

PRODUCTION OF ORGANOMINERAL FERTILIZERS BASED ON LOCAL RAW MATERIALS AND NITROGEN FIXING MICROORGANISMS

ABSTRACT

In the article, local raw materials cattle manure (CM), Kyzylkum phosphorite flour (FF) and Navbahor bentonite (NB) and nitrogen organomineral based on binding microorganisms (NFM). the results of the research on getting fertilizers are presented. CM:NB:NFM=100.0:2.5:(0-4) and CM:NB:FF:NFM =100.0:5.0:2.5:(0-4) in obtaining new types of organomineral fertilizers ratios are used. Composting time is taken from 1 day to 60 days. The physico-chemical and product properties of the obtained new type of organomineral fertilizers were studied. The contents of organomineral fertilizer samples were analyzed by modern physico-chemical methods. Composting local ores (FF and NB) with cattle manure and processing the resulting mixture with a solution containing nitrogen-fixing microorganisms led to an increase in humic substances, a plant-available form of phosphorus and, most importantly, an increase in nutrient components. It was determined that the amount of nitrogen in the organomineral fertilizer obtained due to the biofixation of atmospheric molecular nitrogen is 3.2-4.1 times higher than in the case where NFM was not applied.

Key words: Kyzylkum phosphorite flour, Navbahor bentonite, cattle manure, nitrogen biofixation, humic substances, fulvic acids, composting, physicochemical properties, commodity properties, molecular nitrogen.

1.INTRODUCTION

Due to the rapid increase in the number of people in the world, providing them with sufficient food products is one of the important problems. In order to solve this problem, it is necessary to find ways to obtain high yields from agricultural crops. One of these ways is the extensive use of organomineral fertilizers (OMF). One of such organomineral fertilizers is organomineral fertilizers obtained through nitrogen-fixing microorganisms. By creating an optimal nutrient environment for nitrogen-fixing microorganisms, it is important to research in the direction of achieving the process of maximum nitrogen fixation in the air and creating a flexible technology for the production of OMFs enriched with various components.

The analysis of the studied literature and scientific articles shows that the employees of the Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan have studied various processes of obtaining OMF on the basis of lignite from the Angren mine. OMF with the following composition (wt., %) was obtained by oxidation of Angren lignite with nitric acid and subsequent decomposition of Central Kyzylkum (CK) phosphorites with nitric acid-coal slurry: $P_2O_{5total(t.)}$ - 9.41; $P_2O_{5acceptable}$ by citric acid (ac.c.a.) - 7.71; $P_2O_{5acceptable}$ by trilon B. (ac.trB) - 4.78; $CaO_{water\ solubility\ (w.s.)}$ - 11.27; N - 7.75; OM - 23.62 [1].

Processes for obtaining liquid and solid nitrogen-humic fertilizers by gradual oxidation of lignite are presented in [2].

In [3, 4], lignite is oxidized with nitric acid in the presence of phosphogypsum, and then the oxidized products are neutralized by ammonia, which contains 14.19% nitrogen, 20.70% humic acids (HA), 32.26% organic substances (OS), 5.38% water-soluble SO_3 and OMFs containing 2.31% water-soluble CaO were obtained. Currently, the degree of use of phosphorus fertilizers is on average 15-25%.

U.Sh.Temirov, A.M. Reymov and Sh.S.Namazov carried out scientific-research works on obtaining organomineral fertilizers based on phosphate waste, nitric acid, cattle manure and poultry waste [5-10].

In these works, several options for obtaining OMFs were developed: cattle manure and phosphorites; poultry waste and phosphorus; cattle manure, phosphorites, various mineral fertilizers, phosphogypsum and bentonite; on the basis of poultry waste, phosphorites, various

mineral fertilizers, phosphogypsum and bentonite. Experiments were conducted on the preparation of phosphorous fertilizers based on mineralized mass and cattle manure. In addition, options for obtaining OMF by composting phosphorites (FF) with a mixture of poultry waste recycled with nitric acid and activating phosphorites with nitric acid and then processing with poultry waste were studied. The economic efficiency of obtaining OMFs was calculated and agrochemical tests were carried out on cotton plants on ordinary gray soils. However, this scientific research work has not been applied to the industry. As can be seen from the above information, the creation of rational technologies for the production of OMFs based on low-grade phosphorites with high agro-ecological value and efficiency and on the basis of nitrogen-fixing microorganisms are urgent tasks.

In our previous work [11], obtaining organomineral fertilizers based on cattle manure, bentonite, phosphorite flour, $(\text{NH}_2)_2\text{CO}$, $(\text{NH}_4)_2\text{SO}_4$, KCl and nitrogen-fixing microorganisms and study of fertilizer production processes a number of experiments were conducted on this. Technical and economic indicators of obtained organomineral fertilizers are considered. Another series of experiments on the production of organomineral fertilizers were conducted. In these experiments, they are prepared on the basis of manure and phosphorite, in which the ratio of manure: phosphorite is selected from 100:5 to 100:30 [12].

2. METHODS AND MATERIALS

In order to quickly and easily achieve the intended goal in conducting scientific research and conducting experiments, first of all, it is necessary to know how to correctly choose the methods of analysis. In particular, when obtaining organomineral fertilizers based on local raw materials, it is advisable to use fast, modern and, of course, highly accurate analytical methods to determine various physical and chemical parameters of raw materials and finished products.

The main raw materials used in laboratory work for scientific research were cattle and poultry manure, phosphorite flour (FF) from Central Kyzylkum phosphate raw materials, and various bentonite samples [13]. The main chemical composition of these raw materials is presented in Table 1.

Table 1

The main chemical composition of cattle manure, phosphorite flour and bentonite

Raw materials are available	Humidity	OS	HA	FA	WSOS	WIS	P ₂ O ₅	N	K ₂ O	CaO	Others
Cattle manure	55.4	26.53	7.1	3.67	2.52	13,24	0.28	0.51	0.58	0.59	16.11
FF	P ₂ O ₅	CaO	Al ₂ O ₃	Fe ₂ O ₃	MgO	F	CO ₂	SO ₃	i.r.	$\frac{P_2O_5 \text{ tr.B.}}{P_2O_5 \text{ tot.}} \%$	CaO/P ₂ O ₅
	17.75	47.52	0.95	0.73	1.78	2.0	17.03	3.27	5.27	17.74	2.67
Navbahor bentonite	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	CaO	N	K ₂ O	P ₂ O ₅	SO ₂	Others
	57.9	0.35	13.69	5.10	1.84	0.48	1.53	1.75	0.43	0.75	16.17

Microorganisms of the type Azotobacter were used to fix molecular nitrogen from the air. In addition, urea, ammonium sulfate, and potassium chloride from mineral fertilizers produced at chemical enterprises of our country were used to obtain organomineral fertilizers with different nutrient components.

3. RESULTS AND DISCUSSION

The obtained results from our side were first studied the quantities of organomineral fertilizers based on cattle manure, bentonite and nitrogen-fixing microorganisms. Cattle manure, bentonite and nitrogen -fixing microorganisms of the type Azotobacter were used for laboratory research. For this, cattle manure:bentonite ratios were taken in the range of 100 : (2.5-10) and the

resulting mixture was treated with nitrogen-fixing microorganisms (NFM) grown in Fedorov medium in the ratio of 100 : (2.5-10):0.5-4.0 processed.

The obtained results are presented in table 2 . An increase in humic and fulvic acids, water-soluble organic substances (WSOS) is observed in the fertilizer samples obtained as a result of the processing of the mixture of FF and bentonite with NFMs. For example, in the mixture of organomineral fertilizers on the day of preparation, the amount of HA, fulvic acids (FA) and WSOS is 2.80% , 2.93% and 2.78% , respectively, and when NFM is processed with microorganisms, it is 2.73-2, respectively, depending on the change of proportions. 2.73-2.79%, 2.86-2.92% and 2.71-2.76%, but after 60 days this situation is 3.92-4.33 % , 4.10-4,53% and 3 equal to 3.89-4.29 % .

Table 2

Chemical composition of organomineral fertilizer samples obtained on the basis of cattle manure, bentonite and nitrogen-fixing microorganisms (CM:NB:NFM =100:2,5:(0-4))

Ratoi of FF:NB:NFM	P ₂ O _{5t} , %	CaO %	OS, %	HA, %	FA, %	WSOS, %	K ₂ O, %	N _t , %	Humidity, %
After 1 day									
100 : 2.5 : 0	0.243	0.555	20.79	2.80	2.93	2.78	0.546	0.350	66.20
100:2.5:0.5	0.242	0.552	20.70	2.79	2.92	2.77	0.544	0.349	66.34
100 : 2.5 : 1	0.241	0.550	20.61	2.78	2.91	2.75	0.542	0.347	66.48
100 : 2.5 : 2	0.239	0.545	20.44	2.76	2.88	2.73	0.537	0.345	66,76
100 : 2.5 : 4	0.237	0.541	20,27	2.73	2.86	2.71	0.533	0.342	67.04
After 60 days									
100 : 2.5 : 0	0.310	0.709	22,23	3.73	3.90	3.70	0.698	0.333	56,78
100:2.5: 0.5	0.314	0.717	22.61	3.92	4.10	3.89	0.706	1,083	56.30
100 : 2.5 : 1	0.317	0.725	23.03	4.12	4.31	4.08	0.714	1,220	55.81
100 : 2.5 : 2	0.319	0.729	23,31	4.22	4.42	4.18	0.718	1,310	55,56
100 : 2.5 : 4	0.321	0.733	23.65	4.33	4.53	4.29	0.722	1,442	55,31

It was also found to increase nitrogen content in manure samples recycled with NFMs. The nitrogen content of the fertilizer sample taken without treatment with NFM on the day of preparation is 0.35%, and after 60 days it is 0.33% in the same condition , that is, in this case, the total nitrogen content is slightly reduced, but with treatment with NFM on the day of preparation it is in the range of 0.342-0.349% depending on the change of CM:B:NFM ratios , and after 60 days it is 1.083-1.442%. It can be seen that the amount of nitrogen in the obtained fertilizer samples increases 3.17-4.13 times.

Given in table 3. As can be seen from the results of table 3, when the mixture made of phosphorite flour, cattle manure and bentonite is processed with nitrogen-fixing microorganisms (NFM), NFM has an effect on increasing the content of HA, FA and WSOS and nitrogen in the obtained organomineral fertilizers. For example, when CM:NB:FF:NFM ratio is 100:5:2.5:0.5, 0.576% P₂O₅ total in compost 1 day after preparation . and the amount of its relative acceptable form is equal to 22.72% , these values in the obtained compost (ready organomineral fertilizer) after 60 days are equal to 0.732 and 71.04% , respectively. in which not only P₂ O_{5t} increases, but also increases its relative acceptable form. HA, FA, WSOS, K₂O, and nitrogen in compost prepared in the same proportions are 2.57, respectively; 2.69; 2.55; will be equal to 0.558 and 0.408%.

Table 3

**The main chemical composition of organomineral fertilizers obtained on the basis of cattle manure, bentonite, phosphorite flour and nitrogen-fixing microorganisms
(CM:NB:FF:NFM =100:5:2,5:(0-4))**

Ratio of CM:B:FF:NFM	P ₂ O ₅ t, %	P ₂ O _{5ac.trB} amount (%)	CaO t, %	OS, %	HA, %	FA, %	WSOS , %	K ₂ O, %	N _t , %	Humidity, %
After 1 day										
100:5:2,5:0	0.576	22.44	1.54	19.53	2.58	2.70	2.56	0.561	0.410	62.21
100:5:2.5:0.5	0.574	22.72	1.53	19.46	2.57	2.69	2.55	0.558	0.408	62.36
100:5:2.5:1	0.571	23,28	1.53	19.38	2.56	2.68	2.54	0.556	0.406	62.51
100:5:2.5:2	0.567	23.59	1.52	19,23	2.54	2.66	2.52	0.552	0.403	62.81
100:5:2.5:4	0.562	24.03	1.50	19.07	2.52	2.64	2.50	0.547	0.400	63.10
After 60 days										
100:5:2,5:0	0.724	62.21	1.94	20.55	3.69	3.86	3.66	0.705	0.424	52.47
100:5:2.5:0.5	0.732	71.04	1.96	20.88	3.87	4.04	3.83	0.712	1,379	51.99
100:5:2.5:1	0.739	72.17	1.98	21.25	4.05	4.23	4.01	0.720	1,551	51.49
100:5:2.5:2	0.743	73.94	1.99	21.50	4.14	4.33	4.10	0.723	1,665	51.24
100:5:2.5:4	0.759	76.10	2.03	22.15	4.31	4.50	4.27	0.739	1,862	50,21

After 60 days, in the composition of organomineral fertilizers, the amounts of HA, FA, WSOS, K₂O and nitrogen are 3.87, respectively, in the composition of organomineral fertilizers obtained in the same ratio; 4.04; 3.83; will be equal to 0.712 and 1.379% . General patterns of this type are also observed in other ratios of CM:NB:FF:NFM. In addition, the following can be seen from the results of this table: with an increase in the amount of NFMs, the amount of the relative absorbable form of phosphorus increases, and the amount of nitrogen in the obtained organomineral fertilizers also increases. For example, when the ratio of CM:NB:FF:NFM is 100:5:2.5:0.5 and the value of the relative absorbable form of phosphorus in the compost obtained after 60 days is 71.04 % and the amount of nitrogen is 1.379% , When the ratio of CM:NB:FF:NFM is 100:5:2.5:4.0, it is equal to 76.10 and 1.862 % .

Physico-chemical and product properties of the obtained new type of organomineral fertilizers. It is known that physico-chemical (dispersibility, natural slope angle, etc.) and commodity properties (hygroscopic point, grain strength, etc.) are important properties of solid and powder fertilizers used in agriculture. Because these properties, especially commodity properties, determine the conditions of storage of fertilizers in warehouses, transportation in vehicles and direct application.

To study the hygroscopic points of this type of fertilizers, the samples of organomineral fertilizers listed in Table 4 below were used.

Organomineral fertilizer samples taken to determine hygroscopic points was as follows: 1 – 3.05%; 2 - 3.27%. The hygroscopic points of these samples were as follows: sample 1 – 81%, sample 2 – 78 %.

Table 4

Main chemical composition of organomineral fertilizers

Samples of fertilizes	Humidity, %	Chemical composition						
		P ₂ O _{5t.}	P ₂ O _{5ac.trB}	OS, %	CaO _{t.} , %	K ₂ O, %	N _{t.}	Hygros-copic point, %
Based on CM:NB:NFM	3.05	0.285	-	20.43	0.973	0.788	1, 70	81
Based on CM:NB:FF:N FM	3.27	1,246	73.17	22.75	3.34	0.759	1,913	78

As can be seen from these values, the obtained organomineral fertilizer samples correspond to the average atmospheric humidity, but during storage in the autumn-winter and winter-spring periods, when the relative humidity is very high, they absorb water, that is, they become wet. Therefore, it is recommended to store and transport them in polypropylene bags.

some physico-chemical properties (dispersibility, natural slope angle, etc.) of powdered organomineral fertilizer samples were determined. The dispersibility of organomineral fertilizers was determined using the Mering funnel. The experiments were carried out as follows: first, the outlet of this flask was checked for cleanliness and its suitability, that is, it was not damaged and not bent, then the flask was installed on three legs and its bottom hole was closed with a metal plate or cardboard paper while holding it by hand, and a sample of 100 g of organomineral fertilizer was drawn into the funnel. powder was added. After that, the covering metal plastic or cardboard paper was removed and at the same time the stopwatch was started. The stopwatch was stopped when the last powder fell from the funnel hole. The dispersion of fertilizer samples was calculated in points [14, 15].

Table 5

Some physicochemical indicators of new types of organomineral fertilizers

Fertilizer samples	H ₂ O, %	Pile weigh, g/cm ³	Density, g/cm ³	Streght of grains, mPa/ cm ²	Flowabi-lity, point	Natural slope angle, °	Fluidity, s
Based on CM:NB:NFM	3.05	0.612	0.84	1.73	7.9	40.4	42
Based on CM:NB:FF:NFM	3.27	0.615	0.94	1.85	8.1	42.1	45

The obtained results are presented in Table 5. The results showed that the dispersibility of the fertilizer samples was 7.9, respectively; equal to 8.1 points. This shows that the values have a good dispersion in the ten-point system. In addition, the natural slope angle of the free surface of the samples plays an important role in evaluating the mobility of fertilizer particles. The smaller the natural slope angle, the more mobile the powdery substance. The natural slope angles of the above organomineral fertilizer samples are 40.4° and 42.1°. This shows that the mobility of these samples is close to each other. Bulk weight of organomineral fertilizers, which characterizes their movement rates in storage warehouses and modes of spillage from bunkers and supply equipment. The purpose of determining the bulk weight is to calculate the dimensions of the hoppers, the efficiency of the transport and supply equipment, and to determine the pressure exerted on the opening and closing mechanism of the container and the walls of the dispersible substances. The bulk weight of these 2 organomineral fertilizer samples is 0.612 and 0.615 g/cm³, respectively, and fully meets the general requirements set by production plants [16]. In our subsequent works, the mineral composition of the above-obtained organomineral fertilizers was studied through elemental and X-ray phase studies [17; 18].

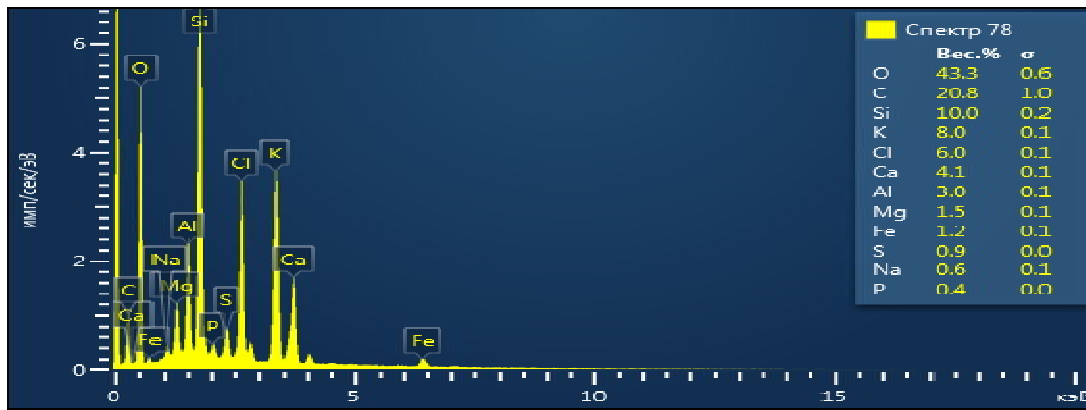


Figure 1. Elemental composition of the organomineral fertilizer sample obtained in the ratio CM:NB:NFM=100:2.5:4.

The obtained results are presented in Figures 1 and 2 (organomineral fertilizer obtained in the ratio of CM:NB:NFM=100:2.5:4). The results presented in Figure 1 fully confirm the results obtained in laboratory conditions. Figure 2 shows the X-ray analysis of this organomineral fertilizer, which shows the mineral content of the fertilizer.

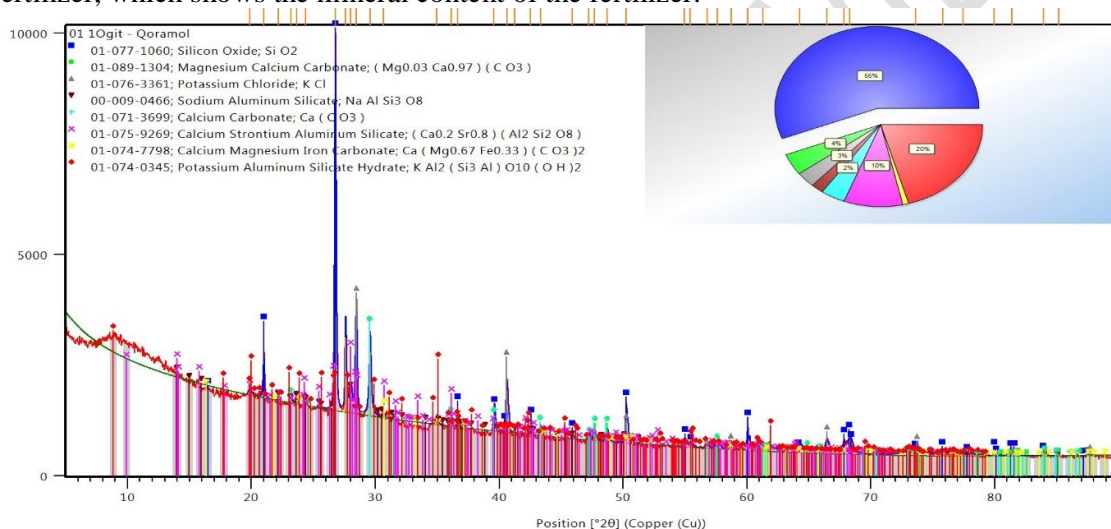


Figure 2. X-ray analysis of the inorganic part of the sample of organomineral fertilizer obtained in the ratio CM:NB:NFM =100:2.5:4.

As can be seen from these results, the inorganic part of the organomineral fertilizer sample obtained in the ratio CM:NB:NFM=100:2.5:4 contains 55% SiO₂, 4% dolomite, 3% potassium chloride, 2% sodium aluminum silicate, 20% potassium hydrosilicate, 10% calcium strontium silicate, 6% calcium carbonate and calcium magnesium iron carbonates are present. Figures 3 and 4 show the elemental composition and X-ray analysis of the organomineral fertilizer obtained in the ratio CM:NB:FF:NFM =100:5:2.5:4. The results presented in Figure 3 fully confirm the results obtained in laboratory conditions. Figure 4 shows the X-ray analysis of this organomineral fertilizer, which shows the mineral content of the fertilizer.

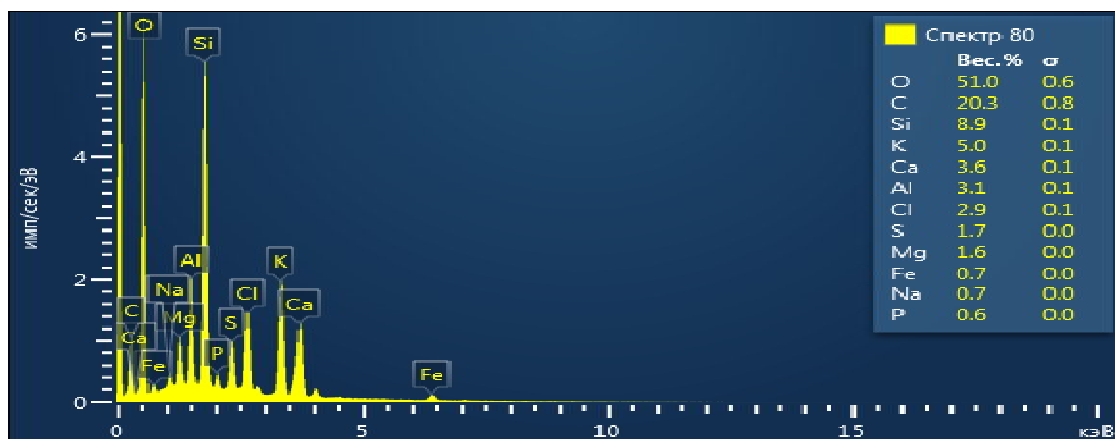


Figure 3. CM:NB:FF:NFM=100:5:2.5:4 elemental composition of the organomineral fertilizer sample taken in proportion.

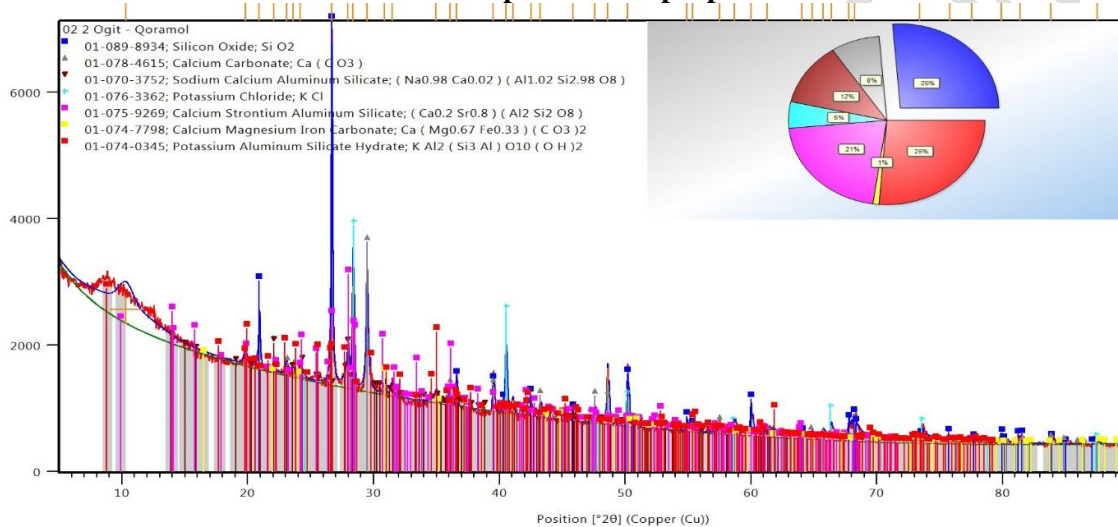


Figure 4. X-ray analysis of the inorganic part of the sample of organomineral fertilizer obtained in the ratio CM:NB:FF:NFM=100:5:2.5:4 .

As can be seen from these results, the inorganic part of the organomineral fertilizer sample taken in the ratio CM:NB:FF:NFM=100:5:2.5:4 contains 26% SiO₂ , 5% potassium chloride, 12% sodium calcium aluminum silicate, 26% potassium aluminum hydrosilicate, 21% contains calcium strontium aluminum silicate, 8% calcium carbonate and 1% calcium magnesium iron carbonates.

4. CONCLUSION

Laboratory experiments on the production of organomineral fertilizers based on nitrogen-fixing microorganisms, cattle manure and bentonite were carried out and their optimal ratios were determined: depending on the change of the CM:NB:NFM ratio , it is in the range of 0.342-0.349% , and in the case after 60 days it is 1.083-1.442%. It can be seen that the amount of nitrogen in the obtained fertilizer samples increases 3.17-4.13 times.

Processes of obtaining organomineral fertilizers based on nitrogen - fixing microorganisms, cattle manure, bentonite and phosphorite flour were studied. The optimal quantities of this type of organomineral fertilizers were determined: when the ratio of CM:NB:FF:NFM was 100:5:2.5:0.5 and after 60 days, the value of the relative absorbable form of phosphorus in the compost was 71.04%, and the amount of nitrogen was 1.379% is equal, the ratio of CM:NB:FF:NFM is 100:5:2.5:4.0, and it is 76.10 and 1.862%.

According to the results of the conducted research, some physico-chemical and commodity properties of 2 new types of organomineral fertilizer samples were studied. The

dispersion of organomineral fertilizer samples is equal to 7.9 and 8.1 points, respectively, and has good dispersion. The natural slope angles of the above organomineral fertilizer samples are 40.4° and 42.1° . The bulk weight of these 2 different organomineral fertilizer samples is 0.612 and 0.615 g/cm^3 , respectively, which fully meets the general requirements of production plants. The hygroscopic points of these samples were as follows: sample 1 – 81%, sample 2 – 78%. As can be seen from these values, the obtained samples of organomineral fertilizers correspond to average atmospheric humidity, but it is recommended to store and transport them in polypropylene bags during storage in the autumn-winter and winter-spring periods, when the relative humidity is very high.

The new type of organomineral fertilizer samples were analyzed using modern physico-chemical methods and their elemental and mineral contents were studied. CM:NB:NFM=100:2.5:4 ratio of organomineral fertilizer contains 55% SiO_2 , 4% dolomite, 3% potassium chloride, 2% sodium aluminum silicate, 20% potassium aluminum hydrosilicate, 10% calcium strontium silicate, 6% calcium carbonate and There are calcium magnesium iron carbonates. CM:NB:FF:NFM=100:5:2.5:4 ratio of organomineral fertilizer contains 26% SiO_2 , 5% potassium chloride, 12% sodium calcium aluminum silicate, 26% potassium aluminum hydrosilicate, 21% calcium strontium aluminum silicate, 8% calcium carbonate and contains 1% calcium magnesium iron carbonates.

REFERENCES:

1. Usanbaev N.H., Namazov Sh.S., Beglov B.M. Process flowsheet and optimal regime of phosphorus humus containing fertilizers production based on central Kyzylkum phosphorite and oxidized brown coal from Angren // *European Applied Sciences*. – 8, 2015, pp.53-57.
2. Usanbaev N.H., Namazov Sh.S., Beglov B.M. Technological scheme, optimal mode and material balance for obtaining liquid and solid nitrogen-humus fertilizers based on brown coal of the Angren deposit // *Uzbek chemical journal*, Tashkent, 2016, No. 1, pp. 63-71.
3. Zhumanova M.O., Usanbaev N.Kh., Namazov Sh.S., Beglov B.M. Organo-mineral sulfur-containing fertilizers based on oxidized brown coal and phosphogypsum // *Chemical industry*. - St. Petersburg, 2011. - v. 88. - No. 8. - pp.407-411.
4. Zhumanova M.O., Temirov U.Sh., Namazov Sh.S., Beglov B.M. Physico-chemical and commercial properties of organomineral sulfur-containing fertilizers based on oxidized brown coal and phosphogypsum // *Chemical Journal of Kazakhstan*, 2015, No. 3, - pp. 52-57.
5. Temirov U.Sh., Reimov A.M., Namazov Sh.S., Usanbaev N.Kh., Nomozov Sh.Yu. Obtaining phosphorus-containing organomineral fertilizers. // *Uzbek chemical journal*. - 2017. - No. 4. - P. 50-56.
6. Temirov U.Sh., Reymov A.M., Namazov Sh.S., Organ mineral fertilizer based on waste from livestock sector and low-grade Kyzylkum phosphorite // XIII international scientific and practical conference «International scientific review of the problems and prospects of modern science and education» Chicago. 21-22 April 2016. – № 5(15). – pp. 17-18.
7. Temirov U.Sh., Reimov A.M., Namazov Sh.S., Usanbaev N.Kh. Organo-mineral fertilizers based on cattle manure and sludge phosphorites of the Central Kyzylkum. // *Bulletin of Samarkand State University*. - 2016. - No. 6 - pp. 141-147.
8. Temirov U.Sh., Reimov A.M., Namazov Sh.S., Usanbaev N.Kh. Hummification of manure organic matter during composting with substandard phosphorites. // *Electronic scientific journal. Universum: Technical sciences*: - Novosibirsk, 2016. - No. 8 (29) - pp. 43-47.
9. Temirov U.Sh., Reimov A.M., Namazov Sh.S., Usanbaev N.Kh. Organo-mineral fertilizers based on chicken manure and slurry phosphorites of the Central Kyzylkum. // *Electronic scientific journal. Universum: Engineering sciences*: – Novosibirsk. - 2016. - No. 10 (31) - pp. 29-33.
10. U.Sh. Temirov, Sh.S. Namazov, N.H. Usanbaev, B.E. Sultonov, A.M. Reymov. Organic-mineral Fertilizer Based on Chicken Manure and Phosphorite from Central Kyzylkum // *Chemical Science International Journal*. Volume 24, Issue 3. USA. – 2018. – pp. 1-7.

11. Voqqosov Z.K. Obtaining organomineral fertilizers based on local agro-ores, mineral fertilizers, cattle manure and solutions of nitrogen-fixing microorganisms // Universum: technical sciences: electron. scientific magazine 2022.6(99). URL: <https://7universum.com/ru/tech/archive/item/13987-pp.44-49>.
12. X.M.Kanoatov, Z.K.Vokosov, A.A. Xodjiev, G.S.Alieva. Organic-Mineral Fertilizer Based On Manure. Nat. Volatiles & Essent. Oils, 2021; 8(5): 10631 – 10636 <https://www.nveo.org/index.php/journal/article/view/3008>.
13. X.M.Kanoatov, Z.K.Vokosov Analysis of physical-chemical and mineralogical indications of local agriculture (bentonite and phosphorite flour) in the production of organomeneral fertilizers // NamETI Scientific-technical journal. ISSN 2181-8622. 2022.-№2 Vol. 7, Issue 2 – pp. 109-113.
14. Kuvshinnikov I.M. Mineral fertilizers and salts. - M.: Publishing House of Chemistry. - 1987. - 256 p.
15. Voqqosov Z., Xoldarova G. Production of organic mineral fertilizers on the basis of local raw materials and nitroficating microorganisms. // NamETI Scientific-technical journal. ISSN 2181-8622. 2022-N1-pp. 84-87.
16. M.R. Shamuratova, B.E. Sultonov, Sh.S. Uzbek scientific, technical and industrial journal. Composite materials. - No. 1/2019. - pp. 76-79.
17. Mikheev V.I. X-ray determinant of minerals. In 2 volumes. - M., 1957. - v. 1. - 868 p.
18. Giller Y.L. Tables of interplanar distances. In 2 volumes - M.: Nedra, 1966. - 330 p.

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