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Investigation on Processing Phosphogypsum in Organic Fertilizer Based on Composting Cattle Manure

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ABSTRACT: In the course of the study, the composts based on cattle manure and phosphogypsum wastes, when the mass ratios of manure: phosphogypsum were obtained in the range of 100: 5, 100: 10, 100: 15, 100: 20, 100: 25 and 100: 30. The prepared composts were kept in for 90 days at 65-70% humidity, and samples were taken and analyzed every 15 days during the ripening period. During the analysis, organic matter, humic acid, fulvic acids, water-soluble organic matter, total P_2O_5, total SO_3, water SO_3, total CaO, acceptable CaO, aqueous CaO, loss of organic matter, loss of nitrogen and degree of humification of organic matter were determined. The results showed that with an increase in the mass of phosphogypsum relative to cattle manure, the amount of total P_2O_5, SO_3, CaO increased, and the loss of total nitrogen and organic matter decreased

KEYWORDS: cattle manure, compost, organic acids, phosphogypsum, ammonium humate, humic acids, ammonium sulfate, fulvic acids, calcium humate.

I. INTRODUCTION

Soil, as a living space for terrestrial organisms of the plant and animal world, serves as the main source of nutrition for plants, and through them both animals and humans receive the necessary substances to create their biomass. Due to its absorption capacity, the retention of mineral, organic substances, microorganisms is carried out and their washing with water or blowing by the wind is not allowed. In the soil, substances are converted from one form to another, available for plant nutrition. The soil performs sanitary functions, helps to cleanse water, air, the destruction of many harmful substances, and is a barrier to pathogens, viruses and other sources of infectious diseases. The lack or excess of certain chemicals and their compounds in the soil causes many specific diseases. The soil acts as a buffer and protects the land surface from overheating, waterlogging or drying. Due to such a property as fertility, soil acts as the main condition for the emergence and means of agricultural production. In this capacity, the following features characterize it: limited, irreplaceable, not movable. These features emphasize the need for an extremely careful attitude to soil resources and constant care for improving soil fertility [1].

The use of mineral fertilizers allowed mankind to make a big leap in providing the population with food by increasing crop yields. However, the use of mineral fertilizers alone has significant agronomic, economic, and environmental limitations, which increase with increasing doses. In soils, surface and ground waters, crop products are contaminated with compounds of nitrogen, phosphorus, potassium and related impurities, cadmium, uranium and other heavy metals are accumulated in the soil layer being treated, which are inevitable impurities of mineral fertilizers. In the arable layer, local excessive concentrations of salts arise, which exert a stressful effect on plants and other soil biota. Especially during droughts and in rainy periods there is a lack of nutrients, which negatively affects the size and quality of crops. Local excess concentrations of mineral fertilizers destroy agronomic valuable soil aggregates, negatively affect the humic complex and soil microbiocenoses. The solution to these problems can be found in the production and use of organic fertilizers, because on the one hand, they have the properties of mineral fertilizers, and on the other, they

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have the properties of organic fertilizers to reduce the negative effects of high concentrations of mineral salts in the soil solution, to improve the soil structure, composition and activity of soil microbiocenoses. Thus, the use of mineral fertilizers has brought mankind many profits and benefits, but at the same time global problems that predetermined the need to switch from mineral fertilizers to more advanced organic fertilizers containing a certain amount of humic substances in their composition [2]. Since the humus content is one of the main indicators of the level of soil fertility, due to this, the main functions are supported and soil fertility is ensured, and the mineralizing humic substances of the plant provide nitrogen and other necessary nutrients in an accessible form. Humic substances together with mineral particles of the soil form a soil absorbing complex, which determines its absorption capacity, enveloping and gluing together mineral particles of the soil, which contributes to the creation of a very valuable water-resistant lumpy-granular structure that improves the water throughput and water-holding capacity of soils, contributes to the fixation of nutrients in it for more rational consumption by plants [3-5].

It should be noted that the nutrients of mineral fertilizers, no matter how many they are brought into the soil, are not able to replace humus, as a source of nitrogen and other nutrients released during its mineralization. Organic soil substances contain up to 98% of soil nitrogen reserves, 60% phosphorus, 80% sulfur, all the main trace elements, physiologically active substances, serve as a source of carbon dioxide necessary for plant photosynthesis. It has been established that even with very high doses of nitrogen fertilizers, crop production by 50-60% is formed due to soil nitrogen and humus reserves, and almost completely on non-fertilized fields [6].

According to the content of this most important substance, the soils of Uzbekistan are classified as low-income. The irrigated land fund of Uzbekistan consists mainly of gray soils, gray-meadow, takyr-meadow soils and, to a lesser extent, gray-brown and desert sandy soils. The humus content in them is relatively low; in the arable layer its amount varies from 1.2-0.8 (in gray soils, takyr and meadow) to 0.8-0.55 (in gray-brown and desert sand), while in the same horizon of black soil the chestnut humus soils contains 4-2% [7]. The specific gravity of soils with a low humus content (in serozem - 0.8-1%) is almost 2/3 of the area, with an average (1-1.2%) - 1/3, and with a high (1.2-1, 5% of the soil weight) - only 7% of the sown area [8]. Humus reserves in the meter soil layer of Uzbekistan are as follows (t / ha): light gray earth 82.8; typical sierozem 78-79; typical bogar sierozem 59.5; dark sierozem 150.5; brown soil 318.6; meadow-bog soil 139.2 [9].

In the process of agricultural production by using land, part of the humus in the soil is gradually mineralized with the release of nitrogen and other nutrients, which transform into a form assimilable for plants. In this case, the loss of humus may be 0.6-0.7 t / ha per year. With high yields of grain crops, the soil annually loses 0.5-1.0 t / ha of humus, while cultivating row crops, the loss of humus increases to 1.5-3.0 t / ha. It was found that a decrease in humus content in the soil by 1% leads to a decrease in crop yields by about 5 centners of grain units per hectare [10.11].

One of the most actual tasks in agriculture is the problem of creating a positive balance of humus in the soil. The only way to achieve a high effect from growing crops is to obtain the optimum amount of humus in the soil. The role of organic and organic fertilizers is indispensable in the reproduction of humus.

The raw materials for obtaining highly effective organic fertilizers are: litter manure, without litter manure, bird droppings, peat, green fertilizer, straw, sapropel, household and industrial waste, and sewage sludge [12]. The cheapest source of organic substances for the reproduction of humus in agriculture is manure of cattle of livestock farms [13].

Manure, tested over the centuries, a practical soil modifier, one of the most valuable types of organic fertilizers. The introduction of manure on sod-podzolic soil at a dose of 30-80 t / ha increases the humus content in the arable layer by 18-64% of the original or by 17-33 t / ha.

The main value of manure as fertilizer is that it contains a lot of nitrogen and carbon material. Nitrogen contributes to the growth and development of plants, and this is a yield increase, which, as we know, is necessarily observed when manure is introduced. Carbon material makes up for or even grows the content of humus in the soil, thus laying fertility for the future. In addition, manure is especially valuable because it "works" for several years after it was laid in the soil. In addition to the enrichment of soils with nutrients, manure has a beneficial effect on the physical properties of soils, improves their structure. When compost is applied to the lungs - sandy and sandy loamy soils, their ability to absorb and retain moisture, as well as nutrients, increases. Heavy clay soils become looser, their “cohesion” decreases and air access increases. However, in order for manure to give a tangible effect, it is necessary to master the technology of its processing into high-quality organic fertilizers.

Livestock farming is one of the leading sectors of agriculture in Uzbekistan. Today, in Uzbekistan, the total number of cattle has reached 12.7 million heads, and poultry - 75 million. The mass of manure and bird droppings per day reaches 6-8% of the weight of the animal. In total, 110 thousand tons of manure and litter are formed every day. This means that over the year the total volume is more than 40 million tons.

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At present, cattle manure is partially composted with aging for several months and used in agriculture. In many farms, manure and poultry manure are stored, and the reclaimed organic waste is used as fertilizer. In this case, the humification process is incomplete, and pathogenic microorganisms are preserved. Organic waste from livestock and poultry is extremely necessary to process in an appropriate way, where the conditions are created for the conversion of organic substances into humic substances and allowing the conservation of nutrients in an accessible form for plants.

The main conditions that provide the normal composting process are: humidity, acidity, C / N ratio, density of the mixture, uniformity of mixing, ambient temperature, aeration, microbiological and biochemical factors [15], also, to obtain high-quality organic fertilizers based on waste livestock, balanced in terms of nutrients, with minimal loss of organic matter and nitrogen, as well as the intensification of the processes of humification, use various additives (ground phosphate rock, simple superphosphate, ammonium sulfate, ammonium nitrate, potassium chloride), industrial waste (phosphogypsum) and agroores (bentonite, glauconite, lime and others.).

Above-mentioned, a number of studies have been carried out on the production of organic fertilizers by composting cattle manure with the addition of substandard phosphorites of the Central Kyzyl Kum, and various mineral fertilizers and phosphogypsum have been added to regulate the pH and nutrient medium.As a result of the studies, it is proved that when mineralized mass, mineral fertilizers and phosphogypsum prepared on the basis of cattle manure are added to compost, on the one hand, it increases the assimilable form of P_2O_5 due to the interaction of humic acids, fulvic acids and water-soluble organic substances with mineralized mass, on the other hand due to the formation of Ca^{2+}, $H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-} ions in compost, the loss of nitrogen and organic substances is reduced. At the same time, the assimilable form of P_2O_5 phosphate raw materials increases by 6.5-7.0 times, losses of nitrogen and organic substances decrease by almost 2.5-3 times, and the degree of humification of organic substances increases by 2 times.

It should be noted that currently in Uzbekistan there are significant reserves of phosphogypsum, which continue to increase. In the process of activity of Ammofos-Maxam JSC more than 700 thousand tons are formed annually phosphogypsum. Over 65 million tons of phosphogypsum accumulated in the dumps. World practice of using phosphogypsum has shown that it is a highly effective and environmentally friendly method of chemical soil reclamation. The technological schemes used for the application of phosphogypsum on solonetzic soils contribute to their sunning and leaching, and the use on degraded soils and rice systems leads to an increase in the reserves of mobile forms of phosphorus. When 1 t / ha of phosphogypsum is added, neutralized as a complex component organomineral fertilizer, (kg) enters the soil: Ca-265, S-215, P_2O_5 -20, SiO_2-9.8 [21-23].

In [24], a decrease in soil salinity is given when a full calculated dose of phosphogypsum (10 t / ha) is introduced by 50%, an increase in calcium content, and good water resistance are achieved. Significant improvement in the physical properties of the soil under the influence of phosphogypsum was also noted: porosity increased from 47 (satisfactory) to 56% (excellent), the percentage of water-resistant aggregates increased from 30 to 50 (water resistance changed from satisfactory to good), the soil density decreased from 1.46 up to 1.16 t / m^3 (the soil from highly compacted turned into a compacted discharge). It provided an increase in crop yields by an average of 46%, including winter wheat - by 54%, fodder beets - by 31%, soybeans for grains - 52%. The high efficiency of fertilizer-reclaiming compost using phosphogypsumhas been proved – the next year after the application, the increase in potato yield was 10.6-11.8 t / ha; over six years, the increase in yield was on average 36-44 %.

The patent [25] provides a method for obtaining a complex organomineral fertilizer, characteristics of the initial substances, and agroecological efficiency of the resulting fertilizers. To obtain this fertilizer, vermicompost, sulfur-perlite-containing waste of sulfuric acid production, and natural clay bentonitewere used as feedstock. Vermicompost contains water-soluble forms of nitrogen (1.0-3.0%), phosphorus (1.0-2.8%), potassium (1.2-2.4%), magnesium (0.5-2.3%), calcium (4.0-6.0%), iron (0.5-2.5%), manganese (0.34-0.67%), copper (0.27-0.49%), zinc (0.07-0.16%), boron (0.01-0.03%), antibiotics, vitamins, enzymes and a large amount of humic substances (1.0-3.0%). Vermicompostis considered not only as a fertilizer but also as an ameliorant and soil improver. The sulfuric acid production waste contains: sulfur (10-20%), perlite (1.0-3.0%), gypsum (1.0-3.0%), hydrated lime (1.0-3.0%).Sulfur is one of the macroelements necessary for plants, it regulates redox processes in soils, and is a part of proteins, enzymes, amino acids. Perlite is a highly porous mineral of natural origin, a variety of the class of natural silicate rocks, which is widely used in agriculture as an ameliorant. The main components contained in perlite are silicon oxide (74.0-75.1%), alumina (7.8-8.3%), gypsum, and lime (in terms of calcium oxide 3.4-4.0%) iron oxide (0.7%). The action of perlite, when introduced into the soil system, is to improve the physicochemical properties of soils, namely, conditions are created for aeration, to increase the capacity of cation exchange, to eliminate crust formation. Bentonite is a fine clay, 60-70% composed of montmorillonite minerals, is also considered a treasure of natural trace elements. The main components are SiO_2 (54-61%); Al_2O_3 (4.4-5.5%); Fe_2O_3 (2.0-3.4 %%); $CaCO_3$ (13.3-13.8%); K_2O (0.8-1.4%); MgO (0.7-1.2%); N_2O (1-0.8%); P_2O_5 (0.08-0.10%). The presence of K, N, P, and trace elements (Mn, Ni, B, V, etc.)

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allows us to consider bentonite as a fertilizer that stimulates growth and reduces the number of diseases in plants. Bentonite clay can be used both as an ameliorant for soils and as a prolongator of mineral fertilizers. Bentonite clay also has a highsorption ability, therefore, when introduced into contaminated soil, it acts as a detoxifier, especially with heavy metals. To obtain organomineral fertilizer, vermicompost, sulfur-perlite-containing waste, and bentonite were mixed in the state of their initial technological humidity at their mass ratios, %, (35-45) (30-45) (20-25), respectively. When using this fertilizer, the average yield increase was 98.85. The quality indicators of yield products also improved, and the synthesis of valuable nutrients of starch and ascorbic acid intensified. The products are environmentally friendly with the content of heavy metals and other harmful substances.

It was shown in [26] that the inclusion of phosphogypsum in the rice fertilizer system positively affects the physicochemical properties of the soil and the dynamics of the content of mobile phosphorus in it. Replacing phosphorus fertilizer with neutralized phosphogypsum does not cause a decrease in yield when applied directly under rice and using its after-effects. Phosphogypsum is applied in an amount of 4 t / ha in combination with nitrogen and potassium fertilizer at the rate of $N_{18+55.2+46}K_{60}$. Its inclusion in the rice fertilizer system is economically viable. Each spent kilogram of the active substance of nitrogen-potassium fertilizer, applied in combination with phosphogypsum, pays off by 8.72 kg with a yield increase with direct action and 8.50 kg with its aftereffect.

The results of a study of the agroecological efficiency of using neutralized phosphogypsum as an ameliorant and as mineral calcium-phosphorus-sulfur fertilizer are presented in [27, 28], and the expediency and environmental safety of its use in corn and sunflower crops in the central zone of the Krasnodar territory are shown. The exclusion of phosphorus from the plant nutrition system against the background of nitrogen-potassium fertilizers and its compensation by introducing various doses of phosphogypsum equally with complete mineral fertilizer provided crops with available nutrients, had a beneficial effect on their physiological and biochemical processes, the accumulation of dry matter by plants, and further increased corn grain and sunflower seeds. Mineral fertilizers in the norm N_{40} P_{60} K_{40} increased the content of available phosphates by 11.3% or 13.0 mg/kg of soil, and in combination with neutralized phosphogypsum (N_{40} K_{40} + FG 4 t/ha and N_{40} K_{40} + FG 6 t/ha) – by 8.7 and 7.8% or 9.0 and 10.0 mg/kg of soil, respectively. The content of metabolic potassium was at a very high level - more than 200 mg/kg of soil. Its effect persists for the third year after application. The use of neutralized phosphogypsum in an amount of 4 t / ha makes it possible to obtain a corn crop after 3 years only by 1.12% less than when using the full mineral fertilizer N_{40} P_{60} K_{40}, and in sunflower crops, the difference in yield does not exceed the smallest significant difference between the options.

From the above data, it can be seen that the use of phosphogypsum in combination with mineral and organic fertilizers in agriculture as an ameliorant and as fertilizer is of great importance for increasing soil fertility. Therefore, we studied the processes of obtaining organomineral fertilizers based on cattle manure and phosphogypsum by composting.

II. SIGNIFICANCE OF THE SYSTEM

In the course of the study, the composts based on cattle manure and phosphogypsum wastes, when the mass ratios of manure.The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

To study the processes of obtaining organomineral fertilizers by composting, we used cattle manure with a composition (weight. %): humidity-72.46; ash-4.63; organic substances-22.91; humic acids-2.36; fulvic acids-2.59; water-soluble organic substances-2.21; insoluble organic substances-15.75; P_2O_5-0.22; N-0.45; K_2O-0.58; San-0.43 and phosphogypsum composition (wt.,%): P_2O_{5total} - 0.71 .; CaO_{total} - 33.46 .; $CaO_{assimilation}$ - 15.92 .; CaO_{aq} - 11.26 .; SO_{3total} - 47.98; SO_{3aq}.-13.93; SO_{3aq}:.. SO_{3total} = 29.03%.

Composts based on cattle manure with the addition of phosphogypsum were prepared at a weight ratio of Manure: phosphogypsum = 100: (5-30). The resulting mixture was placed in containers with a volume of 2.0 l. Water was added to the prepared mixture based on the calculation to achieve a moisture content of up to 60-70%. A thin layer of soil was poured on top of the mixture. Every 15 days, samples were taken and a chemical analysis of compost was performed. Chemical analysis of cattle manure, phosphogypsum, and compost was carried out using the methods described below. Humidity was determined according to GOST 26712-85, ash content according to GOST 26714-85 and organic matter according to GOST 27980-80. The amount of the water-soluble fraction of organic substances extracted from the products with water was determined by filtration and evaporation in a water bath, drying the solid residue to a constant weight, and then burning it to determine the ash content and subtract it. Humic acids were isolated

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by treating the products with 0.1 n solution of alkali followed by acidification of the solution with mineral acid [29]. The solid phase after separation of alkali-soluble organic substances from it contains residual organic matter. It was thoroughly washed with water, dried to a constant weight, and determined the content of organic substances. The difference between the amounts of alkali-soluble organic substances and humic acids gives us the content of fulvic acids.

All P_2O_5 forms were determined by the gravimetric method by precipitation of the phosphate ion with a magnesia mixture in the form of magnesium ammonium phosphate, followed by calcination of the precipitate at 1000-1050 ° C according to GOST 20851.2-75.

The determination of CaO content was carried out complexometrically: by titration with a 0.05 N solution of Trilon B in the presence of the fluorexone indicator, an assimilable form of CaO in solutions of 2% citric acid.

The total nitrogen content in the composts was determined by mineralization of the analyzed fertilizer when heated with concentrated sulfuric acid in the presence of hydrogen peroxide, a mixed catalyst in sulfuric acid, followed by distillation of ammonia into a solution of boric acid and titration with sulfuric acid according to GOST 26715-85, SO_3^{-2} content - ion by weight deposition in the form of barium sulfate [30-31].

IV. EXPERIMENTAL RESULTS

Tables 1 and 2 show the changes in the chemical composition of composts depending on the mass ratios of the starting components and the exposure time. It can be seen from it that with an increase in the duration of composting, the content of humic acids, fulvic acids, and water-soluble organic substances increases significantly. So, if the ratio of cattle manure: phosphogypsum = 100: 5 after 15 days in the compost, the content of humic acids, fulvic acids and water-soluble organic substances is 2.40%, 2.62%, 2.24%, after 30 days - 2.70 %, 2.92%, 2.53%, after 60 days - 3.53%, 3.82%, 3.28%, and after 90 days - 4.05%, 4.31%, 3.69% , respectively. With the mass fraction of phosphogypsum in composts, the loss of nitrogen and organic substances is significantly reduced. Without the addition of phosphogypsum, after 90 days, the loss of nitrogen and organic substances is 28.92% and 23.48%, and with a ratio of cattle manure: phosphogypsum = 100: 5 after 90 days, 21.86% and 18.25%, and with a ratio of 100: 30 after 90 days, 6.75% and 7.22%, i.e. the loss of nitrogen and organic matter due to the addition of phosphogypsum decreases 4.2 and 3.2 times, respectively (table 1 and 2.).Also, with an increase in the mass fraction of phosphogypsum in composts to a certain ratio, the degree of humification of organic substances increases, and the then decreases. If phosphogypsum without additives after 90 days the degree of humification of organic substances is of 54.44%, while the ratio of the cattle manure: phosphogypsum = 100: 5 after 90 days the degree of humification is 69,17% when the ratio of the cattle manure: phosphogypsum = 100: 10 after 90 days 64,63%, at a ratio of 100: 20 after 90 days 57,81% and at a ratio of 100: 30 after 90 days 52,11%. From these data, it can be seen that the preparation of compost based on cattle manure with the addition of phosphogypsum has a positive effect on all composting indicators. Besides, as the duration of composting increases, the water-soluble form of SO_3. increases, and the water-soluble form of Cao decreases. If the ratio of cattle manure: phosphogypsum = 100: 10 after 15 days in the compost, the relative content of SO_{3aq} and CaO_{aq} is 33.14% and 30.63%, after 30 days 38.93% and 27.94%, after 60 days-53.9 and 20.52%, and after 90 days – 62.41% and 16.40%, respectively. It is obvious that, in the process of composting cattle manure with the addition of phosphogypsum, a reaction occurs between organic acids and phosphogypsum with the formation of ammonium sulfate and calcium humate, which helps to reduce the loss of nitrogen and organic substances, as well as increase SO_{3aq} and decrease CaO_{aq} by reaction:

$$2R\,COOH + CaSO_4 + 2NH_3 = 2(R\,COO)_2Ca\downarrow + (NH_4)_2SO_4 \quad (1)$$

Table 1.The chemical composition of composts prepared based on cattle manure and phosphogypsum

The duration of composting days	The weight ratio of Cattle manure: FG						
	100: 0	100: 5	100: 10	100: 15	100: 20	100: 25	100: 30
Organic matter,%							
1	22.91	22.37	21.56	20.33	19.09	18.17	17.53
15	21.31	20.80	20.18	19.21	18.36	17.77	17.42
30	19.92	19.50	19.00	18.28	17.63	17.18	16,94

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45	18.70	18.34	17.93	17.37	16.84	16.47	16.28
60	17.62	17.35	17.02	16.61	16.21	15.96	15.82
75	16,66	16.44	16.17	15.87	15.56	15.36	15.27
90	15,80	15.62	15.39	15.14	14.89	14.73	14.66
	Humic acid%						
1	2,36	2,2	2,05	1,93	1,82	1,72	1,63
15	2,43	2,4	2,24	2,11	1,99	1,88	1,76
30	2,53	2,7	2,52	2,35	2,22	2,08	1,94
45	2,68	3,14	2,89	2,68	2,5	2,32	2,14
60	2,85	3,53	3,23	2,99	2,77	2,55	2,34
75	3,02	3,83	3,49	3,2	2,95	2,7	2,46
90	3,19	4,05	3,67	3,34	3,06	2,79	2,53
Fulvic acids,%							
1	2,59	2,41	2,25	2,11	1,99	1,88	1,79
15	2,66	2,62	2,45	2,3	2,16	2,04	1,93
30	2,78	2,92	2,74	2,56	2,39	2,25	2,13
45	2,93	3,42	3,16	2,93	2,71	2,52	2,36
60	3,1	3,82	3,52	3,26	3	2,77	2,57
75	3,26	4,12	3,79	3,49	3,18	2,93	2,7
90	3,42	4,31	3,94	3,61	3,28	3,01	2,76
Water-soluble organic substances,%							
1	2,21	2,06	1,92	1,8	1,7	1,61	1,52
15	2,28	2,24	2,09	1,96	1,84	1,74	1,64
30	2,38	2,53	2,36	2,21	2,06	1,93	1,81
45	2,51	2,94	2,72	2,52	2,34	2,17	2,01
60	2,65	3,28	3,01	2,78	2,57	2,37	2,2
75	2,81	3,52	3,21	2,94	2,72	2,49	2,31
90	2,94	3,69	3,34	3,04	2,81	2,56	2,36
P_2O_{5total} %							
1	0,21	0,23	0,24	0,26	0,269	0,28	0,289
15	0,214	0,235	0,245	0,265	0,274	0,286	0,295
30	0,221	0,242	0,252	0,273	0,283	0,294	0,303
45	0,227	0,249	0,259	0,281	0,291	0,303	0,312
60	0,233	0,256	0,267	0,289	0,299	0,311	0,321
75	0,242	0,265	0,276	0,299	0,31	0,322	0,332
90	0,252	0,276	0,288	0,312	0,323	0,336	0,347
SO_{3total}%							
1	0,11	2,33	4,27	5,96	7,47	8,8	10,02
15	0,11	2,38	4,35	6,08	7,62	8,98	10,22
30	0,12	2,45	4,48	6,26	7,84	9,24	10,51
45	0,12	2,52	4,61	6,44	8,07	9,5	10,81
60	0,12	2,59	4,74	6,62	8,29	9,77	11,12
75	0,13	2,68	4,91	6,85	8,59	10,12	11,51
90	0,13	2,8	5,12	7,15	8,96	10,56	12,01
CaO_{total} %							
1	0,43	1,96	3,28	4,45	5,48	6,4	7,22
15	0,44	2	3,35	4,54	5,59	6,53	7,36
30	0,45	2,06	3,44	4,67	5,75	6,72	7,58
45	0,46	2,12	3,54	4,8	5,92	6,91	7,8
60	0,48	2,18	3,64	4,94	6,08	7,1	8,01
75	0,49	2,25	3,77	5,12	6,3	7,36	8,3
90	0,52	2,35	3,94	5,34	6,58	7,68	8,66

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SO3 water,%							
1	-	0,65	1,21	1,7	2,14	2,53	2,89
15	-	0,79	1,44	1,99	2,43	2,83	3,15
30	-	0,97	1,75	2,35	2,81	3,21	3,52
45	-	1,25	2,16	2,84	3,29	3,65	3,91
60	-	1,51	2,56	3,32	3,78	4,11	4,33
75	-	1,75	2,91	3,73	4,18	4,5	4,67
90	-	1,94	3,2	4,06	4,51	4,82	4,96
	CaO SPM%						
1	0,14	0,87	1,5	2,06	2,56	3	3,39
15	0,15	0,99	1,66	2,24	2,75	3,21	3,6
30	0,16	1,13	1,87	2,51	3,03	3,51	3,91
45	0,18	1,33	2,15	2,84	3,37	3,86	4,23
60	0,2	1,53	2,44	3,17	3,72	4,21	4,57
75	0,21	1,7	2,69	3,47	4,03	4,53	4,86
90	0,23	1,85	2,92	3,73	4,31	4,81	5,14
Water CaO,%							
1	0,114	0,845	1,479	2,04	2,534	2,976	3,37
15	0,113	0,805	1,437	1,993	2,485	2,924	3,315
30	0,112	0,767	1,384	1,928	2,427	2,864	3,247
45	0,107	0,698	1,289	1,819	2,322	2,772	3,162
60	0,103	0,627	1,195	1,709	2,216	2,67	3,067
75	0,1	0,59	1,138	1,656	2,176	2,649	3,065
90	0,097	0,571	1,13	1,657	2,203	2,694	3,145
The loss of organic matter,%							
1	-	-	-	-	-	-	-
15	2,36	2,39	2,11	1,93	1,53	1,32	1,14
30	5,89	5,3	4,62	4,12	3,41	2,94	2,59
45	11,97	10,41	8,63	7,42	5,93	4,89	4,29
60	16,67	13,84	11,5	9,95	8	6,6	5,76
75	20,69	16,61	13,76	11,93	9,42	7,8	6,77
90	23,48	18,25	14,96	12,94	10,22	8,34	7,22
degree of humification organic Substances,%							
1	-	-	-	-	-	-	-
15	32,93	34,91	34,81	34,78	34,55	34,43	34,1
30	35,68	40,41	40,1	39,72	39,2	38,76	38,24
45	39,95	49,46	47,97	46,81	45,49	44,18	43,03
60	45,04	57,9	55,37	53,63	51,48	49,44	47,74
75	50,03	64,57	61,06	58,46	55,41	52,89	50,7
90	54,44	69,17	64,63	61,36	57,81	54,71	52,11
CaO aq. ./ CaO Society. *100, %							
1	26,52	43,12	45,08	45,85	46,25	46,5	46,68
15	25,91	40,29	42,95	43,92	44,47	44,79	45,02
30	24,76	37,28	40,17	41,26	42,17	42,62	42,84
45	23,08	32,95	36,4	37,85	39,24	40,1	40,56
60	21,55	28,8	32,8	34,59	36,43	37,59	38,27
75	20,17	26,16	30,17	32,36	34,52	35,99	36,92
90	18,87	24,28	28,7	31,03	33,5	35,08	36,3
SO_3obsh, / SO_3 water 100%							
1	-	27,76	28,38	28,59	28,70	28,77	28,81
15	-	33,17	33,14	32,81	31,95	31,48	30,82
30	-	39,83	38,93	37,59	35,84	34,69	33,45

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45	-	49,81	46,76	44,06	40,82	38,41	36,21
60	-	58,55	53,90	50,24	45,58	42,13	38,97
75	-	65,21	59,35	54,46	48,61	44,50	40,60
90	-	69,37	62,41	56,71	50,34	45,68	41,35

Thus, the results of the study showed that with an increase in the duration of composting, the content of humic acids, fulvic acids, and water-soluble organic substances increases. As a result of the interaction of organic acids with phosphogypsum, SO_3 changes from an insoluble form to a water-soluble one. With an increase in the share of phosphogypsum, the degree of humification of organic substances increases, and the loss of nitrogen and organic substances decreases.

Should be noted in [32] the conversion of gypsum to calcium hydrogen phosphate and ammonium sulfate was studied through ammonization of phosphoric acid-gypsum pulp (a semi product of the wet process of phosphoric acid production). The ammoniated pulp of pH in the range of 5.25 - 8.5 is mixed within 120 min at 60°C that is an optimal condition. The conversion of phosphogypsum is 99.61 %.. There is investigation to decrease waste phosphogypsum using mix of solution pohosphoric and sulfuric acids followed by decomposition phosphorite powder for deriving granular NPSCa-fertilizers [33]. The material balances in case of the acids mixtures based on the commercial way (SO_3 : P_2O_5 = 1.2; 1.65; 2.6) and an acid mixture : a phosphorite powder of 100 : 50 are estimated.

However, studying using cattle manure to conversion phosphogypsum is more promising in terms of environmentally friendly.

Table 2. Reducing the dependence on the ratio of nitrogen loss manureCattle: FG into compost after 90 days of incubation

The weight ratio of cattle manure: FG	100: 0	100: 5	100: 10	100: 15	100: 20	100: 25	100: 30
Nitrogen content in the compost,%	0.320	0.327	0,325	0,321	0.313	0,302	0.289
Nitrogen Loss,%	28.92	21.86	16.87	12.56	9.47	7.84	6.75

The choice of optimal ratios of the starting components and the duration of compost exposure were determined by determining the degree of humification of organic substances and the content of the water-soluble form of SO_3. Based on considerations of agrochemical efficiency of organomineral fertilizer, the optimal ratio of manure :phosphogypsum can be considered 100: 10, at which the relative content of the water-soluble form of SO_3 is 56.64%, and the degree of humification of organic substances is 57.32% (table 1). In this case, organomineral fertilizer has a composition (weight. %): P_2O_{5total}. - 0,288; organic substances - 16.94; humic acid - 3.67; phocids - 3.94; water-soluble organic substances - 3.34; CaO_{total}.- 3.94; $CaO_{assimilation}$.- 2.92; CaO_{aq}.- 0.646; SO_3total.- 5.12; SO_{3vod} - 3.20; commonly nitrogen.- 0.325.

V. CONCLUSION AND FUTURE WORK

Thus, by composting cattle manure with the addition of phosphogypsum, it is possible to obtain a high-quality organomineral fertilizer than composting one manure of cattle only. At the same time, a certain amount of phosphogypsum, due to interaction with humic acids, is converted to ammonium sulfate and calcium humate, which are a valuable fertilizer and ameliorant. When using them, of course, the humus content in the soil will increase, its structure will improve significantly, the utilization of nutrients will increase, and crop productivity and soil fertility will increase.

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