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PLASTICITY OF PSEUDOGLEY SOILS IN UB COMMUNITY

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Abstract: The paper includes the results of determination of Atterberg plasticity limits of arable (0-25 cm) and subarable (25-50 cm) horizons in 53 pseudogley profiles from the community of Ub. On the basis of performed laboratory investigations, it has been found that the psudogley belongs to the group of moderately plastic soils, with plasticity index higher than 17. In the arable horizon, average moisture at the plastic limit is about 20 %, and in the subarable horizon – about 19 %. Average values of the liquid limit in the arable horizon are about 38 %, and in the subarable horizon about 40 %. The optimal moisture for machine tillage of the investigated pseudogley and for other field operations varies between 19 and 22 %.

Several other physical and textural characteristics are presented, including clay activity index and potential mechanical instability and soil susceptibility to treading.

Key words: Atterberg plasticity limits, pseudogley, soil physical suitability for tillage.

I n t r o d u c t i o n

Pseudogley comprises a substantial part of arable soil resources in Serbia. The yields of crops grown on pseudogley depend very much on the annual distribution of atmospheric precipitations. The location of impenetrable horizon (R e s u l o v i ć et al., 1972) and high share of powder fraction are the most important causes of unfavourable water-air, physical and textural characteristics of the pseudogley.

Plasticity is an important physical characteristic, which is frequently determinative for a good soil preparation, sowing in optimal time, harvesting and fruit collecting, as well as for the purposes of soil classification and performing of

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agro- and hydro-technical meliorations. On the basis of plasticity degree, the most favourable moment for soil tillage is determined, i.e. soil physical suitability for the tillage.

Pseudogley of Serbia is fairly well investigated, mostly from genetical and classification aspects (P r o t i ć et al., 1995). As far as we know, in our country only few authors reported on pseudogley plasticity (Ž i v k o v i ć, 1960; R e s u l o v i ć et al., 1972; R a c z, 1974; S t o j a n o v i ć, 1984; D u g a l i ć, 1997) using a small number of soil samples.

The aim of the present paper is to investigate pseudogley plasticity in a higher number of samples and to determine its physical suitability, i.e. the moisture interval optimal for field operations (the least energy and time waste, the least soil deformation).

Material and Methods

Location of the investigated soil. Ub community is located in south-west Serbia (geographical coordinates: latitude 44°30'11"N and longitude 20°07'55"E) and it covers an area of about 457 km^2. About 90 % of this area is under pseudogley soils utilized mostly for crop and vegetable production.

Soil sampling and analyses. Field investigations of Ub community soils, soil sample collection, as well as the determination of a number of their most important physical and chemical characteristics were carried out in 2002 (D j o r d j e v i ć et al., 2002). Plasticity was determined in soil samples from arable (0-25 cm) and subarable (25-50 cm) horizons of 53 profiles.

Plastic (Wp) and liquid (WI) limits, as well as plasticity index (Ip) were determined by internationally recognized methods determined by Yugoslav Society for Soil Investigation (B o š n j a k, 1997). Activity index (A = Ip/% fraction < 0.002 mm) and potential mechanical instability and soil susceptibility to treading (Wp/FWC), where FWC is field water holding capacity, were obtained by calculation.

All the results were statistically analysed by computer program ANOVA from statistical package GENSTAT 5 with the probability degree of 95 % for the determination of significant differences ($p < 0.05$).

Results and Discussion

Before presenting the obtained results of plasticity of the investigated pseudogleys, the most important physical and chemical characteristics of these soils are presented. In the Table 1 the data are shown on textural composition, retention water capacity and humus content.

Textural composition. The results of the textural analysis show that about 80% of the analysed samples belong to powdery-clayey loams, 10 of 70 analysed samples belong to powdery clays and only 4 samples to powdery loams. The fraction with the highest share is powder, which according to American classification of textural elements includes particles with the radius between 0.05 and 0.002 mm. This fraction participates with 44.64 to 68.13 % in the soils, most frequently with about 60 %. The content of colloid clay fraction (particles smaller than 0.002 mm) varies between 24.69 and 48.07 %, but is most frequently higher than 30 %.

T a b. 1. – Pseudogley plasticity and some important physical and chemical indicators

Soil property		Arable horizon (0-25 cm)	Subarable horizon (25–50 cm)
Clay (particles < 0.002 mm), %		24.69 - 48.07	29.90 - 45.25
Silt (particles 0.05–0.002 mm), %		44.64 - 68.13	48.25 - 66.06
Sand (particles 2.00–0.05 mm), %		1.61 - 16.36	1.41 - 10.85
Humus content, %		0.79 - 3.25	0.47 - 1.89
Retention water capacity (RWC), % mas		20.26 – 26.41	21.83 - 25.30
Liquid limit (Wl)	n*	53	53
	x	38	40
	max	40	46
	min	32	38
	σ_x	0.52	2.35
	c_v	8.61	5.94
	P	0.09	0.15
Plastic limit (Wp)	n	53	53
	x	20	19
	max	28	26
	min	18	19
	σ_x	1.09	0.52
	c_v	5.48	8.61
	P	0.11	0.18
Plasticity index (Ip)	n	53	53
	x	18	20
	max	19	22
	min	13	14
	σ_x	1.09	1.37
	c_v	18.26	22.77
	P	0.04	0.46
Potential mechanical instability and susceptibility of the soil to threading (Wp/FWC)		0.98	0.93
Activity index (A)		0.55	0.52

Note: n* - number of analysed samples, x – arithmetic mean value, max – maximal value, min – minimal value, σ_x – standard deviation, Cv – variation coefficient (%), P - accuracy indicator (in agronomical practice this indicator must not be higher than 5 %, or $P \leq 5$ %)

Humus content. Data from the Table 1 show that the humus content in the arable horizon (0-25 cm) of the investigated pseudogley varies between 0.79 and 3.25 %, while in the subarable horizon (25-50 cm) this content is significantly lower, and varies between 0.47 and 1.89 %.

Retention (rain) water capacity. The values of retention water capacity in the arable horizon vary between 20.26 and 26.41 % mas. (Table 1), and in the subarable horizon between 21.83 and 25.30 % mas.

Plastic limit. The data presented in the Table 1 show that there is no significant difference ($p < 0.05$) between moistures in arable and subarable horizons at the plastic limit. Wp values in analysed samples are fairly uniform and vary between 18 and 22 %. Similar Wp values were found by R e s u l o v i ć et al. (1972), R a c z and N o v o s e l (1981) as well as by D u g a l i ć (1997). Somewhat wider (18-30 %) interval of Wp value variation was found by S t o j a n o v i ć (1984) in several profiles of pseudogley soils of west Serbia.

From agrotechnical aspect, the plastic limit represents the most important soil characteristics, because it simultaneously represents the upper limit of the moisture of soil physical suitability for machine tillage. Therefore, the knowledge of this plasticity limit is very important for correct and well-timed soil tillage. If at approximately equal colloid clay fraction content Wp values are higher, the interval of moisture suitable for tillage is wider, together with the time interval favourable for good tillage with less resistance and energy waste.

According to S c h e f f e r-S c h a c h t s c h a b e l (1966) soil should be tilled when its moisture is below the plastic limit. In the opposite case, there occurs smearing of the soil and formation of "plough sole". Investigations conducted by Kacinsky (R a s t v o r o v a, 1983) showed that the physical suitability of a soil or its optimal moisture for tillage was 3-5 % lower than the plastic limit.

The cited data show that the optimal moisture for machine tillage of the investigated pseudogley and performance of other field operations varies between 19 and 22 %.

Potential mechanical instability and soil susceptibility to treading. In the investigated pseudogley soils Wp values are lower than the field water capacity, i.e. Wp/FWC varies between 0.93 and 0.98. Therefore, it is difficult to establish favourable moisture status for machine tillage in these soils, or, to be more precise, it is established very slowly. Thus, the present investigation confirms previous results on bad mechanical characteristics of pseudogley soils, the harmful influence of which is most expressed with spring crops due to slow evacuation of atmospheric water.

Liquid plastic limit. The results of the published investigations, similar to the plastic limit, show that there is no significant difference between the moisture at the liquid limit in arable and subarable horizons of the investigated pseudogley

soils. In the arable horizon, the moisture at Wl varies between 38 and 40 %, and in the subarable horizon, between 38 and 44 %. The investigated pseudogley, on the basis of the found Wl values, according to the British soil classification system (BS 5930, 1981), belongs to the group of moderately plastic soils (Wl varies between 35 and 50%).

Plasticity index. The values of plasticity index (Ip) in arable and subarable horizons of the investigated pseudogley are approximately equal and vary within a narrow range, from 16 to 22. Similar results of Ip value were reported by R e s u l o v i ć et al. (1972), R a c z and N o v o s e l (1981), S t o j a n o v i ć (1984) and D u g a l i ć (1997). Somewhat wider (11-22) range of plasticity index variation was established by Ž i v k o v i ć (1960) in three deep profiles of permanent pasture pseudogley soils in the vicinity of Kladovo.

According to the classification of L i e b e r o t h (1969), the majority of the analysed samples (42 samples) of the investigated psuedogleys belong to the group of moderately plastic, and 11 samples to the group of highly plastic soils.

Generally speaking, the plasticity is rather high in the investigated pseudogley, which is a very unfavourable characteristic from the aspect of soil machine tillage and crop growing. At a high moisture degree, such soils become soft and slippery which impairs vehicle mobility over their surface, and the structural aggregates are easily destroyed by treading. After draining, such soils become compressed and very hard.

Activity index. Values of the activity index, which is an indicator of clay type, in the investigated pseudogley, vary within a very narrow range, from 0.52 to 0.55. These values are characteristic for inactive and kaolinite clays.

C o n c l u s i o n

On the basis of the results of plasticity determination in the arable (0-25 cm) and subarable (25-50 cm) horizons of powdery-loamy pseudogley from the area of Ub community, the following may be concluded:

The investigated pseudogley shows very unfavourable textural characteristics. Beside plasticity indicators, it is confirmed by unfavourable ratio between plastic limit and field water capacity (Wp/FWC varies between 0.93 and 0.98).

All the investigated samples from arable and subarable horizons belong to the group of moderately plastic soils. Plasticity index in the investigated samples varies between 18 and 22, which is a very unfavourable characteristic of these soils for their tillage and crop growing.

Moisture content at the plastic limit shows similar values in both investigated depth zones, and varies between 19 and 22 %.

No differences are found in moisture content at the liquid limit in arable and subarable horizons of the investigated pseudogley. Wl values vary between 38 and 44 %.

Optimal moisture for machine tillage of the investigated pseudogley and for performing other field operations varies between 19 and 22 %.

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PLASTIČNOST PSEUDOGLEJNIH ZEMLJIŠTA OPŠTINE UB

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R e z i m e

U radu su prikazani rezultati odredjivanja Aterbergovih granica plastičnosti oraničnog (0–25 cm) i podoraničnog (25–50 cm) horizonta pseudogleja opštine Ub (jugoistočna Srbija) iz 53 profila. Na osnovu sprovedenih laboratorijskih istraživanja utvrdjeno je da ispitani pseudoglej spada u grupu srednje plastičnih zemljišta, s indeksom plastičnosti većim od 17. U oraničnom horizontu, prosečna vlažnost pri donjoj granici plastičnosti je oko 20 %, a u podoraničnom oko 19 %. Prosečne vrednosti gornje granici plastičnosti u oraničnom horizontu su oko 38 %, a u podoraničnom oko 40 %. Optimalna vlažnost za mehaničku obradu istraženog pseudogleja i izvodjenje drugih poljskih radova varira u intervlu od 19 do 22 %.

Odredjene su i prikazane i neke druge fizičko-mehaničke osobine, medju kojima indeks aktivnosti gline i potencijalna mehanička nestabilnost i osetljivost zemljišta na gaženje.

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