The content of soil humus when using organic and mineral fertilizers

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Abstract. This article suggests that the content of humus is the ability of the soil to adapt to human economic activity. The scientific team conducted a three-year field experience, taking into account the humus state of the soil in two terms. Conclusions are made based on the data obtained. The use of organic fertilizers contributes to a positive balance of humus. The amount of the increase varies from 0.06% to 0.14%. The increase in humus content is directly proportional to saturation with mineral nutrition (from 0 to 1 full dose). Mineral fertilizers reduce the loss of soil humus. The dependence is reversed: with a full dose of fertilizers, the decrease in humus content over 3 years is -0.11%, with a half dose -0.12%, and with zero -0.14%. To effectively preserve and increase the humus content in the soil, 14 tons/ha of compost based on bird droppings and a full dose of mineral fertilizers calculated based on the needs of different crops should be applied.

1 Introduction

Scientists from all over the world are working on studying the humus content in the soil [1-5]. It is this indicator of soil fertility that characterizes both the natural potential of the soil and anthropogenic human intervention. Our team of authors believes that the content of humus is not so much the presence of a gross amount of organic matter in the soil, but its ability to adapt to human economic activity.

Humus is a sum of non-mineralized nutrients, which, if necessary, undergo mineralization and pass into an accessible form for plant nutrition. It follows from this that in order to maintain the values of humus content at a high level, it is necessary to artificially create conditions for plant nutrition [6-7].

The most common practice is fertilization. Mineral fertilizers are mainly used due to their high speed, convenient shape, and ease of use [8-10]. However, with the introduction of large doses of mineral fertilizers, there is a violation of the intra-soil mechanisms. This shift is associated with a sharp change in the pH of the soil environment and the suppression of the biological activity of microorganisms. Ultimately, we can observe a deterioration in the agrophysical parameters of the soil (changes in structure, compaction, decrease in water and air exchange) [11].

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The use of organic fertilizers helps to improve soil properties due to the content of a non-mineral component. The mineralization of the organic matter of fertilizers occurs gradually, carrying out this process in the amount of about 30% per year of the applied mass. The remaining part does not disappear, but remains in the soil and is used for the next 2-3 years [12].

In areas of developed poultry farming, litter is available. The waste is used as fertilizer, which solves the problem of waste disposal and economic efficiency of production. Therefore, we conducted experiments to identify the dependence of the humus state of the soil on the use of organic fertilizers.

2 Materials and methods

Type of research: stationary two-factor experience deployed in time and space. Duration: 3 years during the full rotation of the experimental three-field crop rotation: soybeans – winter wheat – corn for grain.

Studied factors:

- factor A – the use of organic fertilizers. Type of fertilizer – compost based on bird droppings;
- A1 – without the use of organic fertilizers;
- A2 – using organic fertilizers in the form of compost based on bird droppings at a dose of 14 t/ha;
- factor B – the use of mineral fertilizers in a dose calculated for the planned harvest;
- B1 – without the use of mineral fertilizers;
- B2 – with the use of mineral fertilizers, ½ of the dose calculated for the planned harvest;
- B3 - with the use of mineral fertilizers in a full dose calculated for the planned harvest.

Experience options:

1. Control without the use of organic and mineral fertilizers. Further in tables, diagrams and graphs in abbreviations: 0/OF + 0/MF
2. Without the use of organic fertilizers + the use of mineral fertilizers ½ of the dose calculated for the planned harvest.

Further in the abbreviation: 0/OF + ½/MF

3. Without the use of organic fertilizers + the use of mineral fertilizers in a full dose calculated for the planned harvest.

Further in the abbreviation: 0/OF + 1/MF

4. Organic fertilizers (compost based on bird droppings) dose 14 t/ha + without the use of mineral fertilizers.

Further in the abbreviation: OF + 0/MF.

5. Organic fertilizers (compost based on bird droppings) a dose of 14 t / ha + the use of mineral fertilizers in a ½ dose calculated for the planned harvest.

Further in the reduction: OF + ½/MF.

6. Organic fertilizers (compost based on bird droppings) a dose of 14 t /ha + the use of mineral fertilizers in a full dose calculated for the planned harvest.

Further in the abbreviation: OF + 1/MF.

An elementary scheme of the field experience is presented in Table 1.

Table 1. Elementary scheme of experience.

field 1		field 2		field 3	
0/OF + 0/MF	OF + 0/MF	0/OF + ½/MF	OF +½/MF	0/OF + 1/MF	OF + 1/MF
0/OF + ½/MF	OF +½/MF	0/OF + 1/MF	OF + 1/MF	0/OF + 0/MF	OF + 0/MF
0/OF + 1/MF	OF + 1/MF	0/OF + 0/MF	OF + 0/MF	0/OF + ½/MF	OF +½/MF

The total dose of mineral fertilizers, taking into account the coefficients of return and use, is 37 kg /ha for soybeans in nitrogen, 115 kg/ha for winter wheat and 135 kg/ha for corn for grain in nitrogen.

Organic fertilizers allowed plants to use 175 kg/ha of nitrogen.

The width of the plot is equal to the width of the sowing and harvesting unit - 8 meters. The length of the plot is 20 meters. The protective corridor between the blocks of plots is 10 meters (for the convenience of turning equipment). The repetition in the experience is threefold. The acreage of the plot is 160 m2, the harvesting area is 140 m2.

Agrotechnics in experience: tillage using Mini-till technology, plant protection complex, timing of technological operations are generally accepted in the economy.

3 Results and discussion

The humus state of the soil of the experimental site was taken into account twice – before the start of the field experiment and 3 years later after the end of the full rotation of the crop rotation. The data obtained from the analysis of soil samples are shown in Table 2.

Table 2. Changes in the humus content in the soil over 3 years in the experimental field, %.

Organic fertilizers (OF)	**Mineral fertilizers (MF)**			
	0	**0.5**	**1**	**the average value**
The initial content of humus				
0 t/ha	4.91	5.08	5.00	5.00
Compost 14 t/ha	5.07	5.21	5.52	5.27
the average value	4.99	5.15	5.26	-
Humus content in the soil after 3 years				
0 t/ha	4.77	4.96	4.89	4.87
Compost 14 t/ha	5.13	5.30	5.66	5.36
the average value	4.95	5.13	5.28	-
The balance of humus content				
0 t/ha	-0.14	-0.12	-0.11	-
Compost 14 t/ha	+0.06	+0.09	+0.14	-
HCP_{95} (OF)	0.18	-	-	-
HCP_{95} (MF)	0.10	-	-	-
HCP_{95} for two samples	0.13	-	-	-

In the first period of soil analysis, humus content values ranged from 4.91% to 5.52%. The difference between these values was 0.60%. Such a difference on this basis can be explained by the heterogeneity of soil fertility, which is inherent in many agricultural lands.

The second period of soil analysis indicates a change in the indicator depending on the experience options. An increase in value was noted in some areas, and a decrease in others. The gap between the highest and lowest humus content was 0.89%. The humus content varied from 4.77% to 5.66%. The lowest value was noted in the control variant without the use of fertilizers. The maximum within the framework of the experiment was recorded at full saturation with fertilizers – 14 t/ha of bird droppings + a full dose of fertilizers (nitrogen doses of mineral and organic fertilizers are indicated in the methodology).

There is a clear positive balance when using organic fertilizers. The amount of the increase varies from 0.06% to 0.14%. The increase in humus content is directly proportional to saturation with mineral nutrition (from 0 to 1 full dose). On plots without fertilization, an exceptional decrease in the studied indicator is observed. Moreover, the dependence is already reversed. So, with a full dose of fertilizers, the reduction in humus content for 3 years is -0.11%, with a half dose -0.12%, and with zero -0.14%. From this it can be concluded that the use of mineral nutrition in the fertilizer system allows you to maintain and increase the humus content. The best option in solving the problem of humus degradation of soils is the use of 14 tons / ha of compost based on bird droppings and the use of a full dose of mineral fertilizers designed for a specific grain crop.

4 Conclusion

Our research team conducted a field experiment in which the humus state of the soil of the experimental site was taken into account twice – before the start of the field experiment and 3 years later after the end of the full rotation of the crop rotation. Based on the data obtained, the following conclusions can be drawn:

The use of organic fertilizers contributes to a positive balance of humus. Mineral fertilizers reduce the loss of soil humus. To effectively preserve and increase the humus content in the soil, 14 tons/ha of compost based on bird droppings and a full dose of mineral fertilizers calculated based on the needs of different crops should be applied.

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