Test areas grouped by humus content (%).

The first group included soils with a humus content of less than 2.9%, the second – 2.9-4.1%, the third – 4.2–5.4%, the fourth – 5.5–6.7%, the fifth – more than 6.7%. From Fig. 2 it can be seen that the maximum number of stands is in 3 groups: pure deciduous, mixed with a predominance of deciduous and mixed with a predominance of coniferous are confined to soil areas with a humus content of 2.9–4.1%. The humus content in sod-podzolic soils varies significantly, including soils under stands belonging to the same group by rock composition. The calculation of humus reserves in soils showed the following (Fig. 3). The least humus reserves were found in soils under purely coniferous and purely deciduous stands. The maximum reserves are under mixed stands with a predominance of deciduous species.

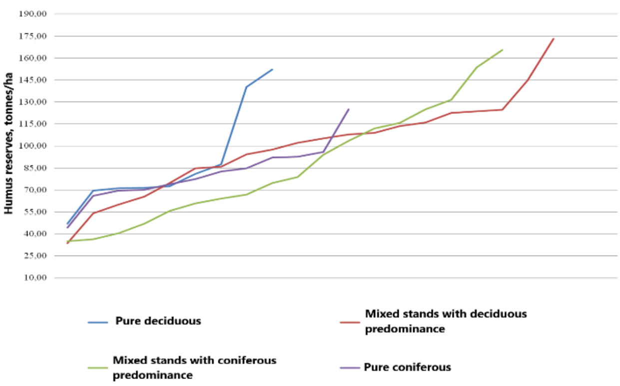

Fig. 3. Humus reserves in sod-podzolic soils of LOD.

The value of hydrolytic acidity (Ha) in sod-podzolic soils of LOD ranges from 1.50 to 17.06 mg-eq /100 g of soil. For statistical processing of the obtained data, five groups of soils were identified: the first group with an Ha value of less than 4.9 mg-eq/100 g of soil, the second – 4.9–8.3 mg-eq/100, the third – 8.4–11.8 mg-eq/100, the fourth – 11.9-15.3 mg-eq/100, the fifth is more than 15.3 mg-eq per 100 g of soil. Figure 4 shows fluctuations in the value of hydrolytic acidity in soils under stands of various compositions.

Soils under deciduous, mixed with a predominance of coniferous and pure coniferous, are mostly presented by group four, where the Ha value varies from 8.4 to 11.8 mg-eq/100g soil. Peak hydrolytic acidity was determined in soils under mixed stands with a predominance of conifers.

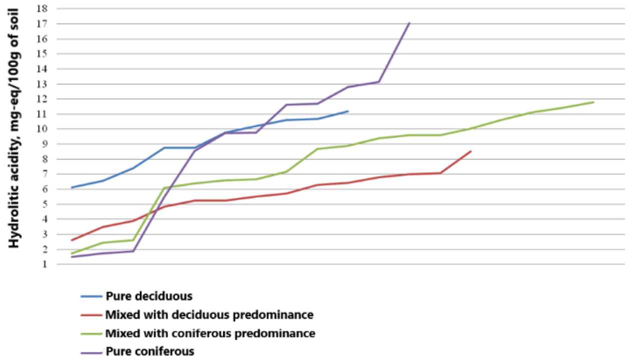

Fig. 4. Hydrolytic acidity of LOD sod-podzolic soils.

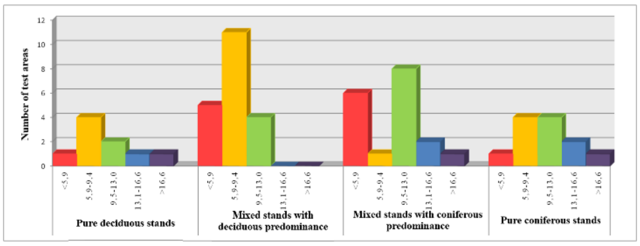

Fig. 5. Test areas grouped by sums of exchangeable base cations (mg-eq/100g).

The sum of exchange bases in sod-podzolic soils ranges from 2.40 to 18.21 mg-eq/100 of soil. For statistical processing of the obtained data, soils were split in 5 groups by the amount of exchangeable bases: less than 5.9; 5.9–9.4; 9.5–13.0; 13.1–16.6; more than 16.6 mg-eq/100 of soil (Fig. 5).

In soils under purely deciduous stands and mixed stands with a predominance of deciduous species are the maximum number of stands grows on soils with intervals of values of the sum of exchange bases of 5.9–9.4 mg-eq/100g soils. According to these values, a group of mixed with a predominance of deciduous stands is distinguished. A more uniform distribution of stands across different soil groups according to the content of the sum of exchange bases was revealed in mixed with a predominance of deciduous and mixed with a predominance of coniferous stands. The distribution of soils in the selected groups according to the sum of exchange bases under pure coniferous stands is close in nature to pure deciduous stands.

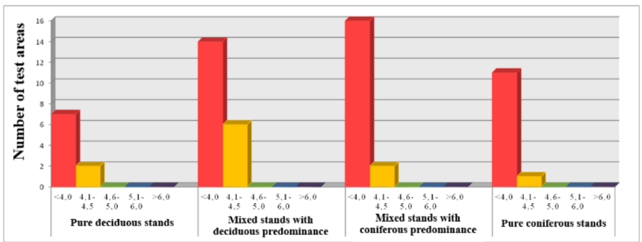

Fig. 6. Test areas grouped by pH_{KCl} of sod-podzolic soils.

The pH_{KCl} value in sod-podzolic soils ranges from 3.29 to 4.45. The following groups of soils were identified by this pH value: less than 4.0; 4.1–4.5; 4.6–5.0; 5.1–6.0; more than 6.0 as represented in fig. 6.

As seen from fig. 6, most of the soils under stands of various species composition have a pH_{KCl} value under 4.0. Significantly fewer stands grow on soils where the pH range is 4.1–4.5. A small number of stands grow on soils with a pH value of more than 4.6. Thus, on the territory of the LOD, most of the stands of various species composition grow on strongly acidic soils.

In this work, the methods of descriptive statistics and ANOVA analysis were used. The statistical evaluation of the data showed that the influence of different vegetation groups on soils in terms of the humus content, hydrolytic acidity, the amount of exchange bases and exchange acidity is similar. Comparison of the average values of the studied physico-chemical properties of soils showed that, according to the Fisher criterion, the level of significance of the differences between the compared groups in the composition of the stand is very low, which gives reason to conclude that there are no statistically significant differences (Table 1).

Table 2. ANOVA results.

Stands type		**Humus, %**	**Ha, mg-eq/ 100g**	**Sum of base cations, mg-eq/ 100g.**	**pH_{KCl}**
Pure deciduous stands	Average	4.21	8.81	10.18	3.92
	N	9	9	9	9
	St.dev.	1.53	1.80	3.90	0.24
Mixed stands with deciduous predominance	Average	4.49	7.08	7.46	3.84
	N	20	20	20	20
	St.dev.	1.08	2.79	2.35	0.26
Mixed stands with coniferous predominance	Average	3.86	7.83	9.35	3.77
	N	18	18	18	18
	St.dev.	1.23	310	4,71	0,20
Pure coniferous stands	Average	4,40	8,74	10,30	3,73
	N	12	12	12	12
	St.dev.	1.35	5.07	4.32	0.22
F-criterion		0.895	0.870	1.871	1.430
Significance		0.450	0.462	0.145	0.244

4 Conclusion

The studied groups of stands are located on the territory of the LOD and differ in: 1) genesis of geomorphological surfaces; 2) thickness of the humus horizon in the soils; 3) the intensity of the manifestation of the podzolic process; 4) depth of the appearance of the podzolic horizon; 5) depth of gley appearance.

The humus content in the sod-podzolic soils of the LOD ranges from 1.74 to 7.04%. Most of the purely deciduous stands and mixed stands with a predominance of deciduous and coniferous, grow on soils with a humus content of 2.9-4.1%. It was found that mixed stands and pure coniferous stands are more evenly distributed through the test areas on soils with both higher and lower humus contents in comparison with pure deciduous stands. The minimum reserves of humus were determined in soils under purely coniferous and purely deciduous plantings. The maximum reserves are found under mixed stands with a predominance of deciduous.

The value of hydrolytic acidity in sod-podzolic soils of LOD ranges from 1.5 to 17.06 mg-eq /100 g of soil. The maximum values of the hydrolytic acidity are determined in soils under mixed stands with a predominance of conifers.

The sum of exchange bases in sod-podzolic soils ranges from 2.40 to 18.21 mg-eq/100 of soil. Most of the plants in purely deciduous stands and mixed stands with predominance of deciduous, grow on soils with the exchange base sum in the range of 5.9 to 9.4 mg-eq/100 of soil, and in the group of mixed stands with a predominance of coniferous in the range of 9.5-13.0 mg-eq/100 of soil.

The pH_{KCl} value in sod-podzolic soils ranges from 3.29 to 4.45. In all groups of the studied stands, most of the plants grow on soils with a pH value under 4.0.

The influence of different groups of stands on the properties of the upper horizons of sod-podzolic soils of LOD has not been established.

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