Effect of application of organomineral fertilizers

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Abstract. The article deals with the problems of increasing soil fertility and crop yields, as well as the utilization of livestock runoff of enterprises. A new organomineral fertilizer was developed, and its effectiveness was studied in the field on typical Chernozem and winter wheat. As a result of research, it was found that the proposed organomineral fertilizer has a positive effect on soil fertility, the excess in relation to the control was: nitrate nitrogen – 1.8 times, mobile phosphorus – 2.2, exchange potassium – 1.3. The increase in yield relative to the control from the use of organomineral fertilizer was 0.99 ton/ha (76 %).

1. Introduction
The use of fertilizers in agriculture is of great importance for managing soil fertility, increasing the yield and nutritional value of agricultural crops [1-4].

Currently, there are several problems in the agriculture of the Belgorod region – it is low fertility, high cost of mineral fertilizers and utilization of livestock runoff enterprises [5-10]. The main task of our research was to eliminate these problems. For this purpose, a new organomineral fertilizer was developed and its effectiveness was studied in field experiments.

2. Materials and methods
The research was conducted on the basis of the Department of agriculture, agrochemistry and ecology of the Belgorod state agrarian university in 2017-2019. The experience is one-factor, its repetition in space is three-fold, in time-three-fold. The sown area of the plot is 120 m², the accounting area is 100 m².

The experiment compared the use of various types of fertilizers in the main application-without fertilizers, mineral fertilizer (nitroammofoska), organic (cattle manure) and organomineral for winter wheat, grade «Synthetic». Mineral fertilizers were applied at a dose of N₆₀P₆₀K₆₀, organic – 25 ton/ha, and organomineral – 10 ton/ha.

Method of basic tillage-minimum treatment with a disc harrow BDT-7 to a depth of 10-12 cm the soil of the experimental site is a typical medium-sized low-humus heavy loam on loess-like loam.

3. Results
As a result of the analysis of the range of modern organomineral fertilizers, we developed our own composition of organomineral fertilizer, which contains the following ingredients: organic part, zeolite, mineral salts, water.

As an organic component, we took cattle manure, although the production technology allows the use of pig litter manure and poultry manure. The zeolite used was a zeolite Hotynetskogo deposits of...
diatomaceous earth (Orel region). The crystal structure of zeolite contains: clinoptilolite - 35%, cristobalite - 27, montmorillonite - 5, mica - 8, calcite - 3, EQ reaches 600 m-EQ/100 g.

The study of the effect of fertilizers was carried out by studying the effect on the indicators of soil fertility and yield of winter wheat of the Synthetic variety in comparison with the use of traditional fertilizers. The results of the research are shown in tables 1 and 2.

Table 1. Effect of fertilizers on soil fertility, 2017-2019.

| Variants | Humus content, % | +/- | Nitrate nitrogen content, mg/kg | +/- | Mobile phosphorus content, mg/kg | +/- | Exchangeable potassium content, mg/kg | +/- |
|----------|------------------|-----|--------------------------------|-----|---------------------------------|-----|-------------------------------------|-----|
| 1        | 5.41±0.27        | -   | 4.9±0.2                        | -   | 7.0±0.4                         | -   | 11.7±0.6                            | -   |
| 2        | 5.96±0.29        | 0.55±0.02 | 6.9±0.3                        | 2.0±0.1 | 11.3±0.6                        | 4.3±0.2 | 13.2±0.7                            | 1.5±0.1 |
| 3        | 6.08±0.30        | 0.67±0.03 | 2.7±0.1                        | -2.2±0.1 | 8.4±0.5                          | 1.4±0.1 | 8.3±0.4                            | -3.4±0.2 |
| 4        | 6.17±0.31        | 0.76±0.04 | 8.9±0.4                        | 4.0±0.2 | 15.6±0.7                         | 8.6±0.3 | 15.5±0.8                            | 3.8±0.2 |

| a | Without fertilizers (control); | b | Nitroammofoska (N$_{16}$P$_{16}$K$_{16}$); | c | Cattle manure; | d | Organomineral fertilizer. |

The humus content in the soil was lowest without the use of fertilizers and amounted to 5.41%, and the highest—when applying organic mineral fertilizer – 6.17%. Also, high content of nitrate nitrogen, mobile phosphorus and exchangeable potassium was observed when using organomineral fertilizer, and amounted to 8.9, 15.6 and 15.5 mg/kg, respectively. And the least – when using cattle manure.

One of the most important tasks facing agricultural production is to ensure the country's food security. This requires the use of fertilizers in high doses, otherwise the yield of crops decreases.

Table 2 shows the yield and protein content of winter wheat grain, depending on the type of fertilizer used.

Table 2. Influence of fertilizers on yield and quality of winter wheat grain, 2017-2019.

| Variants | Winter wheat yield, ton/ha | +/- | The protein content in the grain, % | +/- |
|----------|----------------------------|-----|-------------------------------------|-----|
| 1        | 2.61±0.13                  | -   | 13.93±0.69                          | -   |
| 2        | 3.48±0.17                  | 0.87±0.04 | 14.47±0.72                        | 0.54±0.03 |
| 3        | 3.09±0.15                  | 0.48±0.02 | 13.27±0.66                        | 0.66±0.03 |
| 4        | 4.60±0.23                  | 1.99±0.10 | 14.91±0.75                        | 0.98±0.06 |

| a | Without fertilizers (control); | b | Nitroammofoska (N$_{16}$P$_{16}$K$_{16}$); | c | Cattle manure; | d | Organomineral fertilizer. |

The yield of winter wheat was the lowest at the control (without the use of fertilizers), and the highest when using organomineral fertilizer and amounted to 2.61 and 4.60 ton/ha, respectively. The application of mineral fertilizer increased the yield of winter wheat in relation to the control by...
0.87 ton/ha. And the use of cattle manure, although it was effective, but less than other fertilizers, the increase was 0.48 ton/ha.

The protein content in winter wheat grains was the lowest when applying manure – 13.27%, slightly higher was at the control – 13.93%. The use of mineral fertilizers increased the protein content in winter wheat grain by 0.54% in relation to the control. The most effective was the use of the developed organomineral fertilizer, the protein content was 14.91%.

4. Discussion
Increasing soil fertility, as well as crop yields, is the main task of agriculture in both the region and the country as a whole. The introduction of mineral fertilizers is an effective way to solve this problem, since the increase in humus content in relation to the option without fertilizers was 0.55%, and the content of nutrients was also higher: nitrate nitrogen by 2.0 mg/kg (40.8% of the control), mobile phosphorus – 4.3 mg/kg (31.4%) and exchange potassium – 1.5 mg/kg (12.8%). But it is expensive, the cost of 1 ton of nitroammofoski in the studied years averaged 18 rubles/kg.

The use of manure is more cost-effective, especially if the company has its own resources. However, as our studies showed, its introduction had a positive effect only on the humus content, an increase in relation to the control of 0.67%. The content of nitrate nitrogen and exchangeable potassium on the contrary decreased by 2.2 (44.9%) and 3.4 mg/kg (29.1%), respectively, due to speeding the removal of nutrients on the rate of decomposition of manure.

The use of organomineral fertilizer, in turn, increased all indicators of soil fertility, this is due to the presence of a sufficient amount of nutrients in mineral form, which allows the organic part to completely decompose and also become available to agricultural plants, and zeolite due to its sorption properties contributes to the retention of nutrients in the upper root layer of the soil.

The above conclusions are also repeated when analyzing the yield of winter wheat – the use of organomineral fertilizer was more effective.

5. Conclusion
Thus, the developed organomineral fertilizer contributed to an increase in soil fertility and productivity of winter wheat in comparison with traditional fertilizers. And also partially solves the problem of utilization of animal waste.

References
[1] Lyaskovsky M I 1998 New forms of complex organomineral fertilizers as a factor for sustainable development of biosphere and plant productivity. *Acta agronomica hungarica* **46** (3) 237-57
[2] Naliukhin A N, Glinushkin A P, Khamitova S M and Avdeev Yu M 2018 The influence of biomodified fertilizers on the productivity of crops and biological properties of soddy-podzolic soils. *Entomology and applied science letters* **5** (3) 1-7
[3] Gribut E A, Kulikova M A and Kasharin D V 2020 Optimization of organic fertilizers production technology for fractional separation of biodegradable organic waste. *Materials of the 3rd International Conference on Agribusiness, Environmental Engineering and Biotechnologies Krasnoyarsk* **548** (5) 162670
[4] Elbl J, Brtnicka H, Kintl A, Holatko J and Brtnicky M 2019 Use of organic-mineral fertilizers as alternative to conventional organic and mineral fertilizers: Effect on soil quality. *Materials of the 19th International Multidisciplinary Scientific Geoconference, SGEM* **19(3.2)** 583-90
[5] Shinkarenko O, Kolesnikov A and Smurov S 2020 Economic feasibility of organic agriculture in the Belgorod region. *Journal of Tourism Research and Practice* **54** 7
[6] Stupakov A G, Orekhovskaya A A, Kulikova M A, Manokhina L A, Panin S I, Geltukhina V I 2019 Ecological and agrochemical bases of the nitrogen regime of typical chernozem depending on agrotechnical methods. *IOP Conf. Series: Earth and Environmental Science* **315** 052027
[7] Miroshnichenko I V, Nikulina N V and Petrosov D A 2020 Prospects for processing manure into biogas when using the probiotic drug "Amilocin" in the diet of chickens. Biotechnology 36(5) 72-80

[8] Zdorovets Yu I and Goncharenko O V 2014 Assessment of the economic efficiency of pig breeding in large integrated structures of the Belgorod region. Economic analysis: theory and practice 1(352) 35-41

[9] Litsukov S D, Glukhovchenko A F, Kotlyarova E ., Titovskaya A I and Akinchin A V 2019 Agrochemical substantiation of the inclusion of bird droppings under grain maize at different tillage in terms of the south - western part of the Central Black Earth region. Bioscience Biotechnology Research Communications 12(55) 152-60

[10] Turyansky A V, Kotlyarova E G, Litsukov S D, Titovskaya A I and Akinchin A V 2018 Research of development trends in the field of soil fertility restoration. Ecology, Environment and Conservation 24(3) 1048-52