Dynamics of changes in the content of nutrients in the soil on fine - zapadinny relief

Olga Shlyahtintseva[1] , *Yuri* Mazhayskiy [2], and *Olga* Chernikova[2, *]

[1]Belarusian State Agricultural Academy, Gorki, Ivan Michurin str., 5, Belarus
[2]The academy of the FPS of Russia, 390036 Ryazan, Sennaya str., 1, Russian Federation

Abstract. Studies conducted to study the effectiveness of the introduction of micro-deposits of silt into the soil as part of organo-mineral fertilizers in combination with conventional mineral and organic fertilizers have shown that the accumulation of nutrients in the soil. The best options affecting agronomic indicators were application doses in the amount of 20-25 t/ha. Taking into account more effective results for use in production, it is recommended in these soil-hydrogeological conditions to apply silt deposits at a dose of 25 t/ha, cattle manure 10 t/ha and the introduction of mineral fertilizers at a dose of – $N_{88}P_{43}K_{46}$.

1 Introduction

When reclamation is carried out on the shallow-depression relief characteristic of the north-eastern part of the Republic of Belarus, the soil cover of the reclaimed area is disturbed, especially in the open and closed drainage network when it is installed, and there is also a problem with the placement and disposal of silt deposits from the depressions when wells-sinks or reservoirs-digs are installed in their place [1-4].

Bottom sediment deposits contain biogenic nutrients (phosphorus, nitrogen and potassium), organic and fine-grained particles, as well as possibly carcinogenic elements. At the same time, they can be a good organic-mineral fertilizer, especially when they are composted and used with traditional organic and mineral fertilizers. However, there are currently no technologies and doses for introducing silt deposits into the soil. Most often they are leveled on the territory adjacent to the kopan, which, among other things, worsens the drainage regime and surface runoff, and generally reduces fertility, due to their overabundance at the disposal site [5-7].

In this regard, the study of the effectiveness of the use of silt deposits of micro-deposits as organo-mineral fertilizers in combination with conventional mineral and organic fertilizers is of interest to science and practice for regulating the nutritional and water-physical condition of reclaimed soils, especially with a shortage of organic fertilizers.

The soil and climatic conditions of the Republic of Belarus do not allow intensive farming due to waterlogging on an area of about 8 million hectares (more than 40% of the

[*] Corresponding author: chernikova_olga@inbox.ru

territory) [8]. In this regard, drainage reclamation systems have been of fundamental importance for the development of agricultural production in the Republic of Belarus for more than 120 years [9].

Currently, 3.4 million hectares have been drained, including 2.9 million hectares occupied for agricultural production, of which 1.3 million hectares for row crops, 1.6 million hectares for meadow and pasture crops [10].

There is a need to develop methods of exploitation of these lands, including the use of fertilizer-reclamation mixtures containing silt deposits of micro-deposits and other natural components.

Currently, there is a need to develop a technology for the utilization of silt deposits obtained during the construction of reservoirs-digs, as a waste, a source of nutrition, complex fertilizer and to improve the fertility of disturbed soils.

Agrochemical tests show that there is a significant potential of nutrients in the silt and, in combination with the introduction of organic and mineral fertilizers, it is possible to create a technology that will allow to obtain stable yields of agricultural crops and to dispose of silt as waste generated not directly from the dig, but evenly throughout the reclaimed area.

The study is aimed at establishing the optimal dose of these chemical meliorants, which will improve the fertility of the studied sod-podzolic soils of the north-east of the Republic of Belarus.

2 Methods

The study of the use of silt deposits of micro-deposits obtained as a result of reclamation of reclaimed soils as organo-mineral fertilizers, including in combination with traditional organic fertilizers, has been conducted on the basis of the Tushkovo-1 educational and irrigation complex of the Goretsky district of the Mogilev region since 2021.

Before laying the vegetation experiment, a soil survey was performed. The results of tests of soil samples for the content of nutrients are presented 1rd table.

The soil of the experimental site "Tushkovo-1" is sod-podzolic, light loamy, developing on loess-like loam, underlain by moraine loam from a depth of more than 1 m.

According to the experimental field, the arable land bonus score is 36.5, the humus content is 1.48%. In order to create an equal appropriate background for future experience, as well as to establish and increase the uniformity of soil fertility in 2021, equalizing sowing of winter rapeseed of the Batis variety as a sideral crop was carried out in vegetative vessels. As a result, the soil acquired a density and structure similar to the structure at the site of soil sampling in the Tushkovo-1 educational and irrigation complex.

Table 1. Results of tests of soil samples for nutrient content

Name of the sample	Test results				
	N, %	P_2O_5, mg/kg	K_2O, mg/kg	pH	Organic matter,%
Horizon A	0.05	226.8	295.8	6.34	0.9
Horizon B	0.025	161.6	107.0	3.8	4.5
Horizon C	0.024	61.6	69.3	3.68	4.32
Envelope method	0.1	222.9	241.3	6.28	1.8

The studies were carried out in vegetative vessels with imitation of field experience with accompanying observations, records and laboratory analyses.

In order to obtain a programmable yield and determine the effectiveness of using silt deposits as complex fertilizers, the elementary balance method, which is a classic example of calculating fertilizer doses for the removal of NPK, determined the amount of nutrients (kg d.v./ ha) to be introduced with fertilizers and developed an experiment scheme, according to which in 2022 was conducted vegetation experience. The scheme of the experience is shown the presented 2[rd] table.

Table 2. Scheme of vegetation experience

Experiment variant	Name of agrochemeliorants
1	Control
2	Cattle manure 30 t/ha ($N_{27}P_{15}K_{60}$) + Mineral fertilizers ($N_{83}P_{39}K_{25}$)
3	Silt 30 t/ha ($N_{15}P_{7}K_{23}$) + Mineral fertilizers ($N_{95}P_{47}K_{62}$)
4	Mineral fertilizers ($N_{110}P_{54}K_{85}$)
5	Cattle manure 10 t/ha ($N_{9}P_{5}K_{20}$) + Silt 25 t/ha ($N_{13}P_{6}K_{19}$) + Mineral fertilizers ($N_{88}P_{43}K_{46}$)
6	Cattle manure 10 t/ga ($N_{9}P_{5}K_{20}$) + Silt 20 t/ha ($N_{10}P_{4}K_{15}$) + Mineral fertilizers ($N_{91}P_{45}K_{50}$)
7	Cattle manure 10 t/g ($N_{9}P_{5}K_{20}$) + Silt 15 t/ha ($N_{8}P_{3}K_{11}$) + Mineral fertilizers ($N_{93}P_{46}K_{52}$)

For the experiment, vessels with a volume of 10 liters, a height of 25 cm and an open surface area of 0.053 m^2 with a hole in the bottom through which water seeped and drained into the trays for collecting infiltrate were used. The vessels were installed on specially prepared racks. In the experiments, 7 variants of fertilizer combinations were used, each of which was made in 4-fold repetition.

Maintaining the soil moisture regime at a given level recommended by previous studies was regulated by irrigation, which contributes to ensuring the water needs of agricultural plants during their growing season.

Soil analyses from vegetative vessels were performed in accordance with generally accepted methods in specialized laboratories.

The results of the experiments were processed by mathematical and statistical methods with the determination of $LSD_{0.5}$.

3 Results and Discussion

Under the influence of organic-mineral fertilizers, both in pure form and with the addition of silt obtained during the reclamation of depressions of the western terrain, the agrochemical properties of the soil changed.

The content of total nitrogen, potassium and phosphorus in the soil before and after the vegetation experiments are presented 3[rd] table.

The nitrogen content in the soil after the vegetation experiments increased slightly in the second variant with the introduction of 30 t/ha of cattle manure ($N_{27}P_{15}K_{60}$) and background application of mineral fertilizers containing the active substance ($N_{83}P_{39}K_{25}$) and in the third variant with the introduction of silt 30 t/ha ($N_{15}P_{7}K_{23}$) and background application of mineral fertilizers containing the active substan ($N_{95}P_{47}K_{62}$) by 40 and 20%, respectively. This increase can be explained by the large number of microorganisms contained in these types of fertilizers.

In other variants, the nitrogen content has significantly decreased, which can be explained by the removal of this food element from the soil by plants. The lowest nitrogen content was found in the seventh variant with the introduction of 10 t/ha of cattle manure

($N_9P_5K_{20}$), 15 t/ha of silt ($N_8P_3K_{11}$) and background application of mineral fertilizers containing the active substance ($N_{93}P_{46}K_{52}$).

Table 3. Content of N, P_2O_5, K_2O in soil

Variants	Test results of soil samples					
	before conducting experiments			after conducting experiments		
	N,%	P_2O_5,mg/kg	K_2O,mg/kg	N,%	P_2O_5,mg/kg	K_2O,mg/kg
Variant 1	0.05	226.8	295.8	0.03	328.3	359.3
Variant 2				0.07	366.0	439.0
Variant 3				0.06	396.4	453.0
Variant 4				0.02	364.0	456.8
Variant 5				0.03	402.7	522.6
Variant 6				0.02	426.3	513.4
Variant 7				0.01	413.7	471.7

This indicator decreased in this version by 80%.

The phosphorus content in soil samples after harvesting has increased significantly in all fertilizer applications, which is primarily due to meteorological conditions affecting the ability of plants to absorb moisture. It is well-known to increase the availability (mobility) of phosphates with an increase in the level of soil moisture.

The period from the emergence of seedlings to maturation was characterized by the smallest variation in the moisture reserves in the 20-centimeter soil layer. The greatest increase in the phosphorus content in the soil was revealed in the sixth variant with the introduction of 10 t/ha of cattle manure ($N_9P_5K_{20}$), 20 t/ha of silt ($N_{10}P_4K_{15}$) and background application of mineral fertilizers containing the active substance ($N_{91}P_{45}K_{50}$). It was 426.3 mg/kg, which is 88% higher than the phosphorus content in the soil before the experiment.

In general, the fifth and sixth variants with the use of cattle manure and silt deposits of 20-25 t/ha were the best for the accumulation of phosphorus and potassium.

Different ways of soil formation and their fertility flow into a single channel under the influence of cultivated plants with the same type of direction of the biological cycle of substances. An important indicator of soil fertility is the content of organic matter, which in turn is divided into inhumified organic residues of plant and animal origin contained in the soil and humified – humus, humus. Humic acids, in turn, are divided into humic and fulvic acids.

Humus is the energy basis of the processes of plant growth and development, has a great influence on the regulation of plant nutrition with macro- and microelements.

The studied soil was low in organic matter. Before the experiment, the organic matter content in the arable horizon was 0.9%.

The content of organic matter in soil samples before and after the study, as well as the acidity of the soil are presented in 4rd table.

Analyzing the results of analyses of soil samples, it can be concluded that after the vegetation experiments, the content of organic matter increased in all variants by an average of 92.9%.

The greatest increase in organic matter is observed in the third variant with the introduction of sludge of 30 t/ha ($N_{15}P_7K_{23}$) and background application of mineral fertilizers containing the active substance ($N_{95}P_{47}K_{62}$).

Table 4. Organic matter content in soil samples and soil acidity

Variants	Test results			
	before conducting experiments		after conducting experiments	
	Organic matter, %	pH	Organic matter, %	pH
Variant 1	0.9	6.34	1.62	5.46
Variant 2			1.59	5.52
Variant 3			1.91	5.48
Variant 4			1.83	5.37
Variant 5			1.72	5.32
Variant 6			1.70	5.47
Variant 7			1.80	5.43

Among the variants combining different types of fertilizers, the greatest increase in the organic matter content is observed in the seventh variant containing 10 t/ha of cattle manure ($N_9P_5K_{20}$), 15 t/ha of silt ($N_8P_3K_{11}$) and background application of mineral fertilizers containing the active substance ($N_{93}P_{46}K_{52}$). These changes favorably affect the quality of the soil. Since it is well known that an increase in the amount of organic matter, including through the application of organic fertilizers, improves the soil structure, water-air regime, physico-chemical properties of the soil, and also increases the microbiological activity of the soil.

Soil acidity is a property that provides for the presence of organic and mineral acids in the earth, is determined by a set of hydrogen ions and is expressed in terms of pH and measured on a scale from 1 to 14. This indicator affects the qualitative composition of the soil, as well as the access of plants to various trace elements. Depends on the acidity. Which microorganisms will prevail in the soil. Whether the fertilizers applied will benefit, and how well the crops will develop.

The acidity of the soil in all samples decreased by an average of 14.3%. It can be assumed that the decrease in the pH value is associated with an increase in the amount of calcium in the soil after exposure to fertilizers applied to them.

4 Conclusions

The introduction of fertilizers into the soil not only improves the nutrition of plants, but also changes the conditions of existence of soil microorganisms, which also need nutrients.

Under favorable climatic conditions, the number of microorganisms and their activity after fertilizing the soil increase significantly. The decay of humus increases, and as a result, the mobilization of nitrogen, phosphorus and other elements increases.

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