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Typical Signs and Properties of Agricultural-Podzolic Soils of Northern Forest-Steppe

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Abstract. Based on the results of soil and agrochemical surveys, the state of soil fertility of agro-podzolic soils of the northern forest-steppe under conditions of intensive farming has been studied. The generalization of the soil properties of individual indicators in an amount of 44-148 values characterizing the given territory was carried out by methods of mathematical statistics. The features of the analyzed soils are discussed by dividing into two groups - fundamental and stable. The first group includes a combination of genetic horizons of the soil profile. This group also included the content of clay fraction and physical clay, the pH of the salt extract. The group of stable soil properties includes the humus content, the sum of absorbed bases and hydrolytic acidity. The results of typical soil characteristics and properties, depending on the duration and intensity of the impact of agricultural processing, their indicators are a criterion for assessing and optimizing soil conditions for crops. In this case, the actual data processed by the statistical method is more informative than the specific measurements.

1. Introduction

The application of various methods of mathematical statistics makes it possible to solve a number of genetic problems. In this case, mathematical methods are used to generalize the data of the actual material, and they are more informative than specific measurements.

The object of the study is agro-podzolic soils of the right-bank part of the Privyatka Precamite strip with a total area of 713.5 thousand hectares (including 403.6 thousand hectares of arable land), where they occupy 25% and lie on watersheds and gentle slopes. Soil-forming rocks for them served as deluvial deposits. To obtain statistical parameters of the analytical data and morphological features of agro-podzolic soils, the actual material of a large-scale soil study (scale 1: 10000) was used at the level of agricultural units[1].

Selected indicators of soil properties, differs from the procedure for assessing single indicators of properties or characteristics. Accepted criteria for the sample data are the arithmetic mean, limit values, standard deviation, arithmetic mean error, coefficient of variation, accuracy factor and many others. An obligatory condition for considering these indicators is the correspondence of the sample to the requirements of the normal distribution [2, 3].

The studies consider typical values of the lower boundary of the agrogenic horizon or its thickness. As the last, the lower boundary of the transition horizon BEL is adopted. Under the horizon under processing, there is sometimes a transitional horizon AEL, the horizon EL. However, they are often absent, occur in places, and BEL serves as an indispensable element of the soil profile of the studied soils [4, 5, 6, 7, 8, 9].



2. The problem statement or Material and methods

The indicators of the properties studied are divided into two groups - fundamental and stable. The first group includes a combination of genetic horizons of the soil profile. This group also included the content of clay fraction and physical clay, the pH of the soil extract, determined in the hydrochloric acid solution of potassium chloride [10].

The group of stable soil properties includes the humus content, the sum of absorbed bases and hydrolytic acidity. Despite the mature state of soils, they undergo changes in time due to changes in the environment, including economic activity.

Thus, the humus content is constantly changed, some humic substances are mineralized by the treatment of arable horizon, while the total humus content is replenished due to newly formed humic substances from root and plant residues, as well as the applied amount of organic fertilizers. Of course, any grouping has certain conventions[11, 12].

So, soil pH is attributed to fundamental properties, while its indicators characterizing acidity, in order to create an optimal acidity regime for crops are neutralized by liming. At the same time, pH after a certain period of time is restored to its original values, which for the forest-steppe in the conditions of our republic is from 5 to 8 years. It is this circumstance that allows us to relate the pH to the group of fundamental properties.

In mathematical statistics, different methods are used to estimate the distribution of individual variants. So, with the normal distribution of the sample indicators, individual variants are distributed in the interval 6σ , that is, 3σ from the zero mark.

Typical values of the random variable (V), as E.A. Dmitriev noted (1973), are considered those that are close to its mathematical expectation. And also, for a normally distributed random variable having sample estimates of M and σ , the typicality of the dates is less, the larger their normalized deviations Q [2] are in absolute value.

Typical values fit within confidence limits, where 50% of individual dates, that is, typical values of sample properties make up 50% of its total volume.

Comparison of individual values of the variant (dates) with a confidence interval of typical values make it possible to evaluate individual indicators of soil properties.

3. Results and discussion

The table shows the typical values of a number of morphological features and properties. Analyzed soils belong to the heavy loam variety of agro-podzolic soils with a content of physical clay in the arable horizon of 43.6%, which occupies the middle position of the limiting values of 40.4 - 49.6% (table).

At the same time, 41.9 - 45.3% prevail in the sample, that is, they constitute 50% of the total volume.

The composition of physical clay also includes silt, the most mobile part of physical clay. Typical values of this fraction are 13.5 - 17.9% with an arithmetic mean of 15.7%.

In the sub-arable horizon, ELB contains an average of 45.8% of physical clay, which also occupies an average position in the range of typical values of this fraction.

The silt fraction occupies a similar position in the transition horizon ELB.

The thickness of the arable horizon, having a range of 18 - 30 cm and an average arithmetic of 23.8 sm, is characterized by typical values that fit into the interval 21.9 - 25.7 sm. The lower limit of the typical boundary of the transitional horizon lies at a depth of 27.2 - 33.6 sm.

In arable soils, the pH of the salt suspension is usually regulated by the application of calcareous flour. At the same time, the typical values of both horizons more accurately characterize the acid state of these sod-podzolic soils, and accordingly they better reflect their agrochemical state in pH.

The humus content is an integral indicator of the fertility of arable soils, and characterizing typical values of half the sample size and, correspondingly, half the area of these arable soils, give a quantitative representation of the humus content of the analyzed soils and their fertility levels. Accordingly, soils containing from 1.1 to 1.90% and from 2.70 to 3.90% occupy about 25% of the

total area. These indicators are of interest in the development of design documentation for the optimization of soil properties [14, 15, 16, 17, 18, 19].

Table 1. Typical values of the lower boundary of horizons (sm) and properties in sod-podzolic soils.

Property	n	Limit Meanings	M	σ	$Q_{0,50}$	V_{min}	V_{max}
<i>Fundamental properties</i>							
1	2	3	4	5	6	7	8
PY, sm	102	18-30	23,8	2,77	0,68	21,9	25,7
ELB-(21-42), sm	57	21-42	30,4	4,59	0,69	27,2	33,6
PY -<0,01mm, %	112	40,4-49,6	43,6	2,47	0,68	41,9	45,3
ELB -<0,01 mm, %	44	33,0-61,4	45,8	5,96	0,69	41,7	49,9
PY -<0,001 mm, %	112	8,2-31,7	15,7	3,17	0,68	13,5	17,9
ELB <0,001 mm, %	44	9,1-35,9	2,2	6,69	0,69	15,6	24,8
PY - pH _{kcl}	148	3,6-6,7	5,1	0,55	0,67	4,43	5,47
ELB -pH _{kcl}	68	3,6-6,0	4,6	0,59	0,68	4,20	5,00
<i>Stable properties</i>							
PY - humus,%	141	1,1-3,9	2,3	0,59	0,67	1,90	2,70
ELB - humus,%	70	0,3-1,7	0,8	0,30	0,68	0,60	1,00
PY -S mmol /100g	144	8,3-23,9	15,3	2,80	0,67	13,4	17,2
ELB -S mmol /100g	75	5,7-22,8	13,6	3,60	0,68	11,2	16,0
PY -Hr mmol /100g	135	1,0-7,1	3,5	1,20	0,67	2,7	4,3
ELB -Hr mmol /100g	66	0,7-11,1	3,7	1,75	0,68	2,5	4,9

4. Conclusion

Stable properties of arable horizon bear the imprint of long-term agricultural use, the positive influence of which can be traced along the upper typical values of soil properties. The content of typical values of humus in the arable horizon is in the range from 1.9 to 2.7%, which corresponds to an average and high gradation in humus content for this type of soil [20]. Improvement of this property is necessary and possible with intensive technologies by applying organic fertilizers, composts, chopped straw and siderates.

In the subsoil horizon there is a sharp drop in the humus content, as it can be traced in natural conditions, because it is genetically determined.

The parameters of the absorption capacity and the sum of the absorbed bases of the arable horizon are within their optimal parameters.

Current indicators of hydrolytic acidity are above optimal values, which requires intervention in the regulation of this indicator. In practice, this is achieved by liming. In contrast to hydrolytic acidity, the degree of base saturation is below optimal values. Optimization of this property is also associated with the constant cyclical nature of economic activity in neutralizing acidic soils.

The distribution of genetic horizons, their typical values, more clearly characterize the genetic profile of the analyzed soils, the comparison of individual values of the variant (dates) with a confidence interval of typical values allow one to evaluate individual indicators of soil properties.

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