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BULK DENSITY OF ALLUVIAL SOILS IN VALLEY OF PRUT RIVER[1]

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The general physical properties of the main varieties of alluvial soils in the floodplain valley of Prut river were investigated. The identity of alluvial soils in the floodplain of Prut river mainly to medium density was determined. It was noted that the parameters of the bulk density, density of the solid phase and porosity rarely go beyond the permissible scope for conducting intensive grass farming values. They depend on the genetic characteristics of the soil, its humus content, the presence of root mass and granulometric composition.

Key words: *alluvial soils, bulk density, density of the solid phase, porosity.*

([1]Prof. R.S. Truskavetskyi is the Scientific Curator of this work)

Actuality & content of the study. The Prut floodplain soils being periodically water-submerged in seasonal and high-flood spells, constitute relatively significant areas in Precarpathian (Eastern Carpathia); yet despite its importance, the subject is still not well studied by scholars of soils-science and agronomy. Status of soil cover is mostly determined by physical properties of soil. They affect formation of physico-chemical, morphological and agronomic properties of the soil. Physical properties determine degrees of soil reclamation and ecological state of soil cover.

Objects of studies. Soils of low-terrace, periodically inundated floodplain valleys around Prut river, were the objects of studies. The studies were focused on alluvial soils in Colomyisky and Snyatynsky districts of Ivano-Frankivsk oblast, and Novoselytskiy district of Chernivtsi oblast (whereby the tolal of 28 vertical profiles were cut out and described; and 95 samples from genetic horizons (including subsoil layers) were sampled out. The plotted chain of control sections followed the planned route tracing across near-river (#13 profile), central (#6 profile), and near-terrace (#3 profile) parts of Prut floodplain area and over 1st and 2nd super-flood terraces.

Research methods. Soil bulk density (BD) was assessed in line with Standard DSTU ISO 11272-2001 [1]; density of solid phase of soils (specific density) – by picnometric method (Standard DSTU 4942: 2007) [2]; and general porosity – by method of calculation using conventional formula. Variability of physical index parameters, for all soils studied, was determined through a statistical analysis using Statistica 6.0™ software. Sampling procedures, in the scope of types and sub-types in upper horizons of soils studied, were completed by parameters of density and total porosity.

Results and discussion. The bulk density is an important attribute of physical characteristics of soil, irrespectively of its time-related and spatial dynamics that depend on the nature of soil use and genetic soil properties. Therefore, a characteristic feature of floodplains soil cover is a very expressed spatial heterogeneity [3] The bulk density is affected, to some extent, by soil-inherent moisture and by intensity of root systems' evolution in meadow phytocenosis.

Over floodplain area, soil conditions depend on manner of cattle-grazing, grass land- status and flooding regime. In flooding conditions, soil mass undergoes sealing-compaction whose intensity depends on flood-duration and water-pressure.

Thus, these factors lead to formation of highly contrasting parameters of density and porosity of floodplain soils. A significant part in this process is taken by contemporary alluvial sediments during spells of high-water flood over river valley low-terrace areas. In the course of soil-compaction, overall volume and porous structure undergo reduction. Compacted soil is a poor absorber and filter of the moisture, which fact causes surface- runoffs and launches erosion processes in case of heavy rainfall conditions. Thus, compaction on vast floodplain areas leads to deficiency of oxygen and evolution of gley-genesis processes which, eventually, deteriorates quality and amount of meadow grass land harvestation.

According to existing gradations [4, 5], soils are subdivided into the following groups, in terms of their BD, g/cm^3: super loose – below 1.0; loose – 1.00-1.20; mid-dense –1.20-1.40; dense – 1.40-1.50; super dense – over 1.50. Considering the floodplain soils used mainly as meadow hay & pasture lands, the above gradation data require some correction. Over here, it is important to differentiate the soils in terms of their suitability for intensive grassland management, resting on bulk density parameters first and foremost.

Parameters of bulk density and total porosity were determined for genetic horizons represented by principal soil types and subtypes of the Prut floodplain. As an example, Table 1 holds the above-mentioned parameters of typical sections realized in various geo-morfological (near-river, central, near-terrace) parts of the floodplain and on the 2nd super-floodplain terrace (i.e., meadow depression).

Table 1: Bulk density and total porosity of principal types of soils in Prut floodplain area

Genetic horizon	Horizon depth, cm	Bulk density, g/ cm^3	Solid phase density, g/ cm^3	Total porosity, %
#13 profile. Alluvial soddy sandy loam stratified soil on contemporary sandy alluvium, near Chernivtsi-town				
Hκ	2-19	1.37	2.62	47.6
Hpκ	19-38	1.38	2.64	47.6
P(h)k	38-66	1.37	2.62	47.7
Pκ	66-83	1.37	2.61	47.4
#6 profile. Alluvial meadow mid-loam soil on alluvial loam on pebble & boulder bedrock, village of Trostianka				
H	5-22	1.29	2.52	48.7
Hp	22-37	1.44	2.62	45.0
Phk(gl)	37-60	1.42	2.64	46.2
P1k(gl)(q)	60-70	1.42	2.60	45.4
#3 profile. Alluvial meadow-boggy heavy-loam on alluvial clay, near Sniatyn-town				
HGlk	8-28	1.06	2.61	59.4
HGlk	28-51	1.08	2.63	58.9
Humous-peaty soil on gleyed loam				
HT	0-20	0.25	1.85	86.5

Due to above graduation, thus investigated:

- alluvial-soddy and alluvial-meadow soils of near-river and central parts of the floodplain belong to mid-dense ones,
- near-terrace alluvial meadow-boggy soils belong to the loose ones, and
- humous-peaty soils belong to super loose ones.

Concerning BD, such a character of floodplain soils is specified, above all, by amount of organic matter content and the root mass of plants. The upper horizon, usually possessing the low BD, is therefore characterized by higher porosity rate. The humous-peaty soil stands expressly apart, for its inherent super-high indices of porosity versus low bulk density.

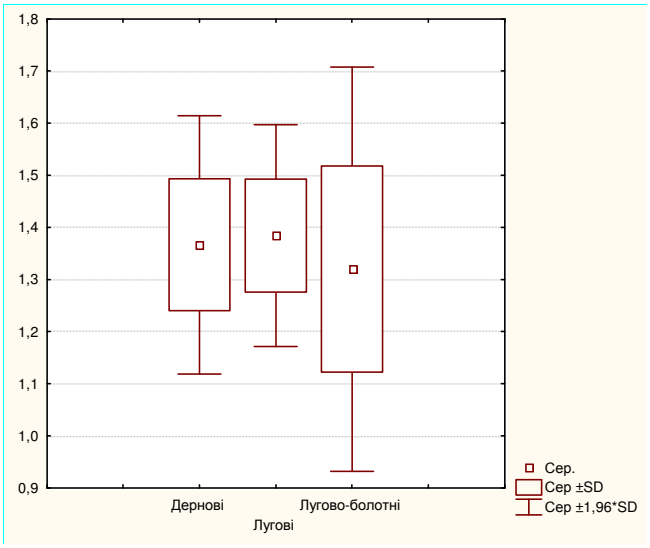
Accounting of phyto-mass at every control section shows that bulk density parameters (in its set range) does not affect the crop yield rate of meadow grass. Beyond this rule were random plots of meadow-boggy soils whos bulk density in the upper horizon reached its maximum, exceeding 1.50 g/cm^3 (Table 2). However in this case, the low crop yield rate of alluvial-soddy soil is related rather to a deficiency of nutrients than to BD index.

Table 2: Indices of bulk density variability in alluvial soils

Soil	Horizon	n	Medium	Minimum	Maximum	Dispersion	Standard deviation	Variability index
Alluvial soddy	H	10	1.35	1.29	1.43	0.002	0.049	3.62
Alluvial meadow	H	11	1.31	1.14	1.43	0.011	0.105	8.01
Alluvial meadow-boggy	H	7	1.26	1.03	1.56	0.062	0.25	19.8

Statistical analysis shows that variability of bulk density parameters of soddy and meadow soils is insignificant, whereas in meadow-boggy soils, variability varies from medium to high. Per average value of the bulk density, soils investigated in the Prut floodplain, belong to the mid-dense group of N.A. Kachynski scale.

In order to assess specifics of alluvial soils' genetic characteristics, variability of bulk density among types and sub-types of Prut floodplain alluvial soils has been analysed (Figure 1).



Legend: *left column: soddy soils; middle column: meadow soils; right column: meadow-boggy soils*

Figure 1. Parameters of alluvial soils' bulk density

Thus obtained data demonstrate a trend of BD parameters variability amplitude growth from soddy to meadow-boggy soils, i.e. towards super-floofland terraces. The solid phase density is known to be the one of stablest parameters of soil. Its values fluctuate in a narrow range as compared with other physical indicators, and their dynamics are weakly expressed. However, the solid phase density is significantly influenced by chemical, granulometric and lithologic compositions and organic matter content in soil. The solid phase density is most significantly depending on relation between mineral and organic parts of soil. Within soil profile boundaries (Table 1), fluctuations of this index were noted in a narrow range. Slight deviations of density parameters are specified also by variable content of quartz and humus quality, due to relevant source data [4].

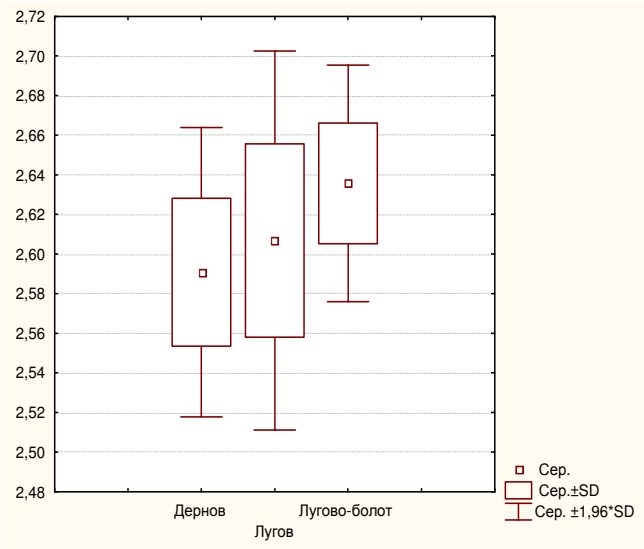
Statistical analysis showed that specific density variability is expressed less than bulk density index. Moreover, amplitude of specific density fluctuations, unlike bulk

density index, prevails for meadow soils (see Figures 1 and 2 for comparison). A clear difference between specific density fluctuation amplitudes is noted for alluvial soils of different genetic types.

The specific density of alluvial soddy soils in humus horizons of near-river part of the floodplain varies between 2.49-2.62 g/cm^3; alluvial meadow soils of central part of the floodplain - within 2.52-2.66 g/cm^3, and alluvial meadow-boggy soils - within 2.60-2.64 g/cm^3 range.

Table 3: Indices of specific density variability in the upper horizon of alluvial soils

Soil	Horizon	n	Medium	Minimum	Maximum	Dispersion	Standard deviation	Variability index
Alluvial soddy	H	10	2.58	2.49	2.62	0.0014	0.038	1.47
Alluvial meadow	H	11	2.58	2.52	2.66	0.0027	0.053	2.05
Alluvial meadow-boggy	H	7	2.62	2.60	2.64	0.00025	0.015	0.57



Legend: *left column: soddy soils; middle column: meadow soils; right column: meadow-boggy soils*

Figure 2: Parameters of alluvial soils' solid phase density dependence on their types

Sustainability of optimum ratio between liquid phase of soil and air is mainly related to structure of the soil-pore volume, which is an important factor that specifies formation of water regime for soils. In high-flood regime, flood water should be actively absorbed and deposited by the soil, to supply the meadow grass with moisture. Parameters of thus identified total porosity, their statistical conversion and parametric fluctuations are in full compliance with above-characterized data obtained from studies on bulk density.

These are evidenced by contents of Table 4.

Table 4: Indices of overall porosity-parameter variability in upper horizons of alluvial soils

Soil	Horizon	n	Medium	Minimum	Maximum	Dispersion	Standard deviation	Variability index
Alluvial soddy	H	10	47.3	44.3	49.9	3.78	1.94	4.10
Alluvial meadow	H	11	49.3	43.1	55.1	16.12	4.01	8.13
Alluvial meadow-boggy	H	7	51.5	40.0	61.1	97.60	9.87	19.16

Conclusions. Assessment of bulk density, solid phase density and total porosity parameters have shown the following results:

- in terms of bulk density, most soils of flooded valley and super-flooded low-terrace plains of Prut River belong to the mid-dense type, with fluctuations of this parameter in upper genetic horizon within 1.3 to 1.4 g/cm^3;

- in concern of bulk density of floodplain soils used prevailably under meadow hay & pasture management, the existing gradation data require some corrections, depending on genetic properties of soil ant its purposed use.

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