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SOD-PODZOLIC GROUNDWATER CRYPTOGLEY AND GROUNDWATER GLEY SOILS OF THE BELARUSIAN POLESYE REGION

Findings of investigation of a constitution, compound and properties of sod-podzolic weakly gleyey and gleyey forest soils of the Belarus Polesye region are resulted. It is defined gradation analysis and properties. It is specified, that sod-podzolic weakly gleyey and gleyey soils are formed on fluvioglacial and old alluvial sandy and sandy-loam deposits. The humus content in sod-podzolic soils averages 2–3%. Soils are characterised middle acidic to subacidic reaction of medium, the degree of soils saturation of the base varies from 33% in a humus horizon to 79% in underlaying horizons. They are formed bracken, bilberry and oxalis phylums of ouk-woods on a given soils.

Introduction. Mineral soils of Belarusian Polesye are created mainly on glacifluvial and ancient alluvial deposits of sandy and sandy loam particle-size distribution, under joint influence of sod and podzolic processes of soil formation [1, 2].

Soils are characterized by not high, sometimes low natural fertility due to low water-retaining and absorbing ability. However in certain combinations of quality and depths of ground waters, a depth of waterproof rock, and the carbonates content in it, there are quite favorable conditions for formation and growth of highly productive plantings of valuable tree species (oak, ash, linden, hornbeam, etc.).

In the conditions of Belarusian Polesye region in certain forestry establishments upland oak forests occupy 4.2–5.5% of the area covered with bracken, sorrel and bilberry woods [3].

These kinds of woods include big variety of wood species (ash, linden, maple, elm, pine, hornbeam, birch, aspen), most of which are exacting to soil fertility. Such conditions in sod-podzolic soils of Belarusian Polesye are created due to moistening of a soil section by the hard ground waters enriched with Ca, Mg and elements of nutrition of plants [4].

Level of ground waters during the year in the most part is within the limits of the soil profile. As a rule, it consists of cmooth slopes located near low-laying bogs, represented by sod-podzol groundwater cryptogley (temporarily overdamped) and groundwater gley soils.

Sod-podzolic groundwater cryptogley soils occupy upper ends of long gentle slopes.

Sod-podzolic groundwater gley soils occupy lower places – edges of low-laying moors with close groundwater occurrence [1].

While conducting researches on the forest soils of Belarus, it was determined that on the territories of all forestry stations of the Polesye region there were marked out sod-podzolic soils with a various degree of moisture content and particle-size distribution. Depending on surface slope, they represent grounds of various square and configuration.

The purpose of the work is to investigate groundwater cryptogley soils and groundwater gley sod-podzolic forest soils on which plantings of common oak grow; to reveal the common patterns in their composition, structure and properties; to establish the most common types of oak groves.

Main part. The analysis of sod-podzolic groundwater cryptogley and groundwater gley soils was performed on the basis of authors' personal researches, and also with the help of results of soil-topologic survey of forest establishments of Lelchitsy, Zhitkovichy, Petrikov, Luninets, Stolin, Vasilevichy regions. On the basis of conducted researches it was ascertained that sod-podzolic groundwater cryptogley (temporarily overdamped) and groundwater gley forest soils were formed on sandy and sandy loam soil-forming materials (Table 1).

Areas of sod-podzolic forest soils. Groundwater gley soils are the most expanded, moisture deposits in them are formed at the expense of capillary fringe and capillary banked moisture.

The composition of soil profile includes following horizons: forest litter (A_0), humus (A_1), podzolic (A_2), illuvial (B), gley (G) or underlaying bedrock (D) with features of gley or solid gley soil.

In sod-podzolic groundwater soils the humus horizon (A1) is featured by dark grey or black colour, it is extended to 18–20 cm.

Table 1

Areas of sod-podzolic forest soils

Forestry	Sandy, ha	Sandy loam, ha
Groundwater gley (temporary overdamped) soils		
Lelchitsky	164.8	33.1
Zhitkovichsky	142.2	–
Petrikovsky	–	177.3
Luninetsky	–	138.4
Stolinsky	–	–
Vasilevichsky	377.2	124.4
Groundwater gley soils		
Lelchitsky	1392.0	1427.3
Zhitkovichsky	1877.1	605.3
Petrikovsky	1816.7	3137.2
Luninetsky	35.4	116.2
Stolinsky	300.0	–
Vasilevichsky	7291.8	707.6

Ground mass of tree and grass plants is concentrated mainly in humus horizon. As a rule, humus horizon is followed by podzol-illuvial one (A_2B_1) that is characterized by dark yellow colour with brownish labile humus tongues. Roots can be met rather seldom. In the soil profile there are 2–3 distinct illuvial horizons with different particle-size distribution, colour, humidity and other morphological features. Illuvial genetic horizons possess signs of gleying such as rusty ochreous and whity mottles. Sometimes certain illuvial horizons are of ochreous colour with orange tint. Underlaying bedrocks also have features of gleying such as whity mottles or cracks. Underlaying bedrock has compact constitution. Round stones can be met in very rare cases, that's why it can be stated that the underlaying bedrock is represented by fluvial glacial or morainic deposits. The groundwater level in groundwater-cryptogley soils in May is located on the depth of 120–180 cm, in dry years it descents lower than 2 m in the summer period.

In groundwater-gley soils the humus horizon with thickness 22–25 cm gives place to podzol (A_2), rarely to podzol-illuvial (A_2B_1). In the soil profile there is one more illuvial horizon with the signs of gleying. At the depth of 0.8–1.0 and deeper the underlaying bedrock is entire gleyic, it's possible to distinguish gleyic horizon (G). The underlaying bedrock is completely gleyic (DG) and is of greyish white colour with blue tint, also there are ochreous bands. In the groundwater-gley soils underground waters in May lay at the depth of 40–80 cm, in summer – 100–150 cm.

The investigated groundwater-cryptogley and groundwater gley forest soils on the territory of Belarusian Polesye are represented by sand and sandy loams. Sandy loam represented, as a rule, by the humus horizon, the illuvial horizons – by sandy deposits. The analysis of particle-size distribution showed that the basis of soil-forming materials and soils is made by fraction of fine sand, which content varies within 50–70% of all mass of the soil (Table 2).

In the studied soils the stony part is absent, and coarse earth makes 0.3–5.3%. The highest content of coarse earth is observed in groundwater-gley soils with the impervious horizon. It should be noticed that the fractional structure of sandy and sandy loam deposits has no considerable distinctions. In the sandy loam humus horizons the content of physical clay makes 10.6–11.3%, and higher coarse dust content is observed.

The increase in the coarse dust content and physical clay has, apparently, a decisive impact on the formation of the capillary fringe moisture in a soil profile and its stocks during the summer period. Despite the excess of moisture during the spring period, because of decrease in level of ground waters during the summer period there is a sharp reduction of humidity at a depth of 40–60 cm, especially in groundwater-cryptogley soils. It is explained by low moisture-holding capacity of podzolic, podzol-illuvial and illuvial sandy horizons. During the summer period the water supply of plants depends on moisture-holding capacity of the humus horizon, where the decisive factor is the humus content, and also on the water-raising capacity of the illuvial genetic horizons that are represented, as a rule, by friable or consolidated sand.

It is necessary to consider thus that the moisture deposit in the studied soils is formed due to the water-holding capacity of the humus horizon, the depth of aquiclude, the level of ground waters and its fluctuation throughout the vegetative period. The analysis of agrochemical properties showed that the humus content in the humus surface horizon of groundwater cryptogley and groundwater gley soils varies within 1.2–3.0% (Table 3).

In groundwater-cryptogley and groundwater-gley soils in podzol-illuvial and podzolic horizons the humus content decreases by 4–7 times and varies from 0.2 to 0.8%. The humus content in the soils is in correlation with particle-size distribution. The humus content in the sandy loam humus horizons is 1.5–2 times higher than in the sandy ones. Active acidity in humus horizons varies from pH 3.2 to 4.7. It is noted that the deeper the layer the lower the active acidity. A significant variation of active acidity is determined by the groundwater quality (hardness). In the undelaying bedrock (D) the active acidity varies in a wide range from pH 3.6 to 5.9.

The hydrolytic soil acidity in humus horizons varies from 3.5 to 8.4 mg eq per 100 g of soil. In the humus horizon the content of calcium and magnesium averages 2.3–5.7 mg-eq per 100 g of soil. In the soils with aquiclude horizon the increase of the total exchangeble bases in the subsurface is noticed.

In the examined soils a natural decrease of exchange calcium and magnesium with increase of depth is observed, the reason is the underlaying illuvial horizons that are presented, as a rule, by easier particle-size distribution that possesses low absorbing capacity. The degree of saturation of the humus horizons bases varies from 33 to 54%, and in the underlaying horizons it's from 60 to 79%, which is characteristic for sod-podsolic soils [5, 6].

No essential difference on the bases saturation between groundwater-gley and groundwater-cryptogley soils is observed. The soils are characterized by wide variation of labile phosphorus and exchange potassium content.

Table 2

Particle-size distribution in sod-podzolic forest soils

Hori-zont	Horisont lenght, cm	selection, *n*	Fraction size , mm, and its content, %				
			Coarse soil	Fine soil			
			3.0–1.0	1.0–0.25	0.25–0.05	0.05–0.01	<0.01
Groundwater gley (temporary overdamped) soils							
Sandy with impervious horizont							
A_1	3–21	27	1.6 ± 0.21	26.4 ± 12.81	58.2 ± 8.02	7.2 ± 2.56	8.0 ± 1.99
A_2B_1	21–40		–	15.8 ± 5.68	71.2 ± 18.61	7.7 ± 1.40	5.4 ± 1.02
B_2g	40–75		–	31.1 ± 13.58	58.2 ± 12.19	3.4 ± 0.81	5.0 ± 1.77
Dg	75–200		–	19.9 ± 0.31	42.6 ± 8.97	11.0 ± 0.21	26.4 ± 8.51
sandy loam soil							
A_1	5–26	12	0.3 ± 0.10	22.3 ± 3.49	64.3 ± 2.10	5.3 ± 0.87	10.6 ± 0.57
A_2B_1	26–50		2.2 ± 0.94	21.7 ± 4.39	69.3 ± 3.31	2.2 ± 1.57	5.3 ± 0.87
B_2g	50–90		0.9 ± 0.29	29.9 ± 5.67	65.4 ± 7.76	1.7 ± 0.40	4.1 ± 2.38
B_3g	90–200		–	40.7 ± 0.22	52.7 ± 0.94	3.2 ± 0.25	3.5 ± 1.41
sandy loam with impervious horizont							
A_1	2–20	22	1.2 ± 0.16	25.8 ± 9.54	47.8 ± 9.26	14.9 ± 1.65	11.3 ± 2.07
A_2B_1	20–45		1.5 ± 0.26	33.0 ± 11.29	50.0 ± 11.19	9.8 ± 0.79	7.6 ± 1.49
B_2g	45–80		1.7 ± 0.29	24.7 ± 8.51	55.8 ± 12.64	13.3 ± 2.17	5.5 ± 1.28
Dg	80–200		–	3.2 ± 0.56	56.5 ± 14.23	19.5 ± 2.81	20.8 ± 9.84
Groundwater gley soils							
Sandy soil							
A_1	3–28	33	2.1 ± 0.51	29.3 ± 8.20	58.4 ± 7.19	5.7 ± 2.92	6.1 ± 0.98
A_2	28–50		1.4 ± 0.47	28.7 ± 8.82	63.4 ± 10.70	3.0 ± 1.44	6.2 ± 1.03
B_1g	50–100		1.4 ± 0.70	30.1 ± 10.24	63.6 ± 9.03	2.2 ± 1.85	4.2 ± 1.69
G	100–150		0.3 ± 0.19	26.0 ± 8.69	68.2 ± 9.21	1.1 ± 0.69	4.1 ± 1.02
Sandy with impervious horizont							
A_1	5–27	19	2.3 ± 1.47	27.8 ± 10.92	57.5 ± 7.94	10.1 ± 5.34	6.4 ± 0.80
A_2	27–40		3.2 ± 1.85	27.6 ± 3.40	58.7 ± 2.47	8.9 ± 2.27	5.2 ± 1.52
B_1g	40–80		2.8 ± 0.72	20.9 ± 4.48	66.4 ± 11.05	3.6 ± 1.74	5.0 ± 1.24
DG	80–150		3.3 ± 1.75	19.2 ± 6.59	33.2 ± 7.82	16.7 ± 8.60	32.6 ± 4.79
sandy loam soil							
A_1	3–28	24	1.4 ± 0.27	22.3 ± 5.18	55.9 ± 14.74	12.1 ± 4.42	11.0 ± 3.51
A_2	28–40		1.2 ± 0.25	25.8 ± 5.75	51.8 ± 8.51	18.0 ± 0.00	4.7 ± 0.22
B_1g	40–80		1.1 ± 0.30	31.1 ± 0.55	55.6 ± 11.07	12.9 ± 5.66	6.4 ± 2.99
G	80–150		5.3 ± 1.05	40.3 ± 15.42	56.7 ± 15.88	1.0 ± 0.44	4.2 ± 1.15
Sandy with impervious horizont							
A_1	4–28	31	2.7 ± 1.13	27.2 ± 4.78	53.2 ± 4.93	8.9 ± 4.95	11.3 ± 1.48
A_2	28–40		5.1 ± 2.01	26.8 ± 0.64	54.1 ± 1.96	10.0 ± 2.62	8.5 ± 1.20
B_1g	40–70		2.8 ± 0.93	27.4 ± 5.63	58.9 ± 8.35	12.2 ± 7.63	5.2 ± 1.63
DG	70–150		3.7 ± 1.46	24.4 ± 9.19	41.5 ± 8.80	12.0 ± 2.04	24.2 ± 11.12

Table 3

Agrochemical property of sod-podzol soil

hori-zont	Horisont lenght, cm	Selection, *n*	Humus, %	pH in KCl	Hydrolytic acidity	Ca + Mg	Level of base saturation in soil, %	P_2O_5	K_2O
					mg/ 100 g soil			mg/ 100 g soil мг	
Groundwater gley (temporary overdamped) soils									
Sandy with impervious horizont									
A_1	3–21	27	1.2 ± 0.10	3.7–3.9	4.3 ± 1.55	5.7 ± 2.29	39 ± 0.4	7.5–17.0	1.2–8.0
A_2B_1	21–40		0.2 ± 0.11	3.8–4.5	2.1 ± 1.67	1.7 ± 0.99	50 ± 10.4	8.7–25.0	1.5–8.2
B_2g	40–75		–	4.0–4.8	0.9 ± 0.25	2.8 ± 1.04	70 ± 15.7	2.5–20.0	1.5–7.5
Dg	75–200			3.8–5.2	1.5 ± 0.64	3.3 ± 0.99	60 ± 5.4	2.5–15.0	8.0–20.5
sandy loam soil									
A_1	5–26	12	2.9 ± 0.70	3.2–4.7	8.4 ± 3.70	5.3 ± 1.26	35 ± 11.5	1.2–9.2	3.1–20.0
A_2B_1	26–50		0.6 ± 0.36	3.6–4.9	4.0 ± 1.59	3.8 ± 1.51	59 ± 14.5	1.8–12.5	2.4–16.0
B_2g	50–90		–	4.4–4.9	1.3 ± 0.28	1.6 ± 0.29	58 ± 6.9	2.5–24.0	3.4–5.5
B_3g	90–200		–	4.7–5.5	0.9 ± 0.25	4.5 ± 0.71	75 ± 10.3	2.5–19.4	3.0–7.0
Sandy with impervious horizont									
A_1	2–20	22	2.1 ± 0.51	3.5–4.1	3.5 ± 1.28	2.3 ± 0.84	36 ± 1.9	1.8–20.5	8.5–25.2
A_2B_1	20–45		0.5 ± 0.12	3.5–4.7	3.8 ± 1.26	3.5 ± 1.11	56 ± 10.8	3.7–20.2	3.4–18.2
B_2g	45–80		–	4.4–5.2	0.9 ± 0.15	1.0 ± 0.32	53 ± 14.8	1.2–14.0	3.4–22.0
Dg	80–200		–	3.6–5.5	6.0 ± 2.25	1.2 ± 0.27	79 ± 12.5	1.2–17.0	6.0–21.0
Groundwater gley soils									
Sandy soil									
A_1	3–28	33	1.6 ± 0.55	3.5–4.1	4.8 ± 2.72	2.6 ± 0.62	37 ± 14.9	5.0–17.5	2.2–23.9
A_2	28–50		0.4 ± 0.26	3.4–4.6	2.2 ± 0.80	2.0 ± 0.73	48 ± 12.6	0.5–22.5	1,4–3.6
B_1g	50–100		–	3.7–5.9	1.5 ± 0.91	2.2 ± 0.92	55 ± 23.5	1.2–20.0	0,4–3.2
G	100–150		–	4.9–5.7	0.9 ± 0.16	2.2 ± 1.05	65 ± 21.1	3.7–15.0	0.6–2.8
Sandy with impervious horizont									
A_1	5–27	19	2.1 ± 0.83	3.7–4.3	5.1 ± 1.31	2.7 ± 0.55	54 ± 24.2	3.8–30.5	2.4–4.2
A_2	27–40		0.3 ± 0.18	4.5–4.9	1.4 ± 0.91	1.7 ± 1.08	54 ± 10.5	2.5–20.0	0.6–1.4
B_1g	40–80		–	4.0–4.4	1.1 ± 0.37	3.2 ± 0.21	69 ± 7.9	1.2–17.5	0.6–3.0
DG	80–150		–	3.7–5.9	1.0 ± 0.63	8.6 ± 2.91	77 ± 10.0	0.5–7.5	1.4–8.4
sandy loam soil									
A_1	3–28	24	2.9 ± 1.26	3.2–4.4	7.0 ± 2.28	3.1 ± 1.54	33 ± 18.0	1.2–8.4	2.2–18.0
A_2	28–40		0.4 ± 0.14	4.5–4.9	1.1 ± 0.29	2.1 ± 0.79	64 ± 11.1	1.2–7.5	0.6–4.0
B_1g	40–80		0.5 ± 0.29	4.7–5.5	0.9 ± 0.42	4.6 ± 2.81	75 ± 15.3	1.2–12.5	0.6–7.0
G	80–150		–	4.1–5.1	0.7 ± 0.19	2.4 ± 0.59	72 ± 19.4	0.6–15.0	0.4–6.0
Sandy with impervious horizont									
A_1	4–28	31	3.0 ± 1.23	3.5–4.2	7.1 ± 3.67	5.4 ± 1.47	52 ± 15.6	1.2–25.0	3.6–9.4
A_2	28–40		0.8 ± 0.12	4.2–4.6	3.5 ± 0.58	2.6 ± 1.50	33 ± 12.8	1.2–21.5	0.6–4.2
B_1g	40–70		0.2 ± 0.11	3.7–5.5	1.1 ± 0.34	5.4 ± 2.06	70 ± 19.9	0.5–5.0	1.2–6.0
DG	70–150		–	3.6–5.2	3.2 ± 1.28	6.6 ± 2.71	63 ± 18.1	1.2–15.0	1.5–22.0

It depends on many factors: mineral composition of soil-forming rock, bog flowage, groundwater quality, influence of agricultural soils which are situated on more increased relief.

Conclusion. Sod-podzolic groundwater-cryptogley and groundwater-gley forest soils in the conditions of Belarusian Polesye are formed close to fen soils on fluvial glacial and ancient alluvial sand and loam sand deposits, during combined sod and podzolic processes of soil formation.

In most cases, soil profile has gleyic or elements of gleyic aquiclude that is represented by clay loam of compact constitution. Fine sand is the basis of soil-forming rock (50–70%). Close bedding of the aquiclude horizon and alkali ground water provides conditions for growing soil-demanding tree species. Oak, linden, hornbeam, birch, aspen, ash, elm, cobnut grow on sod-podzolic groundwater-cryptogley (temporarily overdamped) and groundwater gley soils.

It was discovered that common oak stands could be be formed on groundwater-cryptogley soils only if there was aquiclude horizon.

In the conditions of Belarusian Polesye there are bracken, sorrel and bilberry types of upland mingled and pure oak-groves mostly growing on sod-podzolic groundwater-cryptogley and groundwater-gley soils.

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