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Biologization Of Fertilizer Systems: A Step Towards Organic Farming.

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ABSTRACT

In this paper, we study the dynamics of pH values and agrochemical parameters of chernozem leached for a long period of study recommended by the calculation method, and biologized fertilizer systems for grain-growing crop rotation. The effectiveness of a biologically fertilized fertilizer system with respect to the productivity of crop rotation in conditions of unstable moistening on chernozem leached is shown. When discussing the problems of transition to organic farming, the advantages of siderates are presented, the possibility of using them in many soil and climatic conditions, the value of modifications of manure composts with phosphogypsum and limestone crumb. The importance of these components of fertilizer systems is shown to achieve a zero-deficiency balance of nutrients and maintain soil fertility.

Keywords: biology of fertilizer systems, nutrient balance in soil, soil fertility, crop rotation productivity, organic farming.

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INTRODUCTION

In recent decades there has been a rapid growth of interest in organic products in the world market. A relatively young branch of organic farming is considered one of the most promising and is among the priority. However, due to the lack of legislative basis in this area of agricultural production, errors and irregularities are possible. Given that the Stavropol region, like Russia as a whole, has a huge potential of lands that meet the requirements of this area of agriculture, it is necessary to conduct multi-dimensional studies of the effects of the components of this program before abandoning effective proven practices. In a stationary experiment, "Theoretical and Technological Aspects of the Biogeochemical Cycle of Substances in Agrolandscape", long-term studies are under way aimed at improving fertilizer systems and aimed at minimizing the use of synthetic crops and achieving a zero-balance nutrient balance in plants [1-9].

Purpose of the research. The main goal of the research is to study the influence of various fertilizer systems of grain-growing crop rotation on chernozem leached in the zone of unstable moistening on the dynamics of agrochemical indicators of soils and the formation of productivity of agricultural crops.

MATERIALS AND METHODS

In grain-growing crop rotation, located on chernozem leached in the zone of unstable moistening of the Stavropol Territory, the effect of fertilizer systems based on different principles and with different saturation of NPK is studied. The fertilizer system recommended for this soil-climatic zone has a saturation of rotation of NPK of 115 kg / ha, incl. $N_{50}P_{59}K_{6}$ + 5 t / ha manure; biologized fertilizer system assumes the maximum use of organic fertilizers with a crop rotation saturation of NPK 63 kg / ha + 9 t/ ha of organic fertilizers, including 5 t/ha litter; calculated fertilizer system is oriented to obtaining the maximum possible yield (pea-mixture of 33 t / ha, winter wheat - 6.5 t / ha, winter barley - 5.5 t / ha, maize for silage - 55 t / ha, winter wheat - 5 , 5 t / ha, peas - 3.3 t / ha, winter wheat - 6 t / ha, spring rape - 2.2 t / ha (from 2008 sunflower - 3 t / ha). The norms and doses of mineral fertilizers take into account the results of current soil analyzes and plant diagnostics, which is the basis of yield programming according to the method of V.V. Ageev (1979) and A.N. Esaulko (2006) and annually refined on the basis of soil analysis, visual diagnosis of nutrition [10, 11]. The average saturation of 1ha for two rotations of crop rotation (2000-2015) was 171 kg / ha NPK, incl. $N_{83}P_{76}K_{12}$ + 5 t / ha manure.

The second factor studied in the experiment is the methods of soil cultivation, among which are dump, waste-free, shallow and superficial. Taking into account many characteristics, scientists and practitioners believe that currently the most sparing for chernozem soils in the Stavropol Territory is dump cultivation of soil [3, 4], therefore it is more convenient to consider the results of the fertilizer system experience, as the choice of the least traumatic tillage - one of the requirements of organic farming and this is included in the requirements of GOST R 56508-2015 "Products of organic production. Rules of production, storage, transportation".

Parameters of soil fertility in the crop rotation of the long-term stationary experience of the Stavropol State Agrarian University are determined in accordance with the generally accepted methods for the zone:

- humus by the Tyurin method in the modification of CINAO (GOST 26213-91);
- mobile forms of phosphorus and exchangeable potassium by the method of Machigin in the modification of CINAO (GOST 26205-91);
- pH by ionometric method in aqueous suspension (GOST 26423-85);
- productivity of crop rotation was determined by the method of continuous harvesting of crops with conversion to grain units.

RESULTS AND DISCUSSION

The biologized fertilizer system (63 kg / ha NPK + 9 t / ha manure) by the scientists of the Department of Agrochemistry and Plant Physiology of the Stavropol State Agrarian University is based on the results of research conducted since 1976 in many years of experience. One of the features of this fertilizer system is that the manure in 8-rotary crop rotation is used in 2 fields, maintaining a stable aftereffect of organic fertilizers

during the rotation, and also the stabilization of humus in the cultivated soil layer. One-third of the planned phosphate fertilizers are applied locally, which allows to significantly save resources.

Despite the return to the soil of some of the nutrients used by crops to form the crop, biologization still can not stop the loss of their stock from the soil. It can be seen from the data of Table 1 that the content of humus, the most important indicator of the fertility of chernozems, is steadily shrinking. By the end of the study period, the losses for the period of research reached 1.09% of the level of the initial value at the beginning of the studies in the experiment.

Table 1: Changes in the content of nutrients in 0-20 cm of soil in the dumping of soil under the influence of the biological fertilizer system

Nutrient content	Terms of observation		
	Initial value (1976)	3rd rotation (2000-2007)	4th rotation (2008-2015)
Humus,%	6,70	5,76	5,61
Movable phosphorus, mg / kg soil	24,0	23,8	21,9
Exchange potassium, mg / kg soil	260	268	247
pH	6,7	6,6	6,4

The concentration in the soil of mobile phosphorus hospital by 2007 for 31 years of operation of the experiment decreased by 0.2 mg / kg, and in the following 8 years it decreased significantly - by 1.9 mg / kg for a shorter period.

Provision of soil with exchangeable potassium for a long time, until the third rotation of the crop rotation, changed insignificantly - it increased by 8 mg / kg soil, but for the following rotation decreased by 21 mg / kg soil, indicating an increase in the rate of loss of this battery.

The reaction of the soil solution due to the biologization of the fertilizer system is acidified, for four rotations of the crop rotation the pH has decreased from 6.7 to 6.4 units, and the rate of decrease has increased in the last rotation.

Comparing the effect of fertilizer systems on this indicator, we note that soil acidification occurs in all variants of the experiment. The data in Table 2 show that the process of acidification is most rapid in the calculated fertilizer system. The longest, until the third rotation of the crop rotation, the pH did not practically change on the biological fertilizer system, by the end of the 4th rotation the pH decreased in the given variant of the experiment by the least - by 0.3, and on the recommended and calculated systems by 0.6-0.7 units respectively.

Table 2: Effect of fertilizer systems on physicochemical and agrochemical soil parameters

Option of experience	Initial value (1976)	3rd rotation (2000-2007)	4th rotation (2008-2015)
Value pH			
Control	6,7	6,4	6,3
Biological fertilizer system	6,7	6,6	6,4
Calculation system of fertilizer	6,7	6,1	6,0
Recommended fertilizer system	6,7	6,2	6,1
Humus content, %			
Control	6,37	5,38	5,31
Biological fertilizer system	6,37	5,76	5,61
Calculation system of fertilizer	6,37	5,68	5,64

Recommended fertilizer system	6,37	5,57	5,52
Content of mobile phosphorus, mg / kg soil			
Control	24,0	19,4	18,7
Biological fertilizer system	24,0	23,8	21,9
Calculation system of fertilizer	24,0	28,3	32,7
Recommended fertilizer system	24,0	24,0	24,0
Content of exchangeable potassium, mg / kg soil			
Control	260	243	221
Biological fertilizer system	260	268	247
Calculation system of fertilizer	260	279	265
Recommended fertilizer system	260	256	254

The content of organic matter is also marked by a stable decline in all variants of the experiment, and its loss is most rapid in uncontrolled control, since no compensation for the use of its crops is made. The data in Table 2 show that among the variants studied, the loss of humus occurs most often on the recommended fertilizer system, for 4 rotations of the crop rotation the indicator decreased by 0.85%, the slowest on the calculation system, in this version of the experiment the humus content decreased by 0.73% slightly inferior to the biological fertilizer system - a decrease of 0.76%.

Discussing the dynamics of mobile phosphorus, it is important to note that the concentration of this indicator decreased during the period of research only in control. The reason is that crop rotation is not replenished from external sources, and inadequate quantity of post-harvest residues. Most importantly, the content of mobile phosphorus in the soil increased the calculated method of fertilization, ensuring an increase of 4.3 mg / kg in 3 rotations of the crop rotation, and another 4.4 mg / kg for the last rotation after optimization of the experiment. In the version of the recommended fertilizer system, the soil availability in this indicator is stable, with slight variations corresponds to the level of 24.0 mg / kg soil throughout the study period. During 3 rotations of the crop rotation, the level of mobile phosphorus on the biological fertilizer system changed insignificantly - by 0.2 mg / kg soil, but in the last 8 years it decreased by 1.9 mg / kg, and in relation to the initial content - by 2, 1 mg / kg. This indicates an increase in the flow rate of mobile phosphorus in the 4th rotation rotation.

Increasing the availability of exchange potassium contributes to the calculation system of fertilizer. The annual specification of fertilizer norms allowed increasing this indicator for 3 rotations of crop rotation by 19 mg / kg soil, then the rate of increase in content decreased, and by the end of the third rotation the crop rotation slightly exceeded the initial value by 5 mg / kg soil. The recommended fertilizer system with an insignificant decrease in the indicator keeps it close to the level of the initial one - by 2 -4 mg / kg lower. In the variant of the experiment of the biologically fertilized system, the availability of exchangeable potassium to the soil varies according to the periods of study, in the fourth rotation of the crop rotation, the decrease in 13 mg / kg of soil was observed with respect to the initial index.

Thus, with respect to the pH and agrochemical characteristics of the soil, it is impossible to single out any fertilizer system, the characteristics of each of them affect their indices ambiguously.

Currently, biological farming is armed with a wider arsenal of means and methods than 40-50 years ago, in addition to sowing leguminous and perennial crops, the use of organic fertilizers of animal origin, straw bales, sideration, the choice and principles of the action of biological products, biological agents protection of plants. When developing biologic fertilizer systems, attention should be paid to them.

GOST R 56508-2015 "Products of organic production. Rules of production, storage, transportation "also indicates that" the total amount of organic fertilizers applied to the soil on the basis of animal wastes should not exceed 170 kg of nitrogen per year per hectare of farmland "(6.2.2), i.e. when recalculating to the rate of manure application, we obtain that it should not exceed 34 t / ha. In the biologized fertilizer system

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studied by us, the norm is used 4-6 times lower. And in this demand, we see, with an increase in the level of development of the livestock sector, a reserve for improving the biological fertilizer system, and, consequently, increasing the nutrient content of the soil.

If we compare the effectiveness of fertilizer systems in the experiment, then, as can be seen from Figure 1, the productivity of grain-growing crop rotation during the dumping of soil on all fertilizer systems stably exceeded the control one. In addition, fertilizer rates of the biologized system allow achieving the level of productivity of the recommended fertilizer system, in which 115 kg / ha NPK + 5.0 t / ha manure is used. That is, an increase in the amount of organic substances by 75%, makes it possible to use mineral fertilizers twice less without loss of productivity. Moreover, the increase in yield in relation to control is significant.

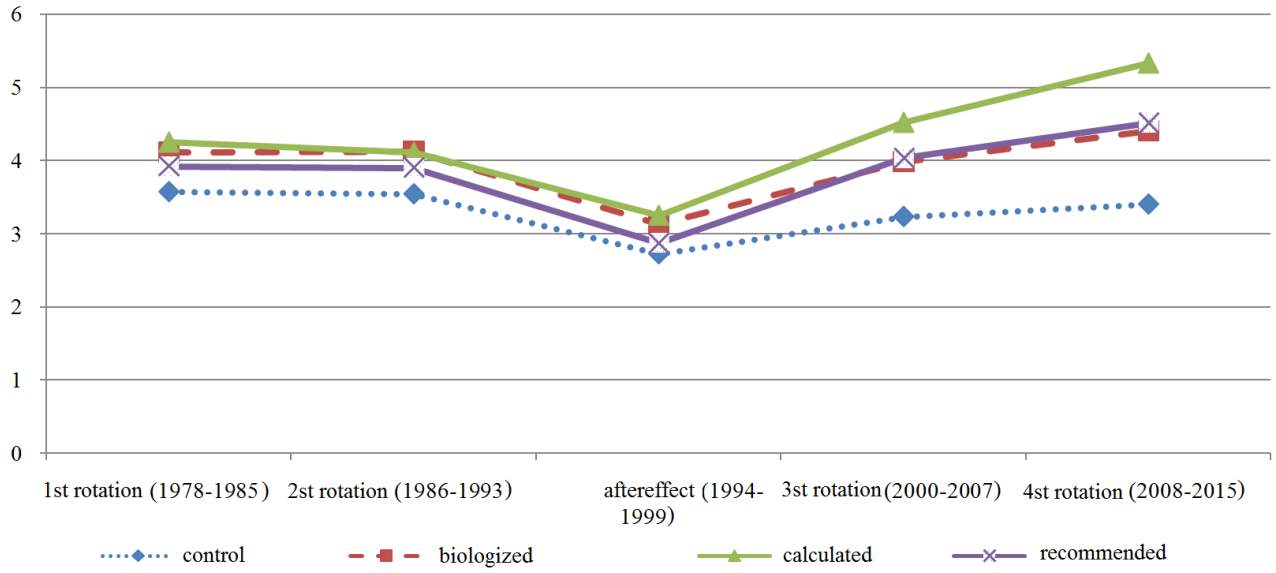

Figure 1: Productivity of grain-growing crop rotation on chernozem leached (t / ha g.u.)

Thus, the studies have proved that the biologized fertilizer system in grain-crop rotation, which is built on the efficient use of organic fertilizers and the economical local application of minimum doses of mineral fertilizers, is low-cost.

Every year, when developing fertilizer systems for agricultural crops, scientists of the Stavropol SAU are tested in practice, refined and use formulas for calculating fertilizer rates, created by the results of their own observations. V.V. Ageev and modified by the results of further studies of the scientists of the Department of Agrochemistry and Plant Physiology [10]. Elements of these calculations are the planned yield, the content of the element in the soil according to the results of the diagnosis, the coefficients of its use by crops from soil and fertilizers.

On January 24 of this year the Government of the Russian Federation approved the bill on organic agriculture [12]. Its task is to provide legal mechanisms for the development of this segment of agricultural production.

In modern conditions of the industry development (a variety of agrochemicals, highly productive varieties that require an appropriate level of soil fertility), a competent farmer can not achieve high yields without a well-thought-out, scientifically-based fertilizer system for crops. After all, ecological, organic farming should focus on achieving a zero-deficiency balance of plant nutrients in the soil. We agree that the use of predominantly environmental factors reduces the costs of producing a unit of crop production, but as a result of the alienation of a large part of the crop, the process of reproduction of soil fertility is dying out, therefore it is impossible to provide plants with a sufficient number of food elements without applying fertilizers. And when switching to organic farming, we should not abandon mineral fertilizers, but orient the choice to a strict selection of the species allowed for use.

Given the importance of the issue, there is no doubt that attention should be paid to training specialists in this field. There are data that according to the results of the first stage of the questionnaire survey of Russian agrarian universities: from 41 to 39 universities consider organic agriculture to be promising for the Russian Federation. Therefore, we can expect a revision of training programs in special disciplines and count on the production of highly qualified specialists in this field.

The generalization of experimental data in the field of biologization, including our studies, convince us that, guided by the fundamental principles of constructing crop fertilization systems, fertilizers play a leading role in increasing the yield of crops and preserving soil fertility [13]. In this area the Stavropol State University has a number of scientific developments successfully implemented in crop production, for example, "Organo-mineral fertilizer based on bird droppings" [14].

A big problem is that a limited number of production facilities allowed by the certification bodies have been allowed to be used in organic crop production. Significant costs for state registration make many effective biopreparations inaccessible. This is one of the reasons why it is required to remove biological plant protection products from the list of pesticides and agrochemicals (they are not products with a registered hazard class) fixed by order of the Ministry of Agriculture No. 357 of 10.07.2007. A simplified system of state registration of such drugs should be organized, this will give the possibility of access and use by their producers of organic products.

Biological fertilizer systems in the conditions of modern requirements of the environment and the consumer market are of great importance. Without the biologization of crop fertilization systems, the transition to organic farming is impossible.

Speaking about biologization, along with manure in large volumes should be used sideral crops, straw in combination with N_{8-10} tons of smell, earth-dung, phosphogypsum-manure, limestone-manure composts; defecation mud; recycled household waste, vermpreparaty, bacterial fertilizers.

Composting of manure with phosphogypsum and limestone crumb is necessary, this method allows enriching it with nutrients, improves physical properties and alkaline-acid environment for the activity of microflora, enriches the mineral constituent of the soil. Dung-phosphogypsum compost has positive physical properties, which allows to achieve an even distribution over the surface. Studies on leached, typical and ordinary chernozems have confirmed the high efficiency of dung-phosphogypsum composts. The chemical composition of the composts described is also favorable for solonetsous soils [15].

Assessing the dignity of straw field crops, as an organic fertilizer, you should focus not only on the content of useful substances, but also on their ratio. Nitrogen of soil is most rationally used at a ratio of carbon to nitrogen as 20-30: 1, while the mineralization of organic matter is most vigorous. It is established that straw, buckwheat, oats and millet are of great value. The concentration of nitrogen in the straw of peas and buckwheat is 2 times higher than that of winter cereals [16, 17].

The dose of nitrogen fertilizers for straw depends on the structure, the nutritional regime of the soil, as well as on the timing, depth and type of plant residues. In practice, preference is given to ammonium nitrate, since the ammonium entering into its composition is better absorbed by soil microorganisms, and nitrate ions can be used by plants at the beginning of vegetation. To avoid the use of mineral nitrogen fertilizers, the stubble straw must be mixed with slurry, liquid or semi-liquid manure before embedding.

Compensation for the removal of nutrients from the soil at the present time is required for nitrogen 55-60%, for phosphorus 80-100%, for potassium 30-45%. Thus, agriculture urgently needs the use of phosphorus and nitrogen fertilizers in order to realize a sufficient saturation of the crop rotation in the proportion N: P: K = 1: 1.4: 0.15. Undoubtedly, the methods of applying fertilizers are important, the main ones should be local methods of fertilization and feeding, strictly based on soil and plant diagnostics. This makes it possible to reduce the consumption of fertilizers to 30%, since the nutrient utilization rates of fertilizers are increased by 15-20%.

To achieve high yields with satisfactory product quality in modern conditions, it is necessary to fulfill the concept of biologization, the principles of constructing fertilizer systems, respectively, focusing on the

latest scientific achievements in the field of selection of highly productive varieties, ecological fertilizers, innovative agricultural machinery.

CONCLUSIONS

Agrarian science faces the task of developing fertilizer systems based on the achievement of a positive balance and a cycle of substances in the soil, which allows us to maximally realize the bioclimatic potential (BCP) and the possibilities of varieties of agricultural plants without damage to the environment. It is the biology of fertilizer systems, based on the inclusion of rich local resources, with a significant land fund in Russia that meets the requirements, should be the main initial step in the transition to organic farming. This, in turn, will create conditions for the development of related areas - the expansion of biodiversity of agrocenoses, certification, the market for biological plant protection products and biofertilizers.

REFERENCES

[1] Ageev V.V., Esaulko A.N., Storozhenko A.Yu. Biologization of fertilizer systems - the way of harmonization of ecology in crop rotation / Proceedings of the International Forum on Science, Technology and Education (Moscow, 02-06 December 2002). - P. 126-127.

[2] Esaulko A.N., Ageev V.V., Grechishkina Yu.I. The biologized fertilizer system will increase environmental efficiency / Agrobusiness - Russia. Agribusiness: Economics, Equipment, Technologies, 2006, No. 1. - P. 64.

[3] Dorozhko G.R., Vlasova O.I., Tskhovrebov VS The development of agriculture in the Stavropol region / Evolution and degradation of the soil cover: Proceedings of the V International Scientific Conference (Stavropol, September 19-22, 2017). - Stavropol, LLC SEVOYA, 2017. - P. 249-251.

[4] Faizova V.I., Tskhovrebov V.S., Nikiforova A.M., Novikov A.A., Marin A.N. Influence of agricultural use of chernozems of Central Ciscaucasia on the abundance and diversity of micromycetes // Agrochemical bulletin, 2017. - No. 4.- P. 38-42.

[5] Esaulko A.N., Ageev V.V., Grechishkina Yu.I., Podkolzin OA Biologization of the fertilizer system in crop rotation / Agrochemical bulletin, 2005. - № 2. - P. 018-019.

[6] Esaulko A.N., Ageev V.V., Lobankova O.Yu., Gorbatko L.S., Korostylov S.A., Sigida M.S., Golosnoy E.V., Radchenko V.I., Belovolova A.A., Voskoboinikov A.V., Gromova N.V., Grechishkina Yu.I., Aisanov T.S., Ustimenko E.A., Fursova A.Yu., Sedykh E.A., Grinko A.P. ., Galda D.E. Biologization of fertilizer systems as a way to improve farming systems / Scientifically grounded farming systems: theory and practice: materials of the Scientific and Practical Conference timed to the 80th anniversary of V.M. Penchukova, Stavropol, 2013. - P. 87-89.

[7] Grechishkina Yu.I., Gorbatko L.S., Aisanov T.S., Fursova A.Yu., Belovolova A.A. Influence of winter wheat fertilizer systems and predecessors on agrochemical indicators of leached chernozem / Soil science - food and ecological security of the country: Abstracts of the Seventh Congress of Soil Scientists. V.V. Dokuchaev and All-Russian with the international participation of the scientific conference (Belgorod, August 15-22, 2016). Responsible editors: S.A. Shoba, I.Yu. Savin. - Belgorod: Publishing House "Belgorod", 2016. P. 148-149.

[8] Grechishkina Yu.I., Esaulko A.N., Sigida M.S., Gorbatko L.S., Ageev V.V., Lobankova O.Yu., Belovolova A.A., Korostylev S.A., Fursova A.Yu. Change in the acidity of the chernozem leached during the systematic application of fertilizers / Evolution and degradation of the soil cover: Collection of scientific articles on the materials of the IV International Scientific Conference (Stavropol, October 13-15, 2015). - Stavropol: AGRUS, 2015. P. 218-220.

[9] Ageev V.V., Mamaev S.A., Lobankova O.Yu., Aisanov T.S., Grechishkina Yu.I., Gorbatko L.S., Belovolova A.A. Influence of vertical zoning, time, anthropogenic activity on the dynamics of morphological features and morphometric parameters of chernozems. Morphology of chernozems modern / Modern problems of science and education, 2014, No. 6. - P. 1646.

[10] Ageev V.V., Esaulko A.N., Lobankova O.Yu., Radchenko V.I., Gorbatko L.S., Grechishkina Yu.I., Korostylov S.A., Sigida M.S., Fursova A.Yu., Ustimenko E.A., Voskoboinikov A.V., Gromova N.V., Golosnoy E.V., Belovolova A.A. Fundamentals of Programming Crops of Agricultural Crops: Textbook. - Stavropol: AGRUS, 2014. - 200 p.

[11] Esaulko A.N. Optimization of fertilizer systems in crop rotation of the Central Ciscaucasia as a factor of increasing soil fertility and productivity of agricultural crops: dissertation for the degree of Doctor of Agricultural Sciences / Stavropol State Agrarian University. - Stavropol, 2006. - 515 p.

[12] Official site of the Ministry of Agriculture of the Russian Federation [Electronic resource] - Access mode: http://mcx.ru/press-service/news/pravitelstvom-odobren-zakonoproekt-ob-organicheskom-selskom-khozyaystve/ - Date of review 29.01.2018.

[13] Ageev V.V., Lobankova O.Yu. To the discussion on humus / Proceedings of the 76th Scientific and Practical Conference "Modern Resource-Saving Innovative Technologies for Cultivating Agricultural Crops in the North Caucasus Federal District" (Stavropol, April 10-20, 2012). - Stavropol: Stavropol publishing house "Paragraph", 2012. - P. 31-37.

[14] Organo-mineral fertilizer / Marchenko V.I., Grebennik V.I., Bychikhin V.V., Ageev V.V., Lebedev A.T. // Patent for invention RUS 1675293 18.04.1988.

[15] Kalugin D.V., Tskhovrebov V.S. Influence of limestone-shell, apatite and phosphogypsum on the content of macroelements and sunflower yield on leached chernozem / Actual issues of ecology and nature management: Proceedings of the V International Scientific and Practical Conference (Stavropol, October 11-12, 2017). - Stavropol: SEKVOYA LLC, 2017. - P. 156-158.

[16] Ageev V.V. Biologization of fertilizer systems in crop rotations in the light of the history of Russian agriculture / Rational use of natural resources and the ecological state in modern Europe: Proceedings of the International Scientific and Practical Conference (Stavropol, May 18-24, 2009). - Stavropol, publishing house Paragraph, 2009. - P. 180-185.

[17] Ageev V.V., Demkin V.I. The role of root and stubble crop residues of grain-growing crop rotation in the accumulation of organic matter and elements of mineral nutrition of plants in soil // Agrochemistry, 1991. - No. 3. - P. 38.